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Market Assessment of Upcoming Planned Refinery Outages December 2008 – March 2009

December 2008

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

Preface and Contacts

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Summary

As required under Section 804 of the Energy Independence and Security Act of 2007 (Pub. L. 110-140), this report reviews the supply implications of planned refinery outages for December 2008 through March 2009, which covers the winter period when demand for distillate fuels (diesel and heating oil) is high. As a result, emphasis in this report is on distillate rather than gasoline. Refinery outages are the result of planned maintenance and unplanned outages. Maintenance is usually scheduled during the times when demand is lowest – in the first quarter and again in the fall. Unplanned outages, which occur for many reasons including mechanical failures, fires, and flooding, can occur at any time.

Distillate production is mainly affected by outages of a refinery's crude distillation unit, while gasoline production is more strongly correlated with fluid catalytic cracking (FCC) unit outages. While other refinery units can also impact distillate and gasoline production, they don't have as large an impact as the outages from crude distillation or FCC units, so other units are not covered in this report.

Market conditions going into the winter months are mixed. Crude prices have dropped considerably, bringing both gasoline and distillate prices down as well. Demand for gasoline and distillate fuels has been falling in 2008 compared with 2007, but distillate demand in PADD 1 (East Coast), which is where most U.S. heating oil demand is concentrated, may by driven up by colder weather expected in the first quarter of 2009. In addition, inventories of both gasoline and heating oil are low for this time of year. This is not as critical for gasoline, since demand falls off over the winter, but distillate inventories are used to help meet peak winter heating demand during December through February.

Crude distillation unit outage forecasts for the United States through March 2009 are fairly typical as shown in Table S-1. U.S. total FCC unit outages are also near typical levels. An issue has surfaced in PADD 1, however. This region is expecting a large FCC outage level in February as shown in Table S-2. While FCC units are major gasoline producing units, they also impact distillate production in two ways. First, the FCC unit produces some light cycle oil that contributes to the distillate fuel pool. Second, the crude distillation unit is frequently run at lower rates when the FCC unit is offline because there is no place to store or move the FCC feedstock coming from the crude distillation unit.

Fortunately, PADD 1 has a number of alternative supply options to replace the lost distillate production. Distillate imports into PADD 1 typically vary around 200-250 thousand barrels per day during the winter months, and can surge to 400 or 500 thousand barrels per day in a given month as the need arises. In addition, domestic production capacity outside of PADD 1 is expected to be in excess of demand requirements, as indicated by Figure S-1, which shows potential distillate production relative to production that was needed over the last several years.

Table S-1. U.S. Crude Distillation Unit Outages (Barrels Per Day)

Month	Planned	Estimated Unplanned	Estimated Total Outage Level	Typical Historical Total Outage Level
November Actual	331,461	27,000	358,461	500,000
December	156,055	210,000	366,055	370,000
January	501,931	150,000	651,931	660,000
February	818,264	210,000	1,028,264	1,000,000
March	863,899	220,000	1,083,899	1,100,000

Note: Unplanned values for December through March are historical average values for 2002-2007 excluding 2005 and 2006 to remove unusual hurricane impacts. Similarly, typical historical values are average planned outages 2002-2007 plus average unplanned outages 2002-2007 excluding 2005 and 2006 hurricane impacts.
Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database; excludes PADD 1 asphalt refineries.

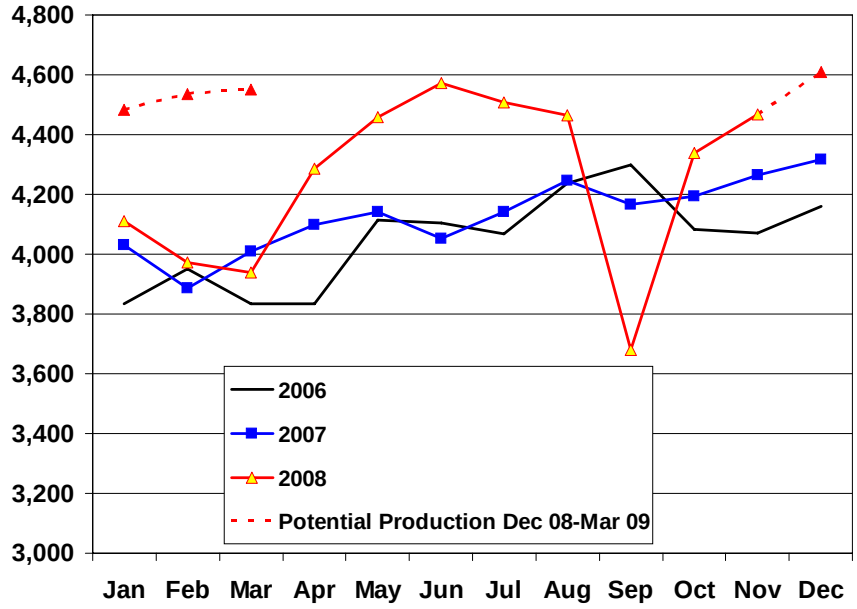
Table S-2. PADD 1 FCC Unit Outages (Barrels Per Day)

Month	Planned	Estimated Unplanned	Estimated Total Outage Level	Typical Historical Total Outage Level
November Actual	-	-	-	24,000
December	-	3,900	3,900	3,900
January	-	16,000	16,000	16,000
February	150,000	14,000	164,000	30,000
March	62,903	3,400	66,303	54,000

Note: Unplanned values for October through December are historical average values for 2002-2007 excluding 2005 and 2006 to remove unusual hurricane impacts. Similarly, typical historical values are average planned outages 2002-2007 plus average unplanned outages 2002-2007 excluding 2005.
Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database; excludes PADD 1 asphalt refineries.

In EIA's view, an effort to encourage greater coordination is unlikely to ameliorate the possible impacts of planned FCC outages in PADD 1 this winter. Another alternative, shifting the planned PADD 1 FCC outages to March or April would simply transfer the problem from a loss of distillate to a loss of gasoline. In February, the lost gasoline from the FCC unit is not as critical as it would be in March or April when gasoline production begins to pick up to prepare for summer demand. Perhaps the best preparation to minimize any price impacts of these outages would be for wholesale buyers who normally rely on opportunistic purchasing of supply in addition to their contracts to recognize the potential for fewer opportunistic purchasing opportunities in February, and to arrange for additional contracts. The publication of this report will help to alert this segment of the industry to that situation.

Figure S-1. U.S. Monthly Distillate Actual and Potential Production, 2006-2008 (Thousand Barrels Per Day)

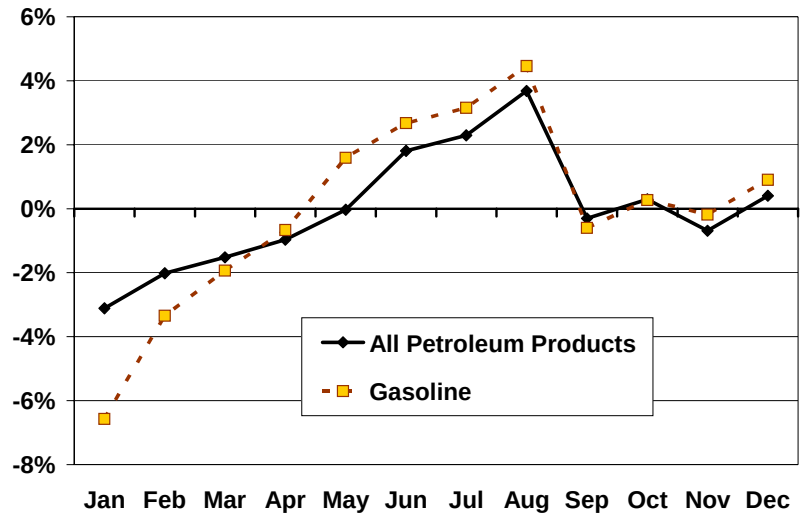


Source: Actual: 2006 – September 2008, EIA *Petroleum Supply Monthly*, and October-November EIA *Weekly Petroleum Status Report*; Potential – December 2008-March 2009 EIA estimates

1. Introduction

Refinery outages are the result of both planned maintenance and unplanned outages, the latter of which occur for many reasons, including mechanical failures, fires, and flooding.[1] Maintenance is usually scheduled during the times when demand is lowest – in the first quarter and again in the fall, as shown in Figure 1. Note that total petroleum demand is driven mainly by gasoline demand. Distillate demand moderates the petroleum demand dip in the winter, but because distillate demand is about half the size of gasoline demand, it does not change the seasonal demand variations substantially.

Figure 1. Seasonal Variation in Petroleum Demand (Average 2000-2004)



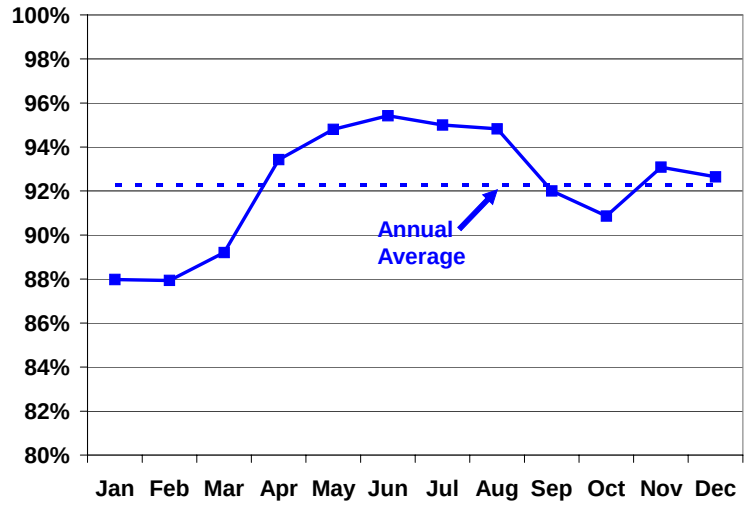
Note: 2000-2004 was used to remove impacts from major hurricanes and the recent economic downturn.
Source: EIA *Petroleum Supply Monthly*

Refinery utilization reflects both the discretionary crude oil throughput changes that follow demand, and maintenance and unplanned outages. While utilization generally follows the seasonal demand pattern, being lowest during the first quarter and dipping again in the fall (Figure 2), it does not distinguish between discretionary run decisions based on demand, and impacts due to outages.

[1] For more detail on refinery outages, see EIA, *Refinery Outages: Description and Potential Impact on Petroleum Product Prices*, March 2007, SR/OOG/2007-1. http://www.eia.doe.gov/oiaf/servicerpt/refinery_outages/SROOG200701.pdf.

Ultimately, the impact that outages have on production is what impacts prices. The impact that planned outages may have on product output is an estimated volume. Outages may involve a number of different units and associated refinery equipment which will affect product output differently. Even refiners analyzing their own facilities will not have a definitive production impact number, but will estimate the potential impact. For this report, EIA used statistical techniques based on historical data to produce aggregate outage impacts on production (Appendix A).

Figure 2. Seasonal Variation in Refinery Utilization (Average 2000-2004)



Note: 2000-2004 was used to remove impacts from major hurricanes and the recent economic downturn.
Source: EIA *Petroleum Supply Monthly*

Distillate production is mainly affected by outages of the crude distillation unit, while gasoline production is more strongly correlated with fluid catalytic cracking (FCC) unit outages.[2] As a result, this report focuses primarily on planned outages of crude distillation and FCC units. Planned outages for alkylation units, reformers, hydrotreaters (sulfur removing units), hydrocrackers, and coking units can also impact volumes, but these units have not had the size of impact on production of gasoline and distillate that the FCC and crude distillation units have had and are therefore not covered.

Crude distillation unit outages affect all product production, although refiners sometimes can use intermediate feedstocks to keep some downstream units such as the FCC units functioning. Conversely, if an FCC unit is offline, the crude oil distillation unit may have to be run at lower rates to slow production of the feedstock that goes to the FCC unit because a refinery may not be able to store or move that feedstock to another refinery.

[2] For more detail on refinery outages, see EIA, *Refinery Outages: Description and Potential Impact on Petroleum Product Prices*, March 2007, SR/OOG/2007-1, Chapter 2. http://www.eia.doe.gov/oiaf/servicerpt/refinery_outages/SROOG200701.pdf.

The remainder of this report reviews the projected December 2008 through March 2009 outage situation in a stepwise fashion. Chapter 2 begins with a review of the current market situation to provide the underlying setting for the outages. Chapter 3 looks specifically at projected outages and compares them with historical outages for that time of year. Chapter 4 looks at the outages in the context of projected demand, i.e., the need for capacity. Chapter 5 translates available refinery capacity after outages are removed into potential product output, focusing on distillate, since first quarter covers the high distillate heating oil season. This chapter provides a view of the potential distillate production cushion that may exist during the first quarter. The report concludes in Chapter 6 with a recommendation to the Secretary, as required under Section 804, as to the need for action to prevent significant price increases that might result from any usually high outage plans.

2. Recent Market Conditions and Outlook

The impact refinery outages may have on product prices depends both on the magnitude of the product output that is affected and on the market conditions in which the outages occur. For example, if demand is low relative to available supply and the outlook is for continuing weak demand, even larger-than-normal refinery outages may not have a significant impact on prices.

Both gasoline and distillate demand have declined in 2008 from 2007 levels as a result of high prices and a slowing economy, but distillate fuel demand in January through September 2008 declined on a percentage basis even more than gasoline due to warmer weather in the Northeast in 2008. This pattern is expected to continue through the first quarter 2009, with U.S. gasoline declining less than 2 percent and distillate demand down over 4 percent compared to first quarter 2008.

Distillate is the product of most interest this time of year since winter is the high heating oil demand season. Most U.S. heating oil demand is concentrated in PADD 1, mainly in the Mid-Atlantic and Northeast regions. PADD 1 presents a regional concern during the first quarter 2009. Unlike the total United States distillate outlook, normal weather projections in the Mid-Atlantic and New England areas are expected to boost heating oil demand (and also total distillate demand) over volumes consumed in first quarter 2008. Given the low current distillate inventories in PADD 1 and the potential for normally cold weather increasing 2009 first-quarter heating oil demand over that of 2008, the potential for price surges increases in the event of cold snaps.

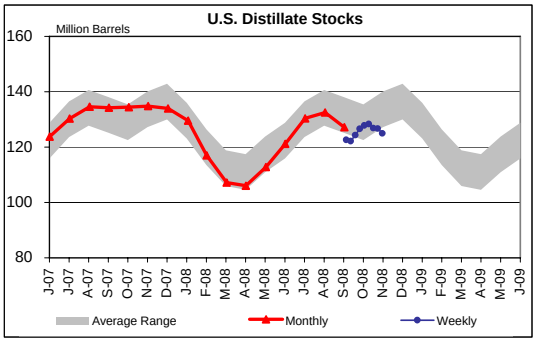
Distillate inventories, which are used to help meet peak winter demand in December through February, typically build through November. Distillate inventories at the end of November 2008, however, are below the typical levels for this time of year (Figure 3). More importantly, inventories in the East Coast (PADD 1), the region with most of the country's home heating oil demand, are below the typical range.

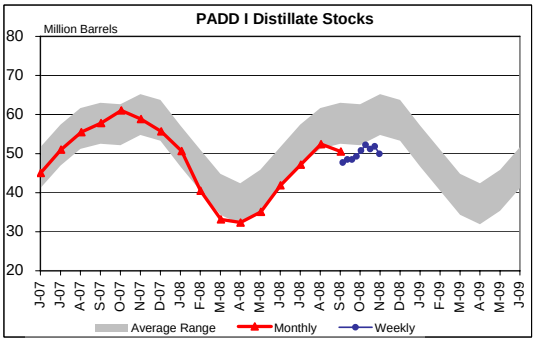
Historically, the largest risk of price surges in the winter comes from cold snaps in the Northeast, which can sharply increase demand in a short time period and also hinder resupply long enough to deplete inventories rapidly. Typically, imports from Europe (especially Russia) provide the largest volume response to the Northeast in these circumstances, and we would expect the same this winter, should a problem occur. While there is still time to build inventories further, entering the coldest winter months with low inventories increases the potential for cold-induced distillate price surges in the Northeast.

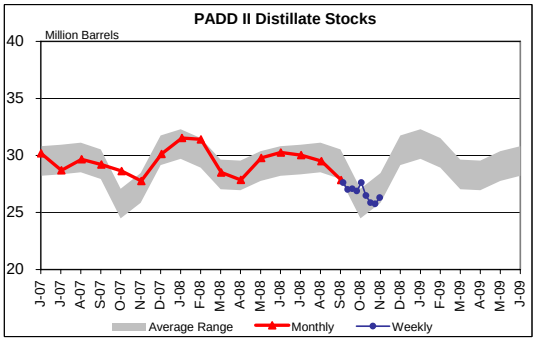
Gasoline inventories are also low (Figure 4). In the aftermath of the hurricanes, lack of electricity kept refineries from returning to normal operations for two to three weeks in most cases. With gasoline demand still having some seasonal strength, gasoline inventories dropped to extremely low levels as they were the only source of supply in

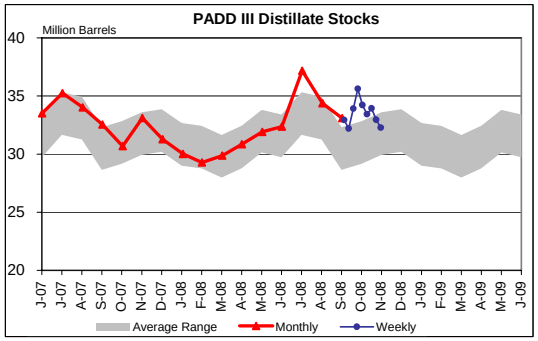
some areas. As refinery operations returned, inventories recovered, but remain in the low end of the typical range. At this time of year, however, gasoline markets are generally of less concern than distillate markets because gasoline demand is seasonally low, not picking up again until spring. In addition, gasoline demand has been weak, declining in 2008 from 2007 due to the slowing economy and high prices experienced for much of the year, and gasoline demand is projected to decline further in 2009. Increased use of ethanol in gasoline to meet the Energy Independence and Security Act mandate will further reduce the need for petroleum-based gasoline in 2009.

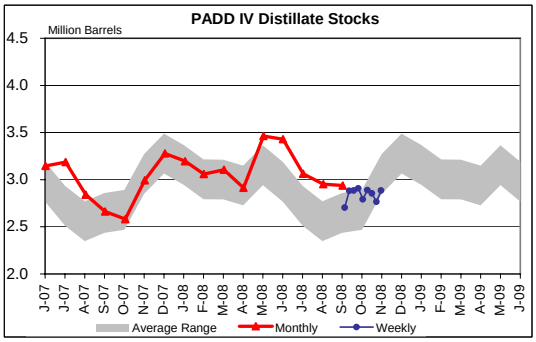
Figure 3. Stocks of Distillate by PADD, June 2007 – November 28, 2008

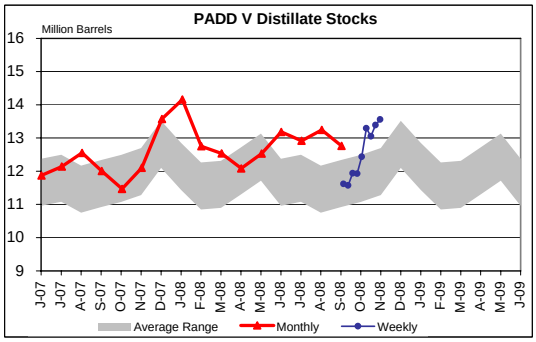






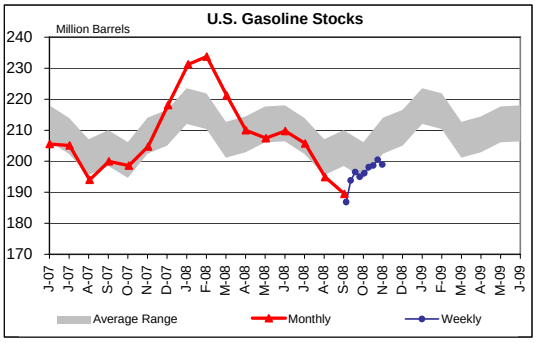


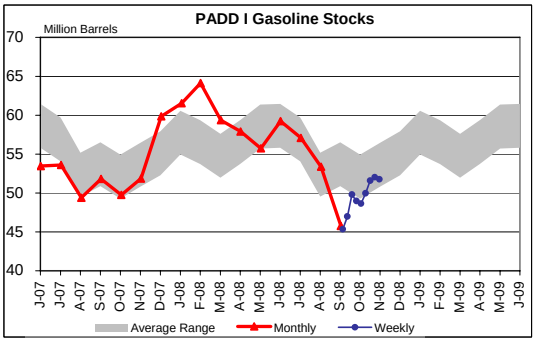


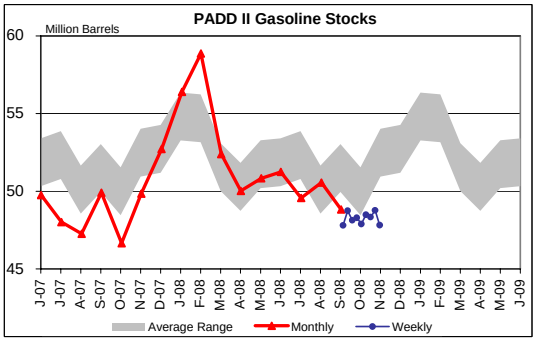


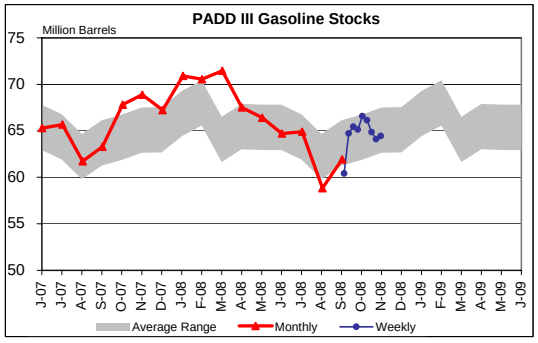
Source: *Weekly Petroleum Status Report*

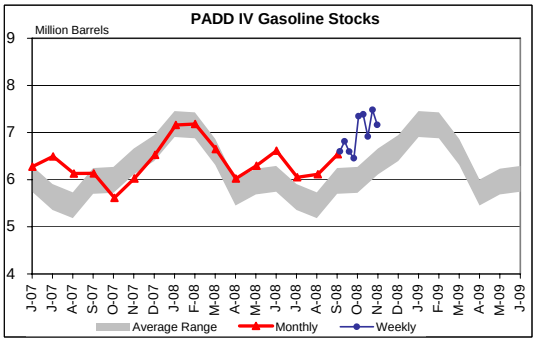
Figure 4. Stocks of Gasoline Distillate by PADD, June 2007 – November 28, 2008

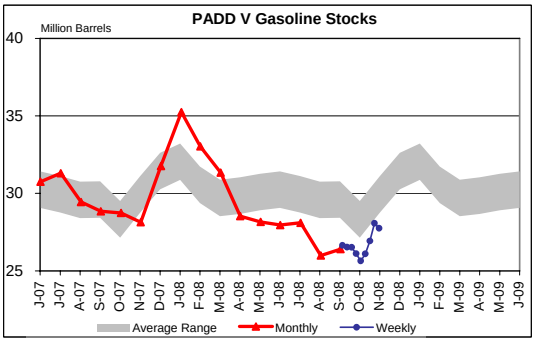












Source: *Weekly Petroleum Status Report*

3. Capacity Outage Review

This chapter looks specifically at projected outages for December 2008 through first quarter 2009 and compares them with historical outage patterns. The chapter describes past planned and unplanned outages for both crude distillation units and FCC units, which are the units that have the most impact on distillate and gasoline production respectively. This review concludes with a potential concern in PADD 1. These outages will be compared against projected demand in the next chapter to asses their impact on the market.

3.1 Data

EIA does not collect outage data directly. However, commercial data are available with enough detail to analyze potential impacts of planned outages on supply and thus price. The main commercial data source used in this report is a database assembled by Industrial Info Resources (IIR), a firm that provides market intelligence in a range of areas, including planned and unplanned refinery outages. Since outages are likely to be the primary cause of any substantial drops in inputs to refinery units, EIA compared total IIR outages (planned and unplanned) to the unit input data collected on Form EIA-810. The historical IIR data compared very favorably to EIA data collection of input variations. EIA has not been able to determine the accuracy of the planned outage data in advance of actual outages, since that analysis would require monitoring these data for some time. In addition to IIR planned outage data, EIA gathers planned outage information from trade press and other public sources to compare with IIR.

For this report, the asphalt-producing refineries in PADD 1 were excluded from the analysis since they produce little distillate and no gasoline. In addition, they are frequently shut down during part of first quarter, and therefore can bias the first quarter assessment of distillate availability.

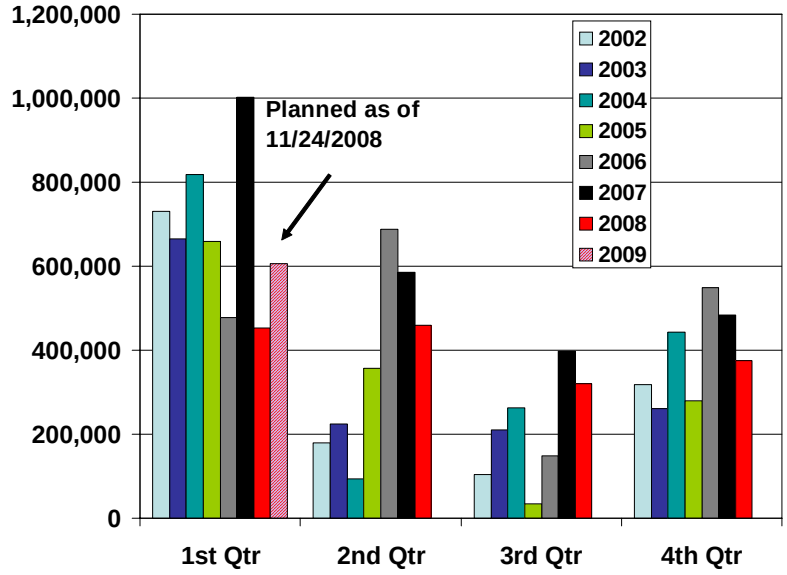
3.2 Crude Distillation Unit Outages

While crude distillation unit outages impact production of all products, these outages have a particularly strong correlation with distillate production. This section looks at both planned and unplanned outages for crude distillation units.

Planned Crude Distillation Unit Outages

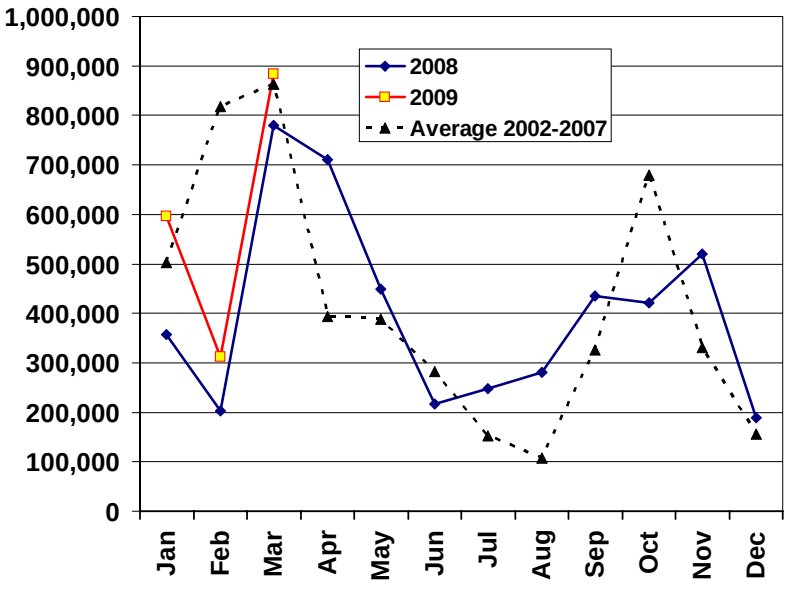
The quarterly outages shown in Figure 5 indicate that for the United States in total, planned outages for the first quarter 2009 are relatively typical. Figure 6 shows planned U.S. outages by month, since quarterly averages can mask a potential high-outage month that could impact prices. As shown, no unusually high-outage months are projected for the first quarter 2009.

Figure 5. Quarterly U.S. Planned Crude Distillation Unit Outages, 2002-2009 (Barrels per Day)



Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database, excludes PADD 1 asphalt refineries.

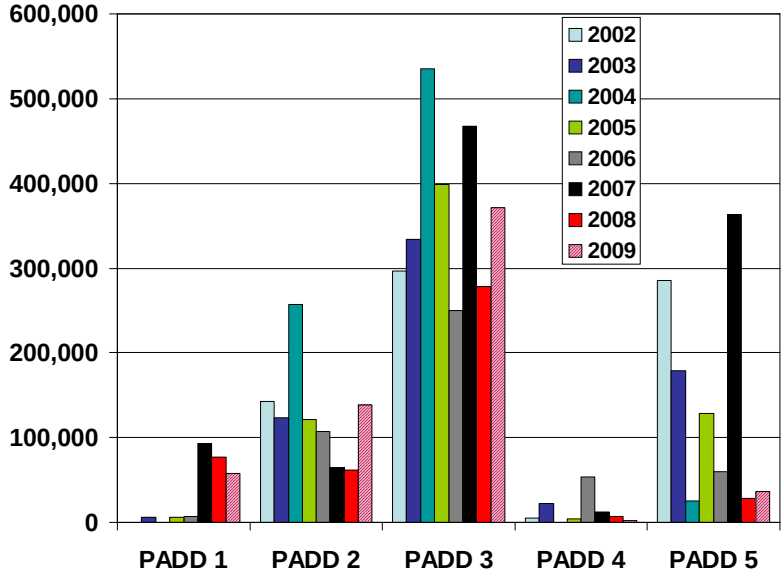
Figure 6. Monthly U.S. Planned Crude Distillation Unit Outages, 2002-2009 (Barrels per Day)



Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database; excludes PADD 1 asphalt refineries.

Regional planned outages for the first quarter over time are summarized in Figure 7 using Petroleum Administration for Defense Districts, or PADDs. While no PADD has an unusually high outage planned, PADDs 1, 2, and 3 are somewhat above average. They are explored in more detail below in conjunction with unplanned outages.

Figure 7. First Quarter Regional Planned Crude Distillation Unit Outages, 2002-2009 (Barrels per Day)



Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database; excludes PADD 1 asphalt refineries.

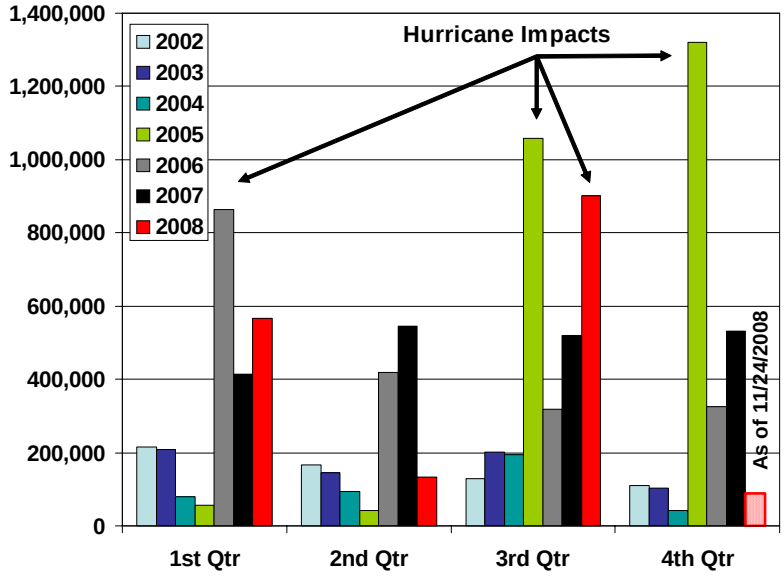
Unplanned Crude Distillation Unit Outages

In addition to planned outages, unplanned outages also occur. Unplanned outages in PADD 3 added substantial loss of capacity at the end of 2005 and into 2006, mainly as a result of refinery damages from Hurricanes Rita and Katrina and a large BP Texas City refinery accident in 2005 (Figure 8). But 2007 experienced large unplanned capacity outages as well. While unplanned outages many times are of short duration, such as when a loss of electricity causes a shutdown, they can be long term if significant equipment damage occurs. Four refineries in PADD 3 experiencing extended unplanned outages accounted for almost 40% of total distillation unit outages during the twelve months from April 2007 through March 2008. The unplanned outages for these refineries varied from just over 100 days to more than 900 days.

All four of these refineries are back in service, and, prior to Hurricanes Gustav and Ike, refinery capacity offline from unplanned outages returned to levels seen prior to the 2005 BP Texas City refinery outage. Based on average historical unplanned outages since

2002, excluding the 2005 hurricane impacts, we might expect U.S. unplanned outages of about 200 thousand barrels per day during the first quarter of 2009.

Figure 8. U.S. Unplanned Crude Distillation Unit Outages, 2002-2008 (Barrels per Day)



Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database; excludes PADD 1 asphalt refineries

Total Planned and Unplanned Crude Distillation Unit Outage Assessment

Actual total U.S. crude distillation unit refinery outages for November and expected outages for December 2008 through March 2009 are summarized in Table 1. Total outage levels for December through March represent planned outages added to typical unplanned outages (excluding the effects of hurricanes). For the total U.S., anticipated crude distillation unit outages are less than typical for December through March.

Returning to total outages at the regional level, PADD 1 (Figure 9) shows a projected outage level in December that, while not large in absolute, is large for December. Given the low inventory situation in PADD 1 at the end of November, this could interfere with inventory rebuilding, although PADD 1 has access to additional supply from imports and PADD 3. Figure 9 also shows a large outage level in March, past the peak heating oil season. This outage will be of more interest in preparation for the gasoline driving season, which EIA will revisit in several months. Table 2 highlights the PADD 1 outages by month compared to typical levels, illustrating the magnitude of the December and March outages relative to typical levels for that time of year.

Table 1. U.S. Crude Distillation Unit Outages (Barrels Per Day)

Month	Planned	Estimated Unplanned	Estimated Total Outage Level	Typical Historical Total Outage Level
November Actual	331,461	27,000	358,461	500,000
December	156,055	210,000	366,055	370,000
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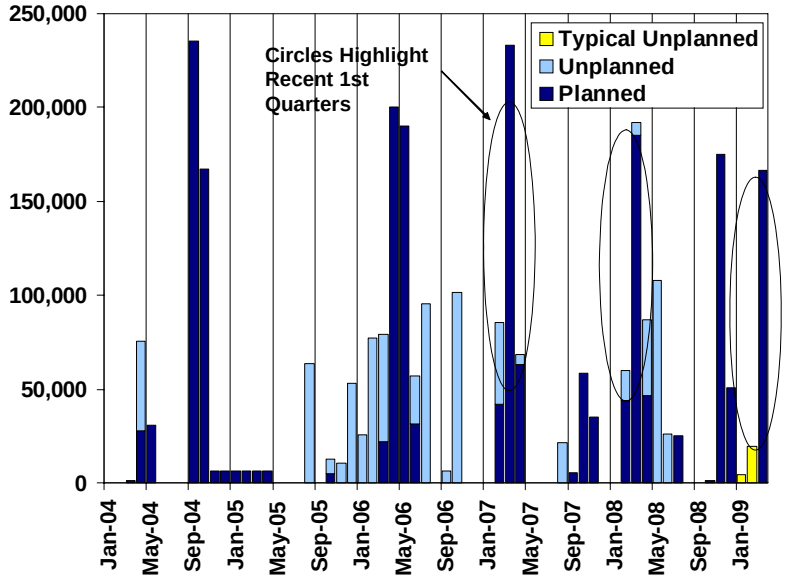
Note: Unplanned values for December through March are historical average values for 2002-2007 excluding 2005 and 2006 to remove unusual hurricane impacts. Similarly, typical historical values are average planned outages 2002-2007 plus average unplanned outages 2002-2007 excluding 2005 and 2006 hurricane impacts.
Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database; excludes PADD 1 asphalt refineries.

Figure 9. PADD 1 Total Crude Distillation Unit Outages. 2004-2009 (Barrels per Day)



Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database; excluding PADD 1 asphalt refineries.

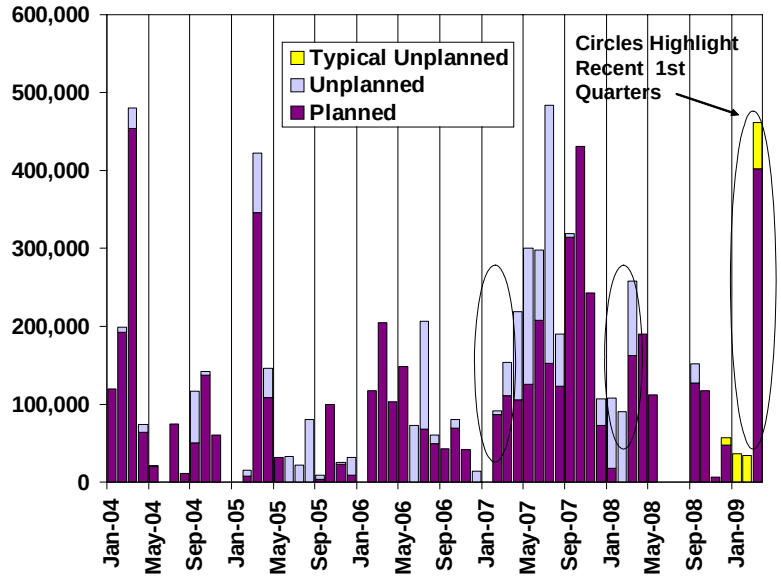
Table 2. PADD 1 Crude Distillation Unit Outages (Barrels Per Day)

Month	Planned	Estimated Unplanned	Estimated Total Outage Level	Typical Historical Total Outage Level
November Actual	175,000	0	175,000	34,000
December	50,806	0	50,806	1,100
January	0	4,500	4,500	5,500
February	0	20,000	20,000	28,000
March	166,452	0	166,452	47,000

Note: Unplanned values for December 2008 through March 2009 are historical average values for 2002-2007 excluding 2005 and 2006 to remove unusual hurricane impacts. Similarly, typical historical values are average planned outages 2002-2007 plus average unplanned outages 2002-2007 excluding 2005 and 2006 hurricane impacts.
Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database; excludes PADD 1 asphalt refineries.

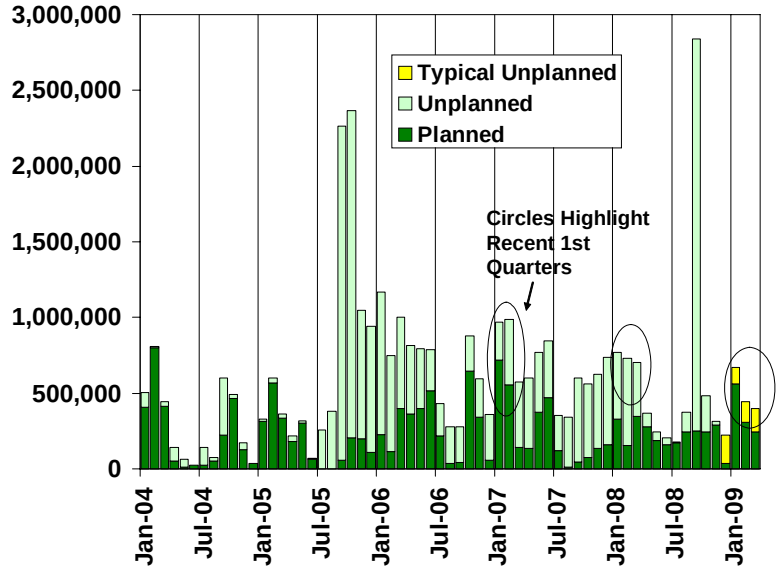
PADD 2 crude distillation unit outages (Figure 10) are small until March, indicating little impact on the winter heating oil market. Furthermore, PADD 2's heating oil market is small, and the region's distillate demand peaks in the fall with harvest season rather than during the cold winter months. PADD 3 does not show any issues at this time. While planned outages in PADD 3 were somewhat higher than average, we expect unplanned outages to be much smaller than seen in the past several years as mentioned at the beginning of the previous section. The net result is that potential total outages for PADD 3 are not expected to be an issue (Figure 11).

Figure 10. PADD 2 Total Crude Distillation Unit Outages, 2004-2009 (Barrels per Day)



Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database

Figure 11. PADD 3 Total Crude Distillation Unit Outages, 2004-2009 (Barrels per Day)



Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database

EIA has also been watching the outages being planned at the end of the distribution chain in the upper Midwest. These areas sometimes experience supply problems as a result of limited supply alternatives. Last year, the primary refineries supplying the Magellan Pipeline, which moves product from the Gulf Coast and lower Midwest into the upper Midwest, had unusually high outages, and refineries directly supplying North Dakota also experienced high late summer and fall outages that affected both diesel and gasoline supplies and prices. Outages this past fall have been significantly lower than in 2007, however, and expected outages December 2008 through March 2009 do not look problematic for the distillate market.

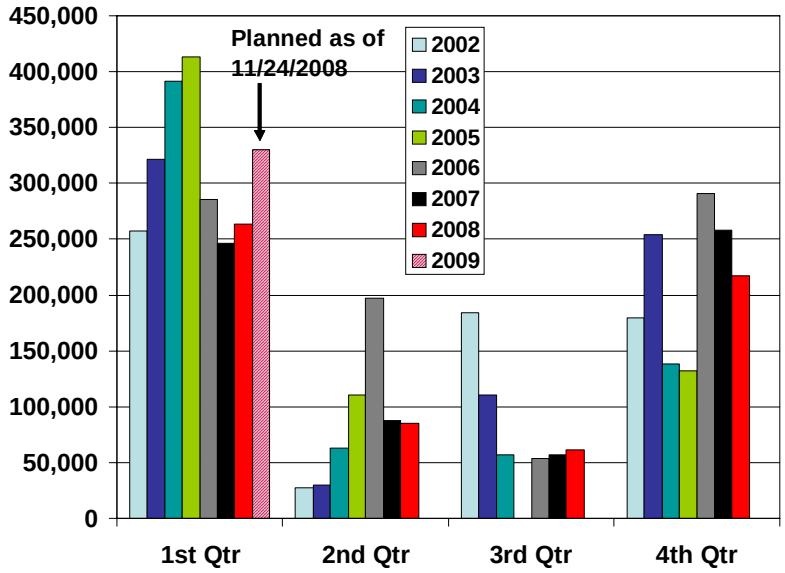
3.3 FCC Unit Outages

FCC unit outages usually have a significant impact on gasoline production, although they can affect crude throughput as well. The large volume of material that goes from the crude unit to the FCC unit may be too much to store while an FCC unit is down. If a refinery does not have a means of moving that FCC feed volume to another facility, the refinery may have to pull back on its crude runs to reduce the generation of FCC feedstock.

Planned FCC Unit Outages

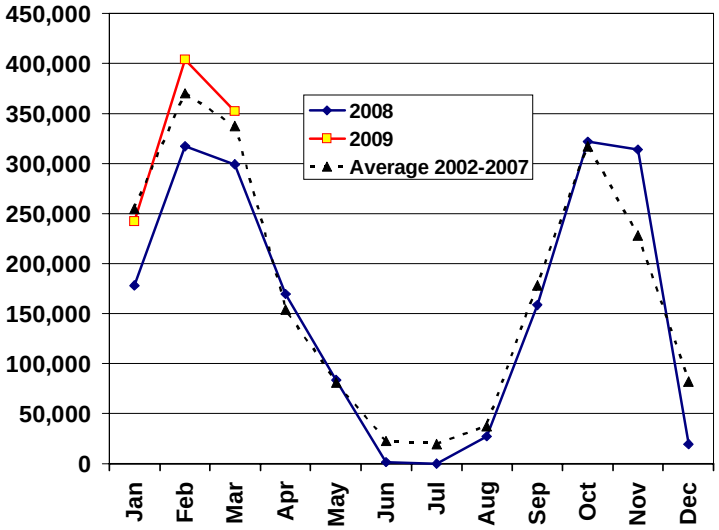
Figures 12 and 13 show that the U.S. planned FCC outage outlook for first quarter 2009 is above average.

Figure 12. Quarterly U.S. Planned Fluid Catalytic Cracking Unit Outages, 2002-2009 (Barrels per Day)



Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database

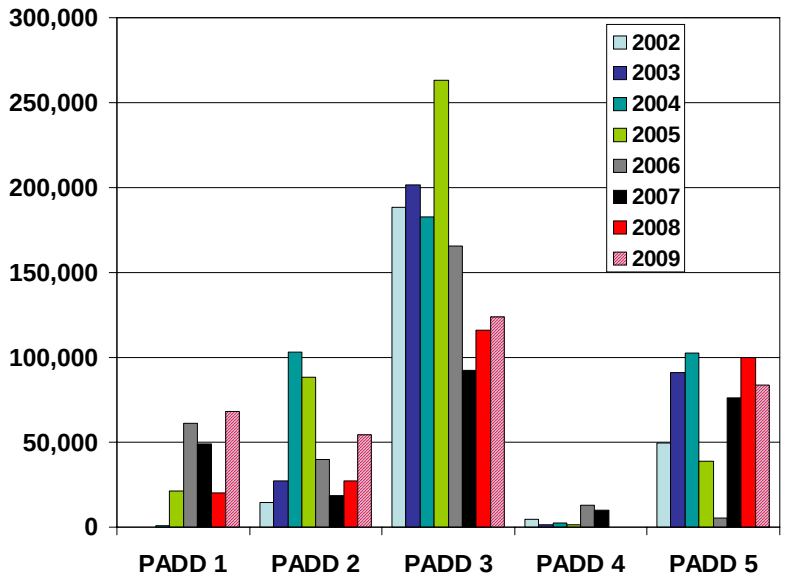
Figure 13. Monthly U.S. Planned FCC Unit Outages, 2002-2009 (Barrels per Day)



Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database

Figure 14 shows that, while the highest volume of outages occurs in PADDs 3 and 5, PADD 1 has higher-than-usual outages for first quarter. Gasoline production lost from the FCC unit at this time of year is not a concern. The issue is to what extent the outage may cause crude inputs, and thus distillate production, to be reduced.

Figure 14. First Quarter Planned Fluid Catalytic Cracking Unit Outages by PADD, 2002-2009 (Barrels per Day)

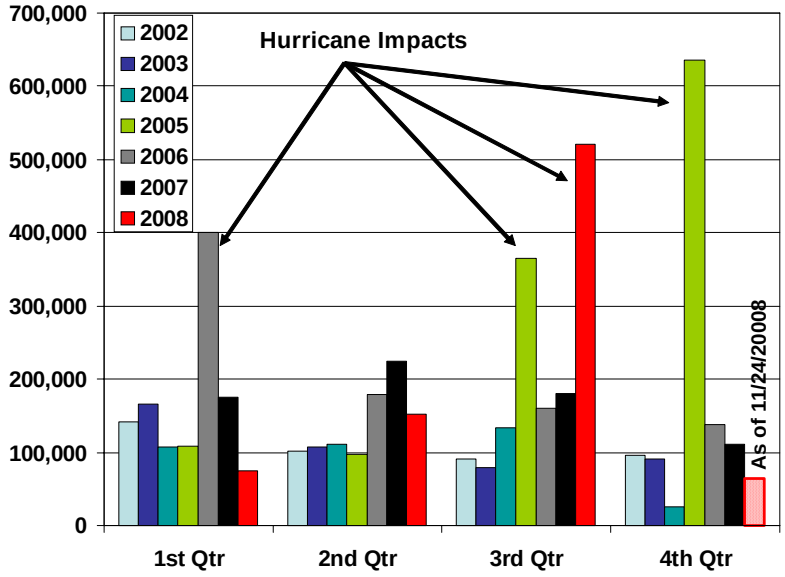


Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database

Unplanned FCC Unit Outages

As with the crude distillation capacity, unplanned FCC outages at the end of 2005 and into winter 2006 were higher than usual as a result of the damages inflicted by Hurricanes Rita and Katrina in fall of 2005 (Figure 15). For first quarter 2009, we expect unplanned outages of about 140 thousand barrels per day, based on average historical unplanned outages excluding hurricane effects.

Figure 15. U.S. Unplanned FCC Unit Outages, 2002-2008 (Barrels per Day)



Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database

Total Planned and Unplanned FCC Unit Outage Assessment

Projected planned plus estimated FCC outages for the United States, summarized in Table 3, are above typical historical outage levels in February and March.

Table 3. U.S. FCC Unit Outages (Barrels Per Day)

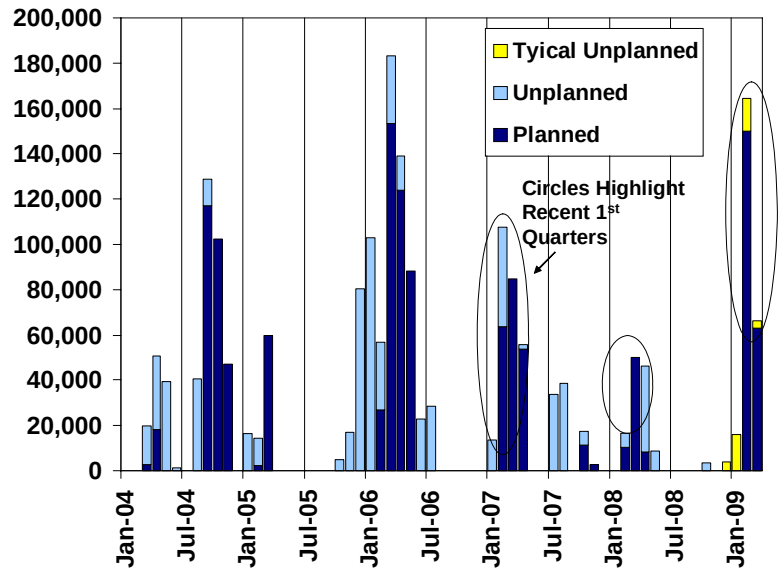
Month	Planned	Estimated Unplanned	Estimated Total Outage Level	Typical Historical Total Outage Level
November Actual	314,267	25,823	340,090	320,000
December	19,839	82,923	102,761	160,000
January	242,048	146,210	388,258	400,000
February	404,054	129,270	533,324	500,000
March	352,581	143,273	495,854	480,000

Note: Unplanned values for December through December are historical average values for 2002-2007 excluding 2005 and 2006 to remove unusual hurricane impacts. Similarly, typical historical values are average planned outages 2002-2007 plus average unplanned outages 2002-2007 excluding 2005 and 2006.
Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database; excludes PADD 1 asphalt refineries.

Figure 16 displays PADD 1 monthly historical planned and unplanned outages, and highlights the large planned outages for first quarter 2009. Table 4 shows the monthly capacity comparisons between projected and typical outage levels. February 2009 is

projected to be much higher than typical, with the outages extending into March, although only slightly above the usual March levels. Given the current low inventory situation, the FCC outages projected for February could create some supply pressure on that regional distillate market.

Figure 16. PADD 1 Total FCC Unit Outages, 2004-2009 (Barrels per Day)



Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database; excludes PADD 1 asphalt refineries.

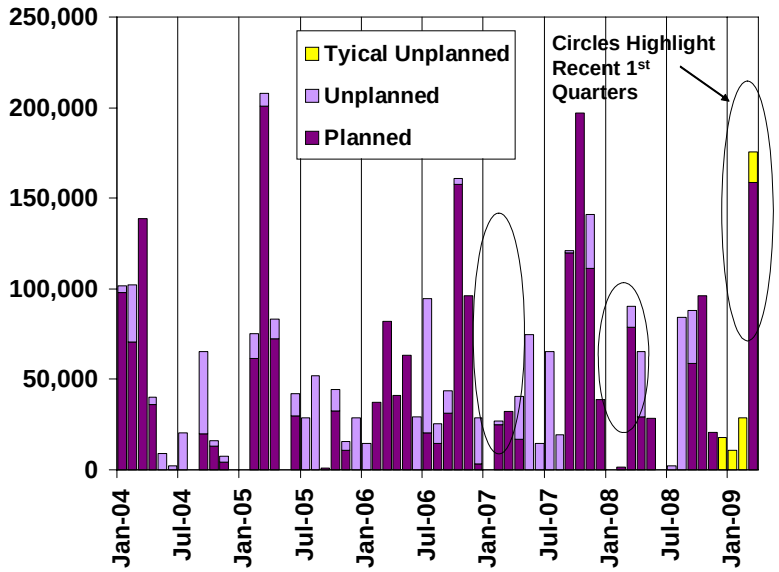
Table 4. PADD 1 FCC Unit Outages (Barrels Per Day)

Month	Planned	Estimated Unplanned	Estimated Total Outage Level	Typical Historical Total Outage Level
November Actual	-	-	-	24,000
December	-	3,900	3,900	3,900
January	-	16,000	16,000	16,000
February	150,000	14,000	164,000	30,000
March	62,903	3,400	66,303	54,000

Note: Unplanned values for October through December are historical average values for 2002-2007 excluding 2005 and 2006 to remove unusual hurricane impacts. Similarly, typical historical values are average planned outages 2002-2007 plus average unplanned outages 2002-2007 excluding 2005.
Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database;excludes PADD 1 asphalt refineries.

PADD 2 FCC outages shown in Figure 17 don't rise until March, which should not be a major issue for the heating oil season.

Figure 17. PADD 2 Total FCC Unit Outages, 2004-2009 (Barrels per Day)



Source: Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database

4. Adequacy of Available Capacity after Outage Considerations

This chapter compares the expected refinery outages summarized in the prior chapter to the projected need for capacity to meet demand December 2008 through March 2009. The EIA Short Term Energy Outlook (STEO) is used as the benchmark to estimate the need for capacity. The previous chapter indicated that, based on typical historical outage patterns, PADD 1 might present a supply issue at the end of the current winter heating oil season. While total U.S. distillate demand is projected to be weak during the first quarter 2009, PADD 1 distillate demand may not be as weak as a result of normally colder weather increasing heating oil demand from 2008, when the Northeast experienced warmer-than-normal weather. The combination of higher regional demand and outages may combine to tighten PADD 1 markets at the end of the 2008-2009 heating season, which this chapter further explores.

4.1 Adequacy of Crude Distillation Unit Capacity

Table 5 compares the EIA Short Term Energy Outlook projection of refinery crude inputs needed to meet total U.S. petroleum demand with an estimate of potential inputs that could be run in available capacity after outages (i.e., total capacity minus capacity lost to outages). As the last column shows, available crude distillation capacity exceeds that needed to meet demand in all months.

Table 5. Comparison of Maximum U.S. Crude Inputs from Crude Distillation Capacity Available After Outages with STEO-Projected Crude Input Needs (Thousand Barrels Per Day)

	Actual and Projected STEO Crude Inputs	Operable Distillation Capacity	Estimated Total Distillation Outages	Distillation Capacity Net of Outages	Potential Crude Inputs (Net Capacity * 0.952)	Potential Crude Inputs minus STEO Inputs
November Actual	14,573	17,470	358	17,112	NA	NA
December	14,575	17,470	366	17,104	16283	1708
January	14,146	17,470	652	16,818	16011	1865
February	13,968	17,470	1,028	16,442	15653	1685
March	14,059	17,470	1,084	16,386	15600	1541

Note: November crude inputs are based on weekly data through November 21. December through March data are STEO-projected crude inputs. The potential crude inputs are estimated by applying a factor (0.952) that represents the average observed difference between crude input volumes and capacity in the U.S. for facilities experiencing no major outages.
Sources: November 2008 Short Term Energy Outlook, Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database; excludes PADD 1 asphalt refineries.

Although U.S. crude distillation unit outages are not expected to interfere with meeting demand, regional outages can create local supply problems. As discussed earlier, PADD

1 outages are expected to be high in December and March. Table 6 looks at the need for PADD 1 crude distillation capacity to meet STEO-projected requirements. Even with the large crude distillation outages, available distillation capacity should be able to meet projected requirements.

Table 6. Comparison of PADD 1 Maximum Crude Inputs from Capacity Available After Outages with STEO-Projected Crude Input Needs (Thousand Barrels Per Day)

	Actual and Projected STEO Crude Inputs	Operable Distillation Capacity	Estimated Total Distillation Outages	Distillation Capacity Net of Outages	Potential Crude Inputs (Net Capacity* 0.952)	Potential Crude Inputs Minus STEO Inputs
November Actual	1,269	1,582	175	1,407	NA	NA
December	1,428	1,582	51	1,531	1,458	29
January	1,415	1,582	5	1,578	1,502	87
February	1,369	1,582	20	1,562	1,487	118
March	1,336	1,582	166	1,416	1,348	12

Note: November PADD 1 crude inputs are based on weekly data available through November 21. December through March values are STEO-projected crude inputs times PADD 1's monthly historical average share of U.S. crude inputs for 2001–2004 and 2007. The potential crude input volumes are estimated by applying a factor (0.952) that represents the ratio between crude inputs and capacity in PADD 1 for facilities experiencing no major outages.
Sources: November 2008 Short Term Energy Outlook, Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database; excludes PADD 1 asphalt refineries.

4.2 Adequacy of FCC Capacity

Table 7 illustrates that the available FCC capacity at the U.S. level should still be able to meet projected demand.

Table 7. Comparison of U.S. Maximum FCC Inputs from Available FCC Capacity After Outages with Projected FCC Input Needs (Thousand Barrels Per Day)

	Projected FCC Inputs	FCC Capacity	Estimated FCC Outages	FCC Capacity Net of Outages	Potential FCC Inputs (Net Capacity* 0.925)	Potential Net Inputs Minus Projected Inputs
November Actual	5,152	6,222	340	5,882	5,441	289
December	5,250	6,222	103	6,119	5,660	410
January	4,922	6,222	388	5,834	5,396	474
February	4,891	6,222	533	5,689	5,262	371
March	4,960	6,222	496	5,726	5,297	337

Note: Projected FCC inputs are estimated by multiplying actual and projected crude inputs from Table 2 by average FCC runs relative to crude runs. The potential FCC input volumes are estimated by applying a factor (0.925) that represents the average observed ratio between crude inputs and capacity for facilities experiencing no major outages.
Sources: November 2008 Short Term Energy Outlook, Industrial Info Resource (IIR) www.iirenergy.com, November 24, 2008 database; excludes PADD 1 asphalt refineries.

PADD 1 is the most problematic region. As shown in Figure 14, planned FCC outages in PADD 1 during the first quarter of 2009 are high by recent historical standards. Table 4, above, shows that planned FCC outages reach a particularly high level in February. As indicated earlier, February 2009 is a month of concern for winter distillate needs. (The coldest weather usually is past by March.) While the FCC unit is mainly a gasoline-producing unit, crude runs may also have to be reduced when one is off line, thereby reducing distillate production below the volume directly impacted by crude distillation unit outages. Even with current weak demand projections, the FCC outage level planned for February could have negative impacts on distillate supply in PADD 1.

5. Outage Impacts on Production

Chapter 4 assessed the adequacy of capacity relative to input requirements, as projected by the EIA Short Term Energy Outlook. It showed that at the U.S. level, neither crude distillation nor FCC capacity outages should prevent refiners from meeting EIA's STEO-projected refining requirements to meet demand. However, PADD 1 showed the potential for a tightening market at the end of the heating oil season in February. Because the mix of supply from imports, inventories, and production all may vary as the winter progresses, this chapter explores the potential distillate production that available capacity (net of outages) might produce.

Unit outages have varying impacts on production, but adequate statistical relationships exist to estimate regional production impacts. In particular, FCC unit outages better explain gasoline production than outages of crude distillation units. Crude distillation units, on the other hand, are a better indicator of distillate production. Distillate and gasoline wholesale margins also help explain some of the production variations historically, and are helpful in estimating future production impacts consistent with prices seen in EIA's STEO. Models developed to capture these relationships are summarized in Appendix A.

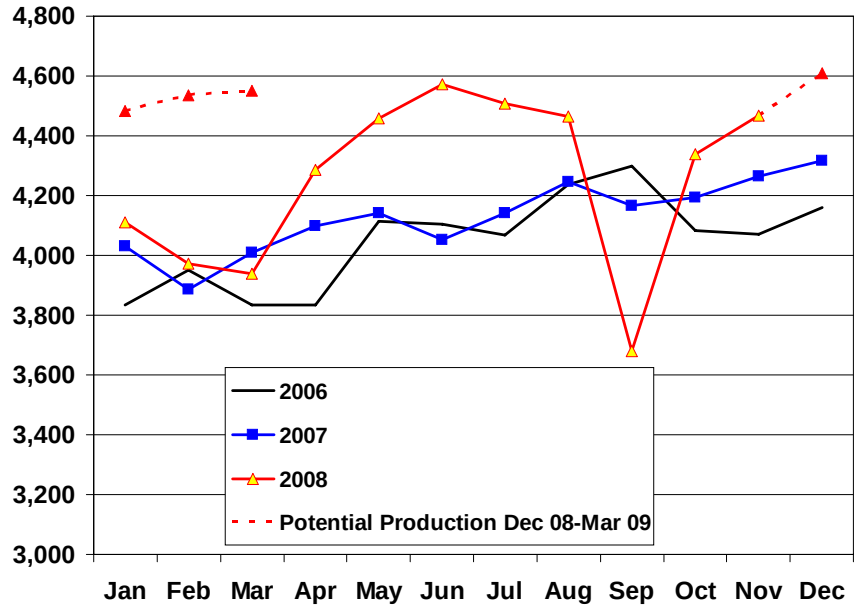
Figure 18 illustrates U.S. actual refinery distillate production for 2006 and 2007 and potential refinery production for December 2008 through March 2009. Potential distillate production is derived using the distillate models in Appendix A, assuming maximum inputs of crude and unfinished oils to available capacity net of outages. The models do not take into account the extra shift away from gasoline towards higher distillate yields seen so far this year.

Apart from the hurricanes, refinery inputs and associated product output this year have been determined by market factors rather than outage constraints. Falling demand and, in the case of gasoline, increased use of ethanol, have reduced the need for refining capacity. While supply looks adequate at the U.S. level, PADD 1 may experience some tightening at the end of heating oil season as a result of large planned FCC outages. Recall that distillate demand in this part of the country is expected to be higher this winter than last due to weather considerations, and inventories are low going into the winter.

In spite of the outages, the situation may still not become a problem. PADD 1 has access to more supply options than many other regions. PADD 1 typically receives distillate imports in the winter months of around 200 to 250 thousand barrels per day. These imports have surged to 400 or 500 thousand barrels per day when needed – increases far more than potential distillate losses from the FCC outages being planned. For example, in February and March of 2003, distillate imports into PADD 1 were 473 and 449 thousand barrels per day respectively, and as recently as January 2006, following Hurricanes Rita and Katrina, they averaged 531 thousand barrels per day. In addition, the

U.S. as a whole is expected to have excess capacity to produce distillate over the next four months, as indicated in Figure 18.

Figure 18. U.S. Monthly Distillate Actual and Potential Production, 2006-2008 (Thousand Barrels Per Day)



Source: Actual: 2006 – September 2008, EIA *Petroleum Supply Monthly*, and October-November EIA *Weekly Petroleum Status Report*; Potential – December 2008-March 2009 EIA estimates

6. Conclusion and Assessment

At the U.S. level, planned refinery outages for December 2008 through March 2009 are not expected to limit supply needed to meet demand for either gasoline or distillate. However, outages in PADD 1 could tighten that region's distillate supply and add to price pressure. In addition, PADD 1 distillate inventories were below normal at the end of November going into the high heating oil demand season, reducing the nearby supply cushion. While heating oil imports from Europe would likely respond to a supply need as has occurred historically, and excess capacity to produce more distillate is available on the Gulf Coast, neither region may be close enough to stop a brief price surge in the event of a cold snap.

In EIA's view, an effort to encourage greater coordination is unlikely to ameliorate the possible impacts of planned FCC outages in PADD 1 this winter. Another alternative, delaying planned PADD 1 FCC outages into March or April would only push the issue from a distillate concern to a gasoline concern. The loss of this major gasoline-producing capacity in March and April could have greater impacts on the gasoline market than it may have on the distillate market in February. Perhaps the best preparation to minimize any potential price impacts of the FCC outages planned for February would be for wholesale buyers who normally rely on opportunistic supply in addition to their contracts to recognize the potential for fewer opportunistic purchasing opportunities, and arrange for additional contracts. This report should help to alert this segment of the industry to that situation.

EIA also explored the outages being planned for areas in the upper Midwest that are at the end of the distribution chain. These areas sometimes experience supply problems as a result of limited supply alternatives. Last year, refineries supplying the Magellan pipeline had unusually high outages during the late fall months, and refineries directly supplying North Dakota also experienced high late summer and fall outages that affected both diesel and gasoline supplies and prices. Planned outages in these areas should not result in supply shortages that would result in significant price increases in distillate for the remainder of this winter, however.

Appendix A. Forecast Models Used to Estimate Gasoline & Distillate Production from Available Capacity

As part of the outage study, an econometric analysis was made of refinery production in order to explore whether forecasting models could be created for refinery output of finished gasoline and distillate given easily obtained unit input variables. This would allow us to explore the impact of outages, which reduce unit inputs, on production. In addition, market variables were explored that would also potentially impact production. An effort was made to model each PADD and the U.S., with representative results for PADD 3 and the U.S. being shown below.

The model estimates show that the refinery output of finished gasoline varies seasonally and depends mainly on FCC inputs, with product margins having small effects. Distillate output also varies seasonally and depends mainly on refinery crude oil inputs, with various product margins having minor effects. The data used in this study came from various sources, including EIA's Petroleum Supply Monthly and Petroleum Marketing Monthly. The data used included:

- Crude oil inputs to refineries, in thousand barrels per day;
- Refinery distillate output, in thousand barrels per day;
- FCC inputs, in thousand barrels per day;
- Refinery finished gasoline and blending component output, excluding oxygenates, butanes and pentanes plus, in thousand barrels per day;
- Various wholesale product margins using the same prices forecast in the EIA Short Term Energy Outlook, in cents per gallon.

$$y_t = c + \alpha_0 x_t + \sum_i \beta_i z_{it} + \sum_{i=1}^{11} \gamma_i m_i + \tau_0 T + \tau_1 D + \alpha_1 y_{t-i} + \varepsilon_t \qquad \text{Eqn. 1.}$$

Where

y_t refers to finished output at time t (gasoline or distillate);

x_t refers to inputs to the fluid catalytic cracking unit (gasoline) at time t, or refinery crude oil inputs (distillate) at time t;

z_{it} refers to margin i at time t;

m_i refers to monthly indicator variables;

T refers to a linear time trend;

D refers to an indicator variable for October 1996;

ε_t refers to error term at time t.

c, α , β , γ , τ are estimated parameters.

The equations were estimated using data from January 1995 through April 2008, except for U.S. gasoline where the data began in January 2002. For the distillate output models, *a priori*, one would expect the coefficient on crude inputs to be about 0.25, and the coefficient signs for heating oil and diesel margins to be positive (greater profit on distillate products leading to greater distillate yields), with the coefficient sign for gasoline margin being negative (higher profit on gasoline leading to lower distillate yields). For the gasoline output models, one would expect the coefficient on FCC input to be about 0.7, and the coefficient sign on the gasoline margin to be positive (more profit leading to higher yields), and a negative coefficient on diesel margins. The positive coefficient on the lagged dependent variable for both types of models indicates that the level of current output depends on the previous month's output, with the effect for distillate being somewhat higher than for gasoline. The U.S. and PADD 3 models are summarized in Tables A-1 through A-4.

The models fit historical data well, as demonstrated by the high R squared, and the small regression error relative to the size of the dependent variable. The models were also evaluated by limiting the estimation periods to include data prior to July 2007, and creating one-month-ahead, out-of-sample forecasts for the July 2007 to April 2008 time period. Comparison of in-sample goodness of fit and out-of-sample forecasts to actual values are shown below in Figures A-1 to A-4. Examination of these figures shows that the in-sample model fit is very good, and that each of the models creates good one-month-ahead forecasts.

Table A-1. PADD 3 Distillate Model

Independent Variable: finish_distillate_P3

Parameter	*Estimated Coefficient*	
C	-678.764	***
crude_input_P3	0.225736	***
margin_mogas	-1.21027	***
margin_diesel(-1)	4.53883	***
JAN	-57.7863	**
FEB	42.1261	*
MAR	25.7613	
MAY	-54.5397	***
JUN	-70.9728	***
JUL	-60.4614	***
AUG	-43.0256	**
SEP	-28.9804	
OCT	7.79356	
NOV	25.8404	
DEC	0.983929	
Trend	0.156778	
D1996M10	184.268	***
finish_distillate_P3(-1)	0.380846	***
adj. R Squared	0.947	
std. error of reg.	48.2	
mean of dep. variable	1696	

Note: *** indicates significance at 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.

Table A-2. U.S. Distillate Model

Independent Variable: finish_distillate_US

Parameter	*Estimated Coefficient*	
C	-1342.8	***
crude_input_US	0.233436	***
margin_heatoil	3.85069	***
margin_diesel(-1)	4.46932	***
margin_mogas	-2.30922	***
Trend	0.553006	
JAN	-115.831	***
FEB	40.2104	
MAR	30.3486	
MAY	-65.7538	**
JUN	-140.034	***
JUL	-140.343	***
AUG	-100.803	***
SEP	-95.1954	***
OCT	8.91459	
NOV	59.0908	*
DEC	-11.8026	
finish_distillate_US(-1)	0.355856	***
adj. R Squared	0.948	
std. error of reg.	75.1	
mean of dep. variable	3646	

Note: *** indicates significance at 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.

Table A-3. PADD 3 Refinery Gasoline Production Model

Independent Variable: finish_mogas_P3

Parameter	*Estimated Coefficient*	
C	993.122	***
FCCinput_P3	0.699957	***
margin_diesel	-2.48552	***
JAN	-82.0657	***
FEB	-110.118	***
MAR	-74.0416	***
MAY	-8.16599	
JUN	-14.7039	
JUL	-44.2863	*
AUG	-51.5939	*
SEP	-23.0597	
OCT	-15.3375	
NOV	36.5619	
DEC	32.4159	
Trend	1.20192	***
finish_mogas_P3(-1)	0.174018	***
adj. R Squared	0.903	
std. error of reg.	62.1	
mean of dep. variable	3400	

Note: *** indicates significance at 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.

Table A-4. U.S. Refinery Gasoline Production Model

Independent Variable: finish_mogas_US

Parameter	*Estimated Coefficient*	
C	2593.96	***
FCCinput_US	0.698585	***
margin_mogas(-1)	1.79761	**
JAN	145.766	**
FEB	-84.1878	
MAR	-128.981	**
MAY	81.6435	
JUN	66.5287	
JUL	52.4208	
AUG	-4.85744	
SEP	90.9212	
OCT	10.1340	
NOV	284.262	***
DEC	390.832	***
finish_mogas_US(-2)	0.150924	*
adj. R Squared	0.871	
std. error of reg.	95.8	
mean of dep. variable	7537	

Note: *** indicates significance at 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.

Figure A-1.

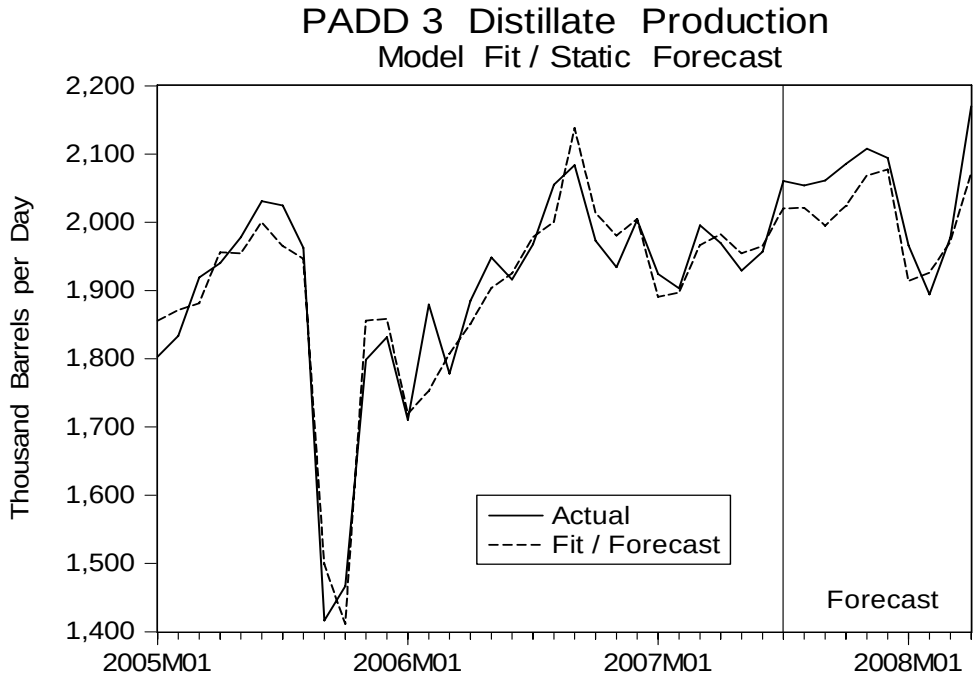


Figure A-2.

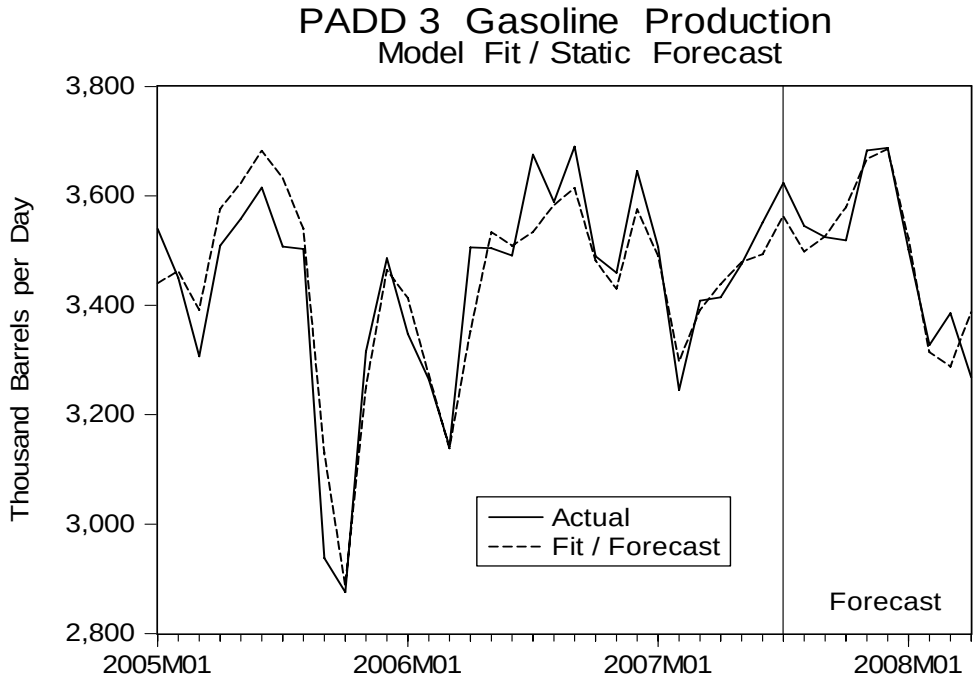


Figure A-3.

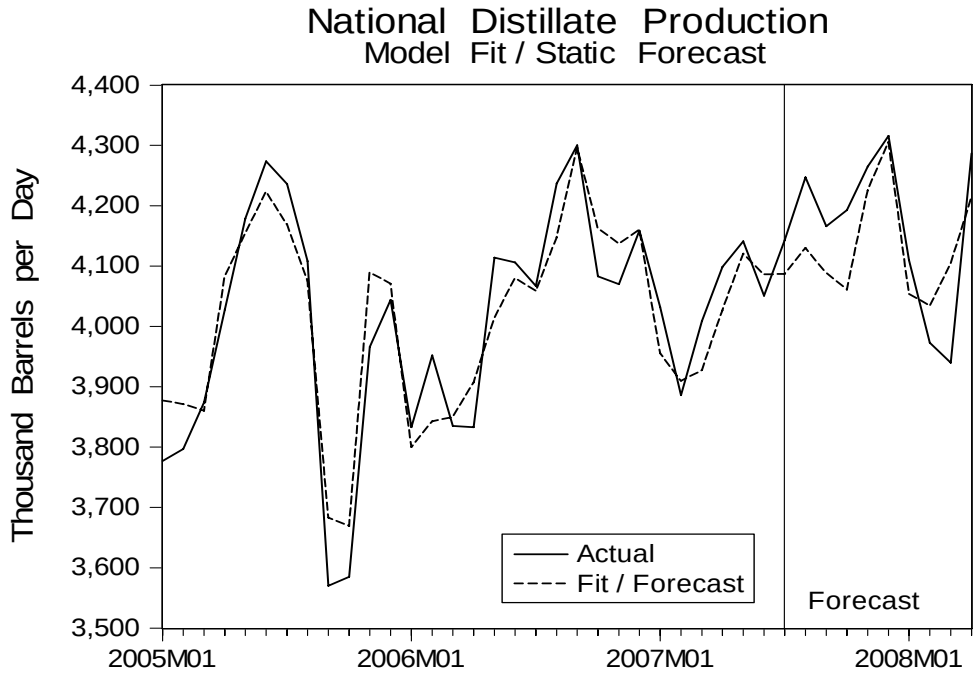


Figure A-4.