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Market Assessment of Planned Refinery Outages
March – June 2009

March 2009

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Office of Oil and Gas
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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 March through June 2009, which time period covers the seasonal increase in driving demand. 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 can occur at any time and for many reasons (e.g., mechanical failures, fires, and flooding).

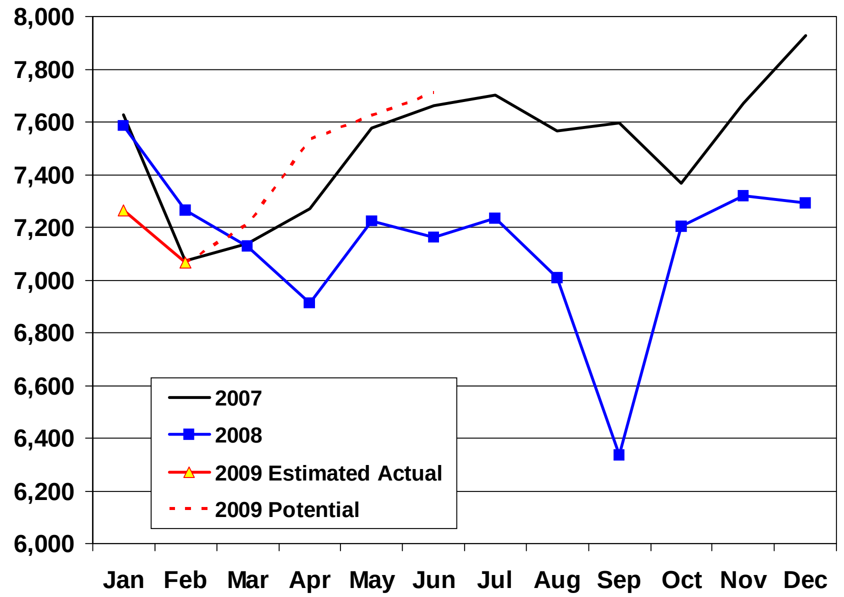
At the U.S. level, available capacity adjusted for outages appears adequate to meet projected demand through June 2009. Apart from the effects of the hurricanes of September 2008, refinery production in 2008 and the first 3 months of 2009 have been determined by market factors rather than outage constraints. Falling demand and, in the case of gasoline, increased use of ethanol, have reduced the need for refining capacity. That situation is expected to continue in 2009.

Figure S-1 shows that potential 2009 U.S. gasoline production from capacity, after adjustments for outages, is well above actual production in 2008. Given that demand in 2009 is expected to be lower than that in 2008, adequate production capacity is available. On a regional basis, most surplus capacity is in Petroleum Administration for Defense District (PADD) 3, or the Gulf Coast region. PADD 1 is projected to experience fluid catalytic cracking (FCC) unit outages in March into April that will require more gasoline to be brought into the region (Table S-1). The Energy Information Administration's (EIA) December Market Assessment of Upcoming Planned Outages previously raised the issue regarding PADD 1, although since then, large unplanned outages have contributed to restricted supply for March, and these outages may extend into April. PADD 1 is normally dependent on gasoline imports and product from PADD 3, and extra supply from these sources has been available to serve the East Coast in March and should continue to be able to provide extra supply. However, prices on the East Coast may have to increase somewhat in order to continue to attract the extra supply. PADD 2 (Midwest) has relatively high inventories, but it is expected to have higher than normal outages in April and May. With declining demand, local capacity may be able to cover for those outages. If not, extra capacity should be available from PADD 3 to help meet PADD 2 demand. PADD 5 (West Coast) has low gasoline inventories, but in PADD 5, available capacity adjusted for outages should be adequate to meet demand.

Distillate supply (diesel and heating oil) going into the summer appears ample (Figure S-2). Inventories are high, and the export market for distillate may be weakening compared to the 2008, which resulted in high distillate exports from the United States. A weaker world distillate market indicates distillate margins may be lower than last year. No outage-related problems affecting distillate supply are evident on a regional basis through June 2009.

In summary, PADD 1 is the region in which outages during March and early April may result in significant price pressure. In EIA's view, an effort to encourage greater coordination among refiners is unlikely to ameliorate the possible impacts of planned outages in this region. Wholesale buyers who normally rely on opportunistic supply in addition to contracts could potentially minimize price impacts of planned March and April FCC outages by recognizing the potential for fewer opportunistic purchasing opportunities and arranging for additional contracts. This report should help to alert this segment of the industry to that situation and minimize price impacts in April.

Figure S-1. U.S. Monthly Refinery Gasoline Actual and Potential Production, 2007-June 2009 (Thousand Barrels Per Day)



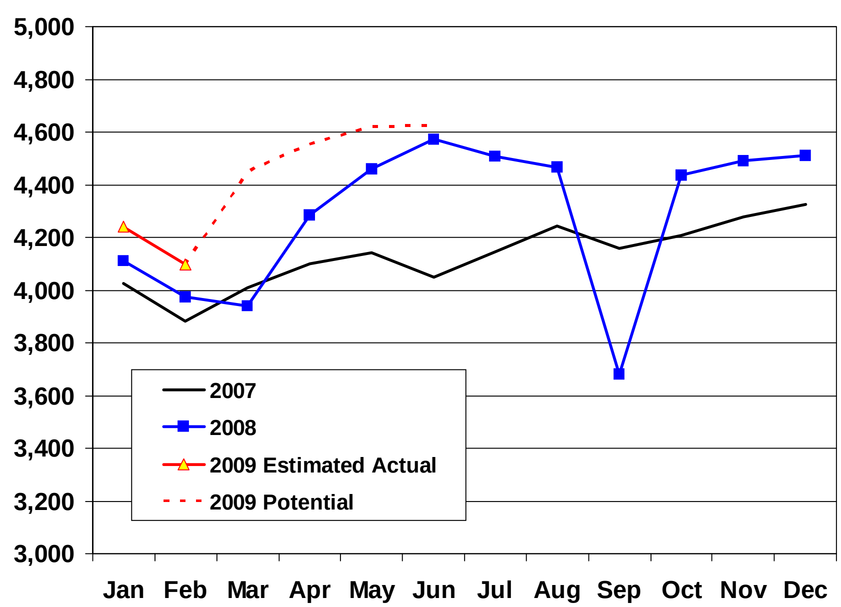
Note: Refinery gasoline production represents finished gasoline and blending components excluding oxygenates, pentanes plus, and butane.
Source: Actual: 2006 – 2008, EIA *Petroleum Supply Monthly*, and January - February Estimated from actual crude runs; Potential – December 2008-March 2009 EIA projections based on available capacity.

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

Month (December 08 Through March 09)	Actual and STEO Projected Crude Inputs	Actual and Projected FCC Inputs (FCC Pct Crude = 0.420)	Operable FCC Capacity	Estimated Total Outages	Capacity Net of Outages	Potential FCC Inputs (Net Capacity * 0.990)	Potential Inputs minus STEO Inputs
December Actual	1,262	583	724	51	673	NA	NA
January Actual	1,352	568	724	41	683	NA	NA
February Actual	1,238	520	724	128	596	NA	NA
March	1,449	609	724	273	452	447	(162)
April	1,495	628	724	42	682	675	48
May	1,519	638	724	8	716	709	71
June	1,510	634	724	4	720	713	79

Note: The FCC input volumes are estimated by multiplying crude inputs by a factor (0.420) that represents the average observed ratio between FCC and crude inputs for facilities experiencing no major outages. The potential FCC inputs are estimated by applying a factor (0.990) that represents the average observed difference between FCC input volumes and capacity in PADD 1 for facilities experiencing no major outages and running at high input levels.
Sources: March 2009 Short Term Energy Outlook, Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database.

Figure S-2. U.S. Monthly Distillate Actual and Potential Production, 2007-June 2009 (Thousand Barrels Per Day)

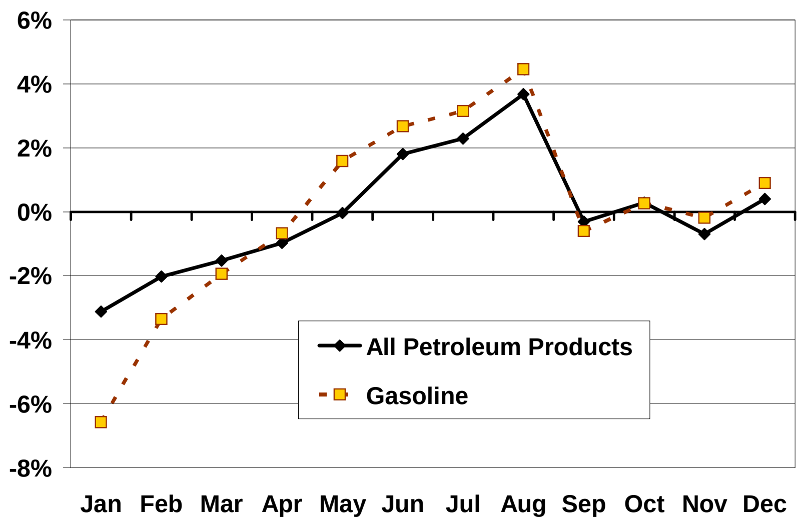


Note: Refinery gasoline production represents finished gasoline and blending components excluding oxygenates, pentanes plus, and butane.
Source: Actual: 2006 – 2008, EIA *Petroleum Supply Monthly*, and January - February Estimated from actual crude runs; Potential – December 2008-March 2009 EIA projections based on available capacity.

1. Introduction

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 March through June 2009, which covers the seasonal increase in driving demand. 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. Figure 1 demonstrates these seasonal variations in demand. Note that total petroleum demand is driven mainly by gasoline demand. Distillate demand (diesel and heating oil) moderates the petroleum demand dip in the winter, but because distillate demand is about half as much as gasoline demand, it does not substantially affect the seasonal demand variations.

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



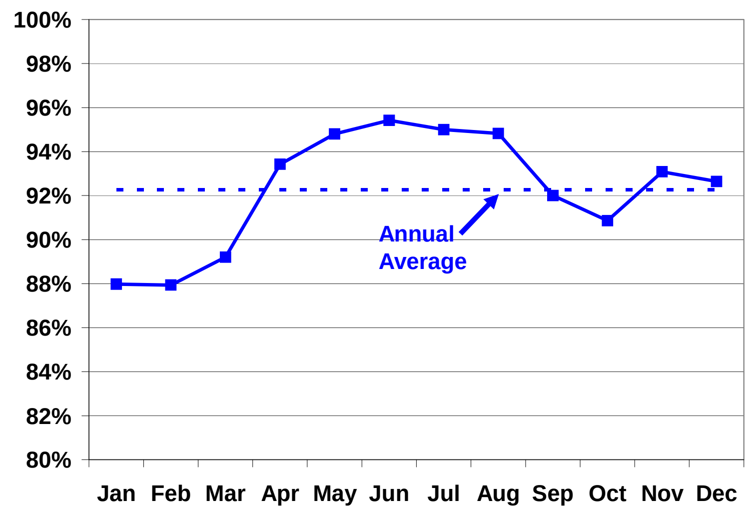
Note: 2000-2004 average was used to remove impacts from major hurricanes and the recent economic downturn.
Source: EIA *Petroleum Supply Monthly*

Refinery utilization reflects both discretionary crude oil throughput changes that follow demand, as well as maintenance and unplanned outages. While utilization generally follows the seasonal demand pattern, falling to its 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, changes in production impact price, so the impacts outages have on production must be determined. The relationship is not simple and can only be estimated. Outages may involve a number of different units and associated refinery equipment that 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 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 same degree of impact on gasoline and distillate production as the FCC and crude distillation units 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, e.g., the FCC units, functioning. Conversely, if an FCC unit is offline, a refinery may not be able to store or

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[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.

move the FCC unit feedstock to another refinery; therefore, the crude oil distillation unit may need to run at lower rates to slow production of this feedstock.

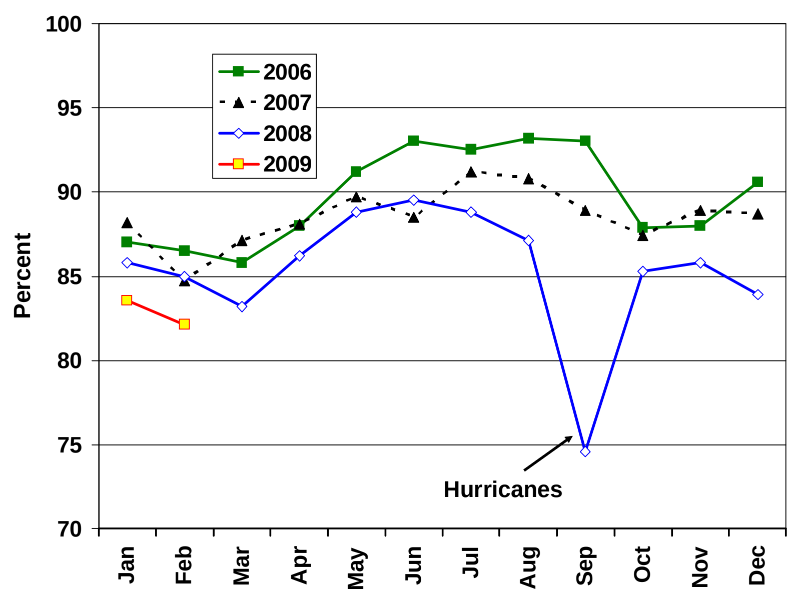
The remainder of this report reviews the projected March through June 2009 outage situation in a stepwise fashion. Chapter 2 begins with a review of the current market situation to provide the underlying setting for the outages. Chapter 3 looks specifically at projected outages and compares them with 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. Chapter 6 concludes the report 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 affected product output 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 much impact on prices.

With high prices and the economic recession, petroleum demand in 2008 fell 6.1 percent from 2007, with the steepest drop occurring in the second half of the year. While 2009 projected demand is expected to continue to fall, the rate of decline will likely slow. In total, the United States is projected to lose 1.7 million barrels per day of petroleum demand from 2007 to 2009. The volume lost is roughly equivalent to that produced from about six refineries running at full capacity. In response to falling demand, refiners are running at lower utilization rates (Figure 3). Apart from the hurricane impacts in September 2008, utilization was falling off with demand and continues to drop in the early months of 2009.

Figure 3. U.S. Refinery Utilization



Source: 2006-2008 – EIA *Petroleum Supply Monthly* data; 2009 – Monthly estimates using EIA *Weekly Petroleum Status Report* data.

Both gasoline and distillate demand followed total consumption decline patterns in 2008. Gasoline demand was 3.6 percent lower in 2008 than 2007 but is projected to average only 0.3 percent lower in 2009 than in 2008. However, gasoline is expected to decline more in the first half of 2009, falling about 1.3 percent from the first half of 2008. The annual “refinery demand” for petroleum-based gasoline declined about 5 percent in 2008, which is more than the consumer gasoline demand decline of 3.6 percent. Part of the refinery decline was the result of the increased use of ethanol to meet the renewable fuel mandate of the Energy Independence and Security Act of 2007. Increased use of ethanol reduces the need for petroleum-based gasoline to meet demand. Gasoline imports fell about 6 percent, with inventory draws and ethanol making up the supply difference to meet demand. In 2009 the need for refinery-based gasoline is expected to decline even more, with the renewable fuel mandate continuing to increase, falling demand, and the continued availability of gasoline imports.

Distillate demand fell about 6.2 percent from 2007 to 2008 and is projected to fall another 2.5 percent in 2009. During the first half of 2008, distillate demand fell about 4.6 percent over 2007 and is projected to fall 3.8 percent during the first half of 2009.

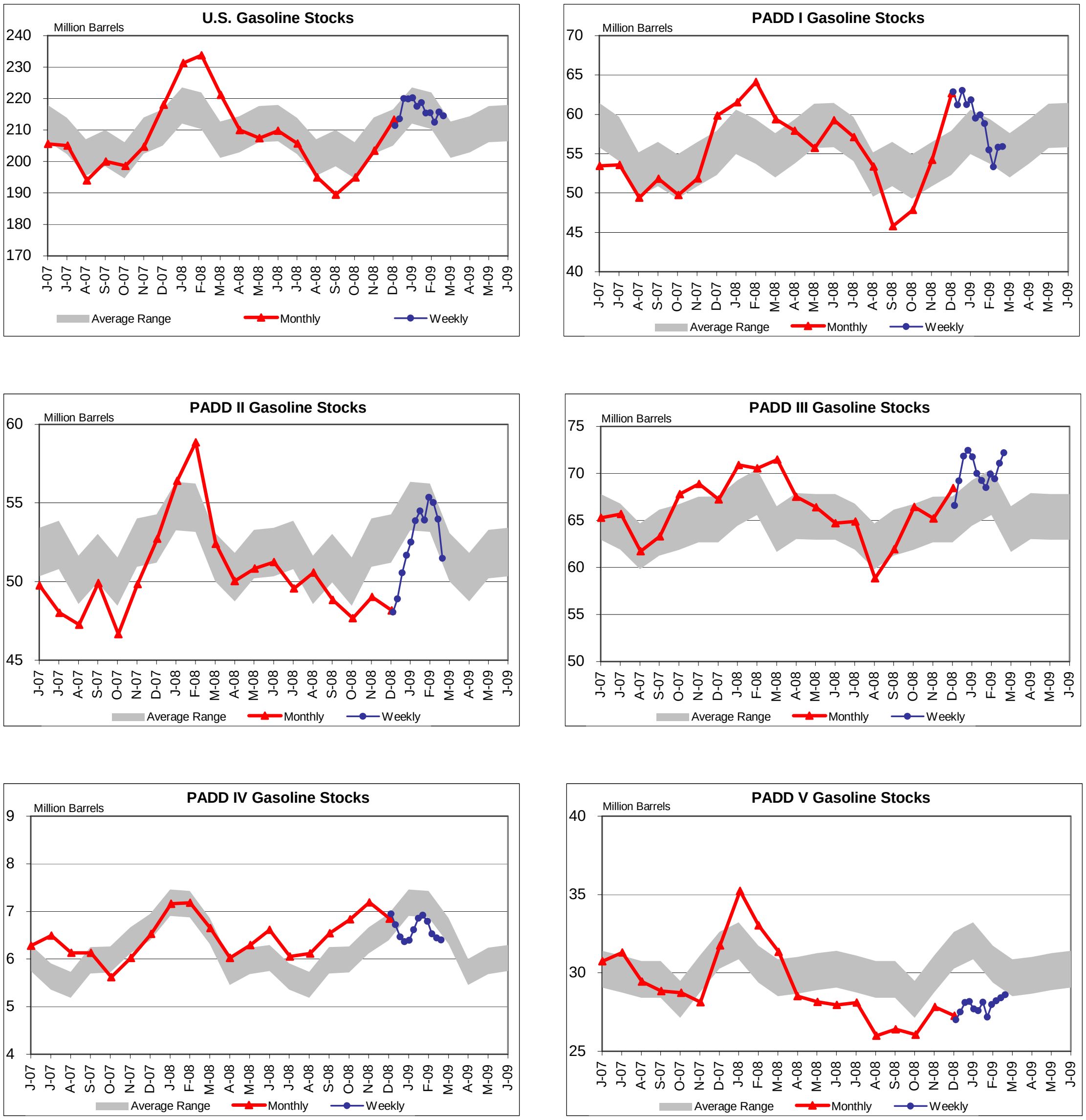
Total U.S. gasoline inventories are in the normal range for this time of year, but vary regionally (Figure 4). Gasoline inventories for PADDs 2 and 3 are in the high side of the normal range. PADD 1 inventories fell at the end of February through early March but picked up recently as imports, which are a major source of PADD 1 supply, picked up. PADD 4 inventories have been running somewhat low but are now approaching normal levels. PADD 5 gasoline inventories have been low since April 2008 but are slowly moving back towards the normal range.

Distillate inventories, which are used to help meet peak winter demand in December through February, are quite high, as shown in Figure 5, with all PADDs showing ample supply. The high distillate level in PADD 3 may indicate a reduction in distillate exports from the high export levels seen in 2008.

Crude oil and product prices peaked in July of 2008. As the world economy slowed, world demand declined, and crude prices fell steeply, carrying product prices down as well. Crude prices bottomed out in December 2008 but have increased since then, pushing product prices higher in March than at the beginning of the year.

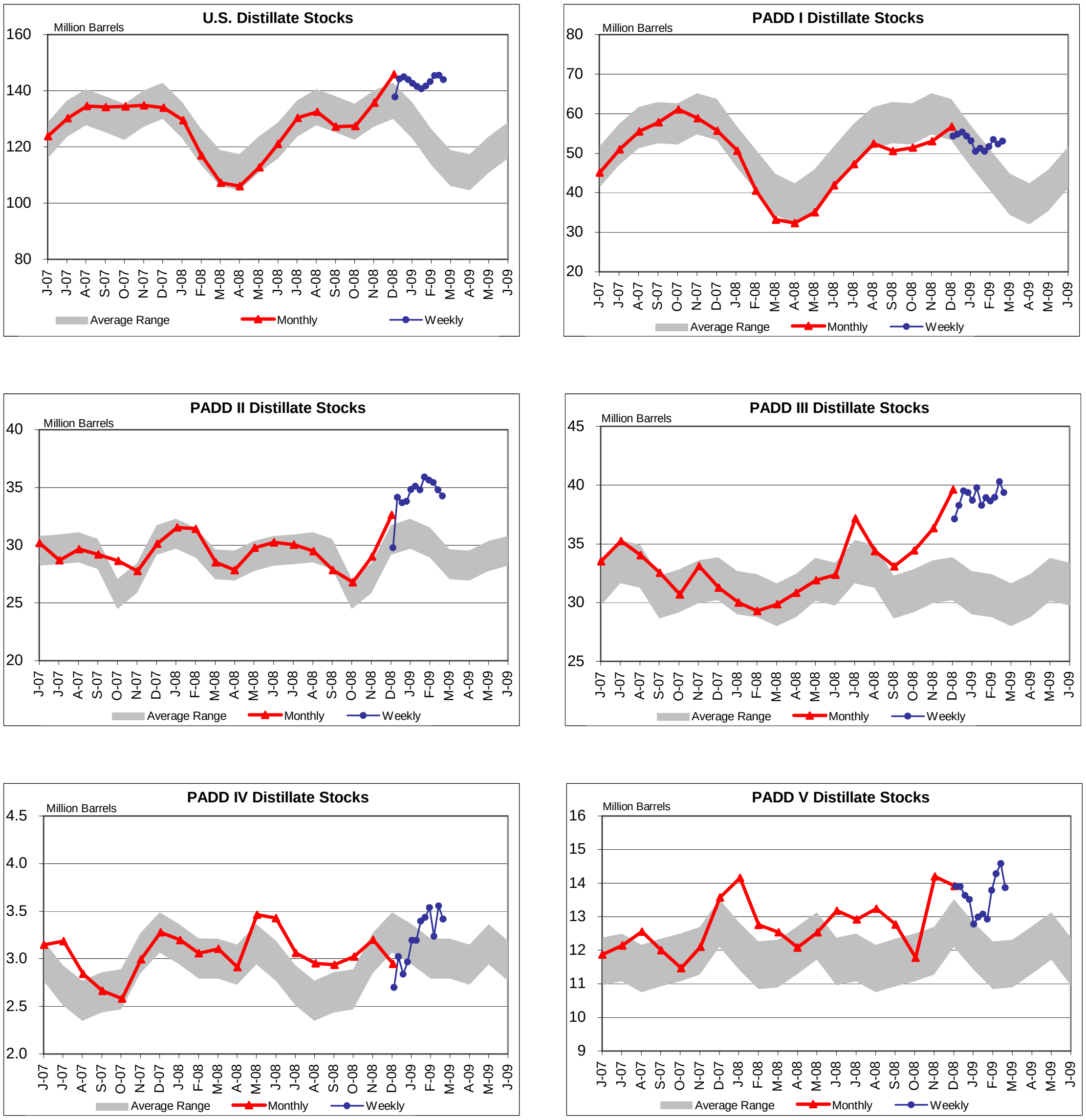
Product markets, apart from crude oil markets, have also been changing, which impacts wholesale product prices relative to crude oil prices. The spread between wholesale or spot product prices and crude oil prices is shown in Figure 6 for gasoline and distillate. World markets for distillate fuel oil were unusually strong in 2008, pulling diesel prices well above gasoline prices for most of the year. In contrast, gasoline markets weakened considerably. Growing export availability from Europe and declining demand pushed gasoline prices below the price of crude oil during the peak summer driving season in July of 2008 and again following the hurricanes in September.

Figure 4. Stocks of Gasoline by PADD, June 2007 – March 20, 2009



Source: *Weekly Petroleum Status Report*

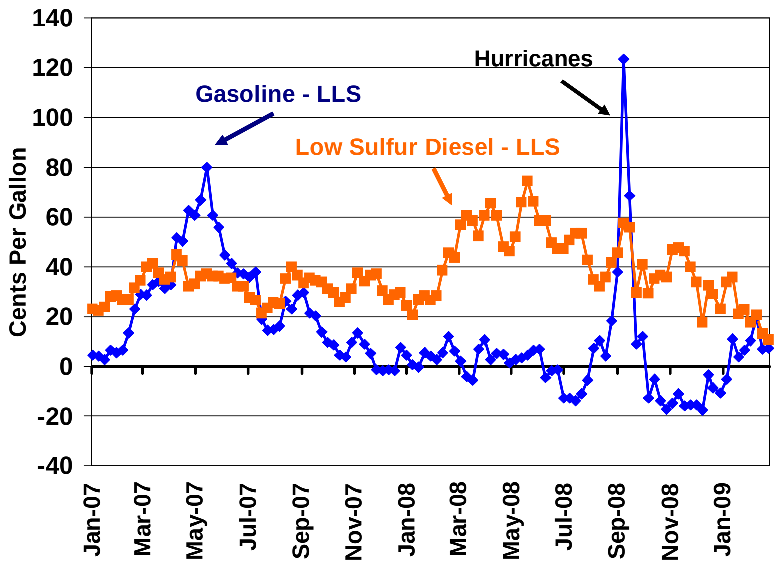
Figure 5. Stocks of Distillate by PADD, June 2007 – March 20, 2009



Source: *Weekly Petroleum Status Report*

In response to the higher prices for distillate versus gasoline, U.S. refiners changed their operations in 2008 to produce more distillate and less gasoline from a barrel of crude oil. At the same time, they ran fewer barrels of crude as a result of falling demand. This situation continued through the winter. Wholesale diesel prices relative to crude oil have fallen as the winter heating season comes to an end and world demand eases. Refiners are running at low utilization rates, but with low demand, supply has been ample, and prices for both diesel and gasoline relative to crude oil are currently fairly low, in spite of some large outages that will be discussed in the next chapters.

Figure 6. Gasoline and Distillate Spot Price Minus Crude Oil Price Comparison



Source: Bloomberg weekly average spot prices for Gulf Coast regular gasoline, low sulfur diesel and Louisiana Light Sweet (LLS) crude oil.

3. Capacity Outage Review

This chapter looks specifically at projected outages for March 2009 through the second quarter of 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. Large outages may occur both at the U.S. level and at regional levels. However, with low demand, these outages may not create significant price impacts, a trend that will be discussed in Chapter 4.

After the data description is covered in the first section below, the chapter reviews outages at the total U.S. level, followed by outages in specific PADDs. Over this time period, i.e., March 2009 through second quarter 2009, large crude distillation and FCC unit outages are expected in PADDs 1, 2, and 5, both planned and unplanned.

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 (Monthly Refinery Report). 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.

3.2 United States Outages

This section covers the U.S. aggregate crude distillation outages first, followed by U.S. FCC unit outages.

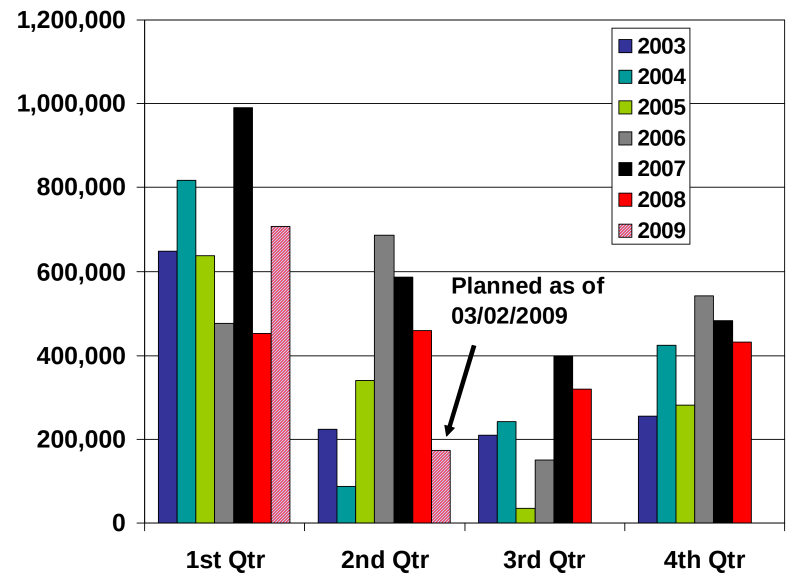
3.2.1 Crude Distillation Unit Outages

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 7 indicate that for the United States in total, planned outages for first quarter 2009 have been above average, but planned outages for the second quarter are below typical levels. Figure 8 shows planned U.S. outages by month, since quarterly averages can mask potential high-outage months that could impact prices. As shown, no unusually high-outage months are projected for first or second quarter 2009.

Figure 7. Quarterly U.S. Planned Crude Distillation Unit Outages, 2003-2009 (Barrels Per Day)



Source: Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database, excludes PADDs 1 and 5 asphalt refineries.

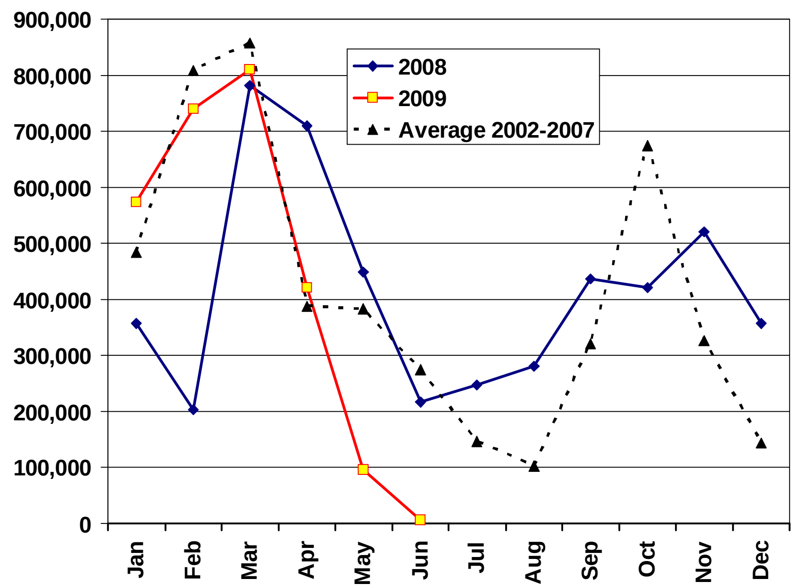
Regional planned outages, however, are showing some high months and are described in more detail later in this chapter.

Unplanned Crude Distillation Unit Outages

In addition to planned outages, unplanned outages also occur. While unplanned outages are often of short duration (e.g., a shutdown caused by loss of electricity), they can be long term if significant equipment damage occurs.

Based on average historical unplanned outages since 2002, excluding the 2005 hurricane impacts, we might expect U.S. unplanned outages of about 190 thousand barrels per day during the first quarter of 2009 and slightly higher outages, around 230 thousand barrels per day, during the second quarter. The first quarter this year is already well ahead of the typical unplanned outage levels, averaging about 420 thousand barrels per day. Still, as prices and inventories have illustrated, these outages have not had a large impact on supply relative to demand, and thus have not had an unusual impact on product prices.

Figure 8. Monthly U.S. Planned Crude Distillation Unit Outages, 2002-2009 (Barrels Per Day)



Source: Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database; excludes PADDs 1 and5 asphalt refineries.

Total Planned and Unplanned Crude Distillation Unit Outage Assessment

Actual total U.S. crude distillation unit refinery outages for December 2008 through February 2009 and expected outages for March through June 2009 are summarized in Table 1. Total outage levels for April through June represent planned outages added to typical unplanned outages (excluding the effects of hurricanes). March includes some actual unplanned outages as well.

As shown in Table 1, total outages for the United States have been running higher than typical from December through February, and higher-than-typical outages are expected to continue through April. However, the situation varies across PADDs.

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

Month (December 08 Through March 09)	Planned	Estimated Unplanned	Estimated Total Outage Level	Typical Historical Total Outage Level
December Actual	357,419	60,000	417,419	360,000
January Actual	573,652	210,290	783,942	640,000
February Actual	739,714	501,857	1,241,571	1,000,000
March	810,181	565,923	1,376,103	1,100,000
April	421,400	346,000	767,400	670,000
May	96,774	306,000	402,774	620,000
June	6,333	246,000	252,333	460,000

Note: Unplanned values for April through June 2009 are historical average values for 2002-2007 excluding months in 2005 and 2006 affected by hurricanes. Similarly, typical historical values are average planned outages 2002-2007 plus average unplanned outages 2002-2007 excluding 2005 and 2006 hurricane impacts. March unplanned outages includes large known unplanned outages that began during early March.
Source: Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database; excludes PADDs 1 and 5 asphalt refineries.

3.2.2 FCC 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 require more storage than is available 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. Also, in periods when demand is low and margins are weak, refiners may reduce refinery inputs when there is an outage on a key downstream unit such as the FCC unit.

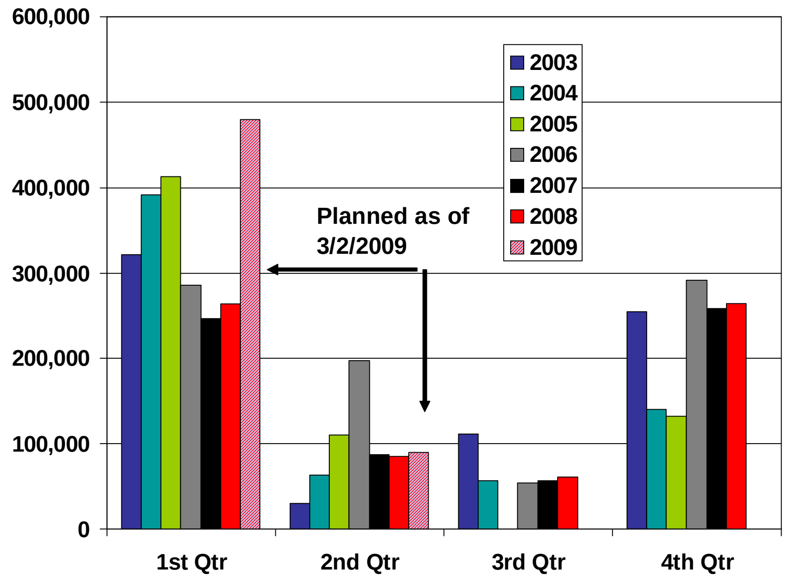
Planned FCC Unit Outages

Figure 9 shows that the U.S. planned FCC outage outlook for first quarter 2009 is above average, and Figure 10 illustrates the monthly profile. Most of the large outages were in January and February, but regional outages show some different patterns, as was the case with the crude distillate unit outages.

Unplanned FCC Unit Outages

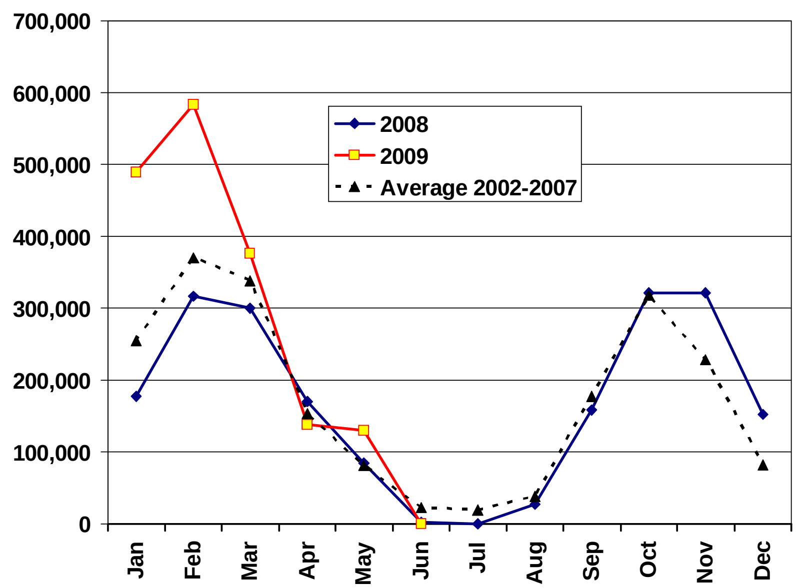
Not only were planned FCC unit outages during first quarter 2009 higher than typical, unplanned outages were high as well. Average unplanned outages for both first and second quarter 2009 have been about 140 thousand barrels per day; however, unplanned outages first quarter 2009, (including known unplanned outages through March 6, averaged about 210 thousand barrels per day.

Figure 9. Quarterly U.S. Planned Fluid Catalytic Cracking Unit Outages, 2002-2009 (Barrels Per Day)



Source: Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database

Figure 10. Monthly U.S. Planned FCC Unit Outages, 2002-2009 (Barrels Per Day)



Source: Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database

Total Planned and Unplanned FCC Unit Outage Assessment

Table 2 summarizes both planned and unplanned U.S. outages by month. Estimated total FCC outage levels are above typical historical outage levels in December 2008 through March 2009, and again in May, although the May estimate is not much above average levels for that month.

Table 2. U.S. FCC Unit Outages (Barrels Per Day)

Month (December 08 Through March 09)	Planned	Estimated Unplanned	Estimated Total Outage Level	Typical Historical Total Outage Level
December Actual	152,323	227,748	380,071	160,000
January Actual	489,629	92,071	581,700	400,000
February Actual	583,179	281,700	864,879	500,000
March	376,613	263,400	640,013	480,000
April	137,833	160,000	297,833	310,000
May	130,161	110,000	240,161	190,000
June	0	150,000	150,000	170,000

Note: Unplanned values for April through June 2009 are historical average values for 2002-2007 excluding months in 2005 and 2006 affected by hurricanes. Similarly, typical historical values are average planned outages 2002-2007 plus average unplanned outages 2002-2007 excluding months in 2005 and 2006 affected by hurricanes. March unplanned outages includes large known unplanned outages that began during early March.
Source: Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database.

3.3 Regional Outages of Interest for Potential Price Impacts

3.3.1 PADD 1 Outages

As shown in Table 3, PADD 1 was not planning any significant crude distillation unit outages first or second quarter 2009, but the region has experienced large unplanned outages in February and March. These are not expected to continue into April. Table 4 displays PADD 1 FCC planned and unplanned outages. Planned outages are larger than typical total outages during the first quarter, but large unplanned outages have contributed to the total outage levels as well. The large FCC outages in February and March coincide with large PADD 1 crude distillation unit outages. The March unplanned outages for both crude distillation and FCC units include the full shutdown of Valero's Delaware City refinery.[3] EIA's December Market Assessment of Upcoming Planned Outages raised the issue of large outages this spring in PADD 1, although the large unplanned outages have added to constraints on March supply.

[3]Jeff Montgomery, "Valero orders shutdown for repairs," The News Journal, March 5, 2009.

Table 3. PADD 1 Crude Distillation Unit Outages (Barrels Per Day)

Month (December 08 Through March 09)	Planned	Estimated Unplanned	Estimated Total Outage Level	Typical Historical Total Outage Level
December Actual	67,742	0	67,742	1,100
January Actual	0	0	0	5,500
February Actual	0	82,679	82,679	28,000
March	0	210,200	210,200	47,000
April	18,000	13000	31,000	68,000
May	0	1700	1,700	39,000
June	0	4300	4,300	9,500

Note: Unplanned values for April through June 2009 are historical average values for 2002-2007 excluding months in 2005 and 2006 affected by hurricanes. Similarly, typical historical values are average planned outages 2002-2007 plus average unplanned outages 2002-2007 excluding 2005 and 2006 hurricane impacts. March unplanned outages includes large known unplanned outages that began during early March.
Source: Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database; excludes PADDs 1 and 5 asphalt refineries.

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

Month (December 08 Through March 09)	Planned	Estimated Unplanned	Estimated Total Outage Level	Typical Historical Total Outage Level
December Actual	0-	51,452	51,452	3,900
January Actual	40,806	0	40,806	16,000
February Actual	66,429	61,571	128,000	30,000
March	150,000	122,700	272,700	54,000
April	30,000	12,000	42,000	45,000
May	0	8,300	8,300	23,000
June	0	4,300	4,300	4,300

Note: Unplanned values for April through June 2009 are historical average values for 2002-2007 excluding months in 2005 and 2006 affected by hurricanes. Similarly, typical historical values are average planned outages 2002-2007 plus average unplanned outages 2002-2007 excluding months in 2005 and 2006 affected by hurricanes. March unplanned outages includes large known unplanned outages that began during early March.
Source: Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database.

3.3.2 PADD 2 Outages

Planned crude distillation unit outages in PADD 2 are high in March and April 2009, as shown in Table 5. PADD 2 does not show any large FCC unit outages until April and May (Table 6). While crude distillation unit outages are higher than typical in March, FCC unit outages are not. However, FCC unit outages rise above average levels in April and May.

Table 5. PADD 2. Crude Distillation Unit Outages (Barrels Per Day)

Month (December 08 Through March 09)	Planned	Estimated Unplanned	Estimated Total Outage Level	Typical Historical Total Outage Level
December Actual	47,161	0	47,161	81,000
January Actual	0	55,161	55,161	67,000
February Actual	65,429	49,286	114,714	120,000
March	445,516	59,000	504,516	340,000
April	227,200	71,000	298,200	160,000
May	0	63,000	63,000	120,000
June	0	33,000	33,000	68,000

Note: Unplanned values for April through June 2009 are historical average values for 2002-2007 excluding months in 2005 and 2006 affected by hurricanes. Similarly, typical historical values are average planned outages 2002-2007 plus average unplanned outages 2002-2007 excluding 2005 and 2006 hurricane impacts. March unplanned outages includes large known unplanned outages that began during early March.
Source: Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database; excludes PADDs 1 and 5 asphalt refineries.

Table 6. PADD 2 FCC Unit Outages (Barrels Per Day)

Month (December 08 Through March 09)	Planned	Estimated Unplanned	Estimated Total Outage Level	Typical Historical Total Outage Level
December Actual	0	22,935	22,935	18,000
January Actual	0	29,419	29,419	27,000
February Actual	0	13,929	13,929	66,000
March	65,000	17,000	82,000	110,000
April	96,167	9,000	105,167	43,000
May	76,935	23,000	99,935	35,000
June	0	9,700	9,700	15,000

Note: Unplanned values for April through June 2009 are historical average values for 2002-2007 excluding months in 2005 and 2006 affected by hurricanes. Similarly, typical historical values are average planned outages 2002-2007 plus average unplanned outages 2002-2007 excluding months in 2005 and 2006 affected by hurricanes. March unplanned outages includes large known unplanned outages that began during early March.
Source: Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database.

3.3.3 PADD 3 Outages

As seen in Table 7, PADD 3 had some fairly sizeable outages in February, but estimated total outages are below typical levels from March through June. This indicates that extra capacity will be available from March through June to help supply PADD 2 and potentially PADD 1. PADD 3 FCC outages follow the trend of the crude distillation unit outages (Table 8). The major FCC outages for PADD 3 occurred before March. The FCC outage level in May is expected to be slightly above average, but very close to normal for that time of year.

Table 7. PADD 3 Crude Distillation Unit Outages (Barrels Per Day)

Month (December 08 Through March 09)	Planned	Estimated Unplanned	Estimated Total Outage Level	Typical Historical Total Outage Level
December Actual	184,839	60,000	244,839	250,000
January Actual	433,290	104,032	537,323	460,000
February "Actual	592,964	303,893	896,857	600,000
March	258,258	150,000	408,258	470,000
April	49,833	200,000	249,833	340,000
May	67,742	160,000	227,742	350,000
June	6,333	140,000	146,333	320,000

Note: Unplanned values for April through June 2009 are historical average values for 2002-2007 excluding months in 2005 and 2006 affected by hurricanes. Similarly, typical historical values are average planned outages 2002-2007 plus average unplanned outages 2002-2007 excluding 2005 and 2006 hurricane impacts. March unplanned outages includes large known unplanned outages that began during early March.
Source: Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database; excludes PADDs 1 and 5 asphalt refineries.

Table 8. PADD 3 FCC Unit Outages (Barrels Per Day)

Month (December 08 Through March 09)	Planned	Estimated Unplanned	Estimated Total Outage Level	Typical Historical Total Outage Level
December Actual	136,194	79,813	216,006	81,000
January Actual	262,645	49,232	311,877	290,000
February Actual	389,679	188,343	578,021	310,000
March	105,419	93,000	198,419	240,000
April	0	130,000	130,000	190,000
May	53,226	71,000	124,226	110,000
June	0	110,000	110,000	120,000

Note: Unplanned values for April through June 2009 are historical average values for 2002-2007 excluding months in 2005 and 2006 affected by hurricanes. Similarly, typical historical values are average planned outages 2002-2007 plus average unplanned outages 2002-2007 excluding months in 2005 and 2006 affected by hurricanes. March unplanned outages includes large known unplanned outages that began during early March.
Source: Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database.

3.3.4 PADD 5 Outages

PADD 5's crude distillation unit outage profile is shown in Table 9. This region had large outages in December and January relative to typical levels for that time of year. The area is expecting larger than typical crude distillation unit outages again in April before dropping back again. Compared to the region's crude distillation unit outages, PADD 5 FCC outages have been higher relative to typical levels (Table 10). January and February were very high, and March may stay a bit above typical levels. However, April seems to be back in line, even though crude distillation unit outages may be higher than typical for that month. Crude distillation and FCC outages include the shutdown of the 66,000-barrel-per-day Big West Refinery in Bakersfield.[4]

[4] John Cox, "Who Wants to Buy Big West Refinery," The Bakersfield Californian, February 11, 2009.

As shown in Figure 4 (see Section 2), PADD 5 gasoline inventories have been running below typical levels since April 2008. In November 2008, they were increasing towards more typical levels but then fell back. Large outages in both crude distillation and FCC units in December and January may have hindered supply rebuilding to some extent. Large FCC outages continued from February into March. While April FCC outages are still a little high relative to typical outages at that time of year, volumes offline of about 18,000 barrels per day are much smaller than the 200,000 barrels per day offline in January. Crude distillation unit outages are large in April, but by then, FCC availability may keep gasoline from becoming tighter.

Table 9. PADD 5 Crude Distillation Unit Outages (Barrels Per Day)

Month (December 08 Through March 09)	Planned	Estimated Unplanned	Estimated Total Outage Level	Typical Historical Total Outage Level
December Actual	55,258	0	55,258	20,000
January Actual	140,361	51,097	191,458	100,000
February "Actual	81,321	66,000	147,321	260,000
March	91,548	74,600	166,148	180,000
April	126,367	71,500	197,867	58,000
May	29,032	78,000	107,032	82,000
June	0	72,800	72,800	54,000

Note: Unplanned values for April through June 2009 are historical average values for 2002-2007 excluding months in 2005 and 2006 affected by hurricanes. Similarly, typical historical values are average planned outages 2002-2007 plus average unplanned outages 2002-2007 excluding 2005 and 2006 hurricane impacts. March unplanned outages includes large known unplanned outages that began during early March.
Source: Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database; excludes PADDs 1 and 5 asphalt refineries.

Table 10. PADD 5 FCC Unit Outages (Barrels Per Day)

Month (December 08 Through March 09)	Planned	Estimated Unplanned	Estimated Total Outage Level	Typical Historical Total Outage Level
December Actual	16,129	73,548	89,677	26,000
January Actual	186,177	13,419	199,597	71,000
February Actual	127,071	17,857	144,929	86,000
March	50,000	27,000	77,000	64,000
April	11,667	6,400	18,067	16,000
May	0	3,300	3,300	5,900
June	0	22,000	22,000	23,000

Note: Unplanned values for April through June 2009 are historical average values for 2002-2007 excluding months in 2005 and 2006 affected by hurricanes. Similarly, typical historical values are average planned outages 2002-2007 plus average unplanned outages 2002-2007 excluding months in 2005 and 2006 affected by hurricanes. March unplanned outages includes large known unplanned outages that began during early March.
Source: Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database.

3.4 Other Outages

The estimated total outages for PADD 4 from March through June are not unusual. EIA also reviewed the outages being planned at the end of the distribution chain in the upper Midwest (PADD 2). These areas sometimes experience supply problems as a result of limited supply alternatives. The primary refineries supplying the Magellan Pipeline, which moves product from the Gulf Coast and lower Midwest into the upper Midwest, are showing few planned outages, and refineries directly supplying North Dakota do not look problematic this spring.

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 March through June 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, both crude distillation and FCC unit outages were larger than typical in certain months both at the total U.S. level as well as in various PADDs.

With U.S. gasoline and distillate demand during the first half of 2009 projected to decline from 2008, the larger-than-typical outages do not seem to present any major supply concerns. As was the case in the December outage report, the large outage volumes in PADD 1 could add some additional tightness, but capacity availability on the Gulf Coast and import availability should allow the region to obtain additional supply without experiencing significant price increases.

4.1 U.S. Capacity Adequacy

This section looks at the ability of refining capacity that is available after outages to meet *STEO*'s projections for refinery needs. Looking at historical refinery crude inputs for those refineries not experiencing outages and running at fairly high input levels, a "potential crude input" utilization factor (crude inputs divided by available capacity) was developed to estimate the "potential crude inputs" that could be achieved with available capacity net of outages. These "potential crude inputs" are then compared to *STEO*'s projected crude inputs.

Similarly, historical FCC inputs for refineries with no major outages and running at high input levels were analyzed to determine a ratio relationship between FCC inputs and FCC capacity. This ratio was used to estimate "potential FCC inputs" from FCC capacity available net of outages. Since *STEO* does not project FCC inputs, a second ratio had to be developed from refineries that had no major outages to compare historical FCC inputs to crude inputs. This second ratio was applied to *STEO*'s projected crude runs in order to estimate *STEO* projected FCC inputs. The "potential FCC inputs" were then compared to the estimated *STEO* projected FCC inputs.

Table 11 compares the EIA *STEO* 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. The surplus capacity of around 1.7 million barrels per day represents a possible increase in U.S. refinery utilization of 10 percent.

Table 11. U.S. Comparison of Maximum Crude Inputs from Crude Distillation Capacity Available After Outages with STEO-Projected Crude Input Needs (Thousand Barrels Per Day)

Month (December 08 Through March 09)	Actual and Projected STEO Crude Inputs	Operable Distillation Capacity	Estimated Total Distillation Outages	Distillation Capacity Net of Outages	Potential Crude Inputs (Net Capacity * 0.961)	Potential Crude Inputs minus STEO Inputs
December Actual	14,353	17,621	417	17,204	NA	NA
January Actual	14,311	17,621	784	16,837	NA	NA
February Actual	14,138	17,621	1,242	16,379	NA	NA
March	14,070	17,621	1,310	16,311	15,675	1,605
April	14,515	17,621	701	16,920	16,260	1,745
May	14,745	17,621	337	17,284	16,610	1,865
June	14,659	17,621	186	17,435	16,755	2,095

Note: January and February crude inputs are based on weekly data through February 27. March through June data are STEO-projected crude inputs. The potential crude inputs are estimated by applying a factor (0.961) that represents the average observed difference between crude input volumes and capacity in the U.S. for facilities experiencing no major outages and running at high input levels.
Sources: March 2009 Short Term Energy Outlook, Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database.

Table 12 illustrates that the available FCC capacity at the U.S. level should also be able to meet projected demand. March is the tightest month for capacity, behavior that is relatively typical during the spring maintenance cycle. After March, the surplus FCC capacity represents a possible 6-percent increase in FCC unit utilization.

Table 12. U.S. Comparison of Maximum FCC Inputs from FCC Capacity Available After Outages with Estimated STEO-Projected FCC Input Needs (Thousand Barrels Per Day)

Month (December 08 Through March 09)	Actual and STEO Projected Crude Inputs	Actual and Projected FCC Inputs (FCC Pct Crude = .352)	Operable FCC Capacity	Estimated Total Outages	Capacity Net of Outages	Potential FCC Inputs (Net Capacity * 0.985)	Potential Inputs minus STEO Inputs
December Actual	14,353	4,886	5,854	380	5,474	NA	NA
January Actual	14,311	5,037	5,854	582	5,272	NA	NA
February Actual	14,138	4,977	5,854	865	4,989	NA	NA
March	14,070	4,953	5,854	640	5,214	5,135	183
April	14,515	5,109	5,854	298	5,556	5,473	363
May	14,745	5,190	5,854	240	5,614	5,529	339
June	14,659	5,160	5,854	150	5,704	5,618	458

Note: The FCC input volumes are estimated by multiplying crude inputs by a factor (0.352) that represents the average observed ratio between FCC and crude inputs for facilities experiencing no major outages. The potential FCC inputs are estimated by applying a factor (0.985) that represents the average observed difference between FCC input volumes and capacity in the U.S. for facilities experiencing no major outages and running at high input levels.
Sources: March 2009 Short Term Energy Outlook, Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database.

4.2 Regional Capacity Adequacy

4.2.1 PADD 1 Capacity Adequacy

Large crude distillation unit and FCC outages during March in PADD 1 will reduce available capacity levels significantly, as shown in Tables 13 and 14. The projected crude and FCC inputs in the first columns of Tables 13 and 14 assume that the region will run with its typical share of U.S. crude inputs. The outages indicate the region's refineries will run at less than their typical share in March. Even though March distillation unit outages appear adequate, refiners would not likely choose to run at the potential crude input levels shown in Table 13 because of the large level of FCC outages; however, this region benefits from being able to access additional supply from PADD 3 and import sources. PADD 3 has extra capacity available, and import availability is expected to be high in 2009, as demand worldwide is expected to decline.

Table 13. PADD 1 Comparison of Maximum Crude Inputs from Crude Distillation Capacity Available After Outages with STEO-Projected Crude Input Needs (Thousand Barrels Per Day)

Month (December 08 Through March 09)	Actual and Projected STEO Crude Inputs (Regional = 0.103 U.S.)	Operable Distillation Capacity	Estimated Total Distillation Outages	Distillation Capacity Net of Outages	Potential Crude Inputs (Net Capacity * 0.979)	Potential Crude Inputs minus STEO Inputs
December Actual	1,262	1,722	68	1,654	NA	NA
January Actual	1,352	1,722	0	1,722	NA	NA
February Actual	1,238	1,722	83	1,639	NA	NA
March	1,449	1,722	210	1,512	1,480	31
April	1,495	1,722	31	1,691	1,655	160
May	1,519	1,722	2	1,720	1,684	165
June	1,510	1,722	4	1,718	1,682	172

Note: January and February crude inputs are based on weekly data through February 27. March through June data are STEO-projected crude inputs. The potential crude inputs are estimated by applying a factor (0.979) that represents the average observed difference between crude input volumes and capacity in PADD 1 for facilities experiencing no major outages and running at high input levels.
Sources: March 2009 Short Term Energy Outlook, Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database.

Table 14. PADD 1 Comparison of Maximum FCC Inputs from FCC Capacity Available After Outages with Estimated STEO-Projected FCC Input Needs (Thousand Barrels Per Day)

Month (December 08 Through March 09)	Actual and STEO Projected Crude Inputs	Actual and Projected FCC Inputs (FCC Pct Crude = 0.420)	Operable FCC Capacity	Estimated Total Outages	Capacity Net of Outages	Potential FCC Inputs (Net Capacity * 0.990)	Potential Inputs minus STEO Inputs
December Actual	1,262	583	724	51	673	NA	NA
January Actual	1,352	568	724	41	683	NA	NA
February Actual	1,238	520	724	128	596	NA	NA
March	1,449	609	724	273	452	447	(162)
April	1,495	628	724	42	682	675	48
May	1,519	638	724	8	716	709	71
June	1,510	634	724	4	720	713	79

Note: The FCC input volumes are estimated by multiplying crude inputs by a factor (0.420) that represents the average observed ratio between FCC and crude inputs for facilities experiencing no major outages. The potential FCC inputs are estimated by applying a factor (0.990) that represents the average observed difference between FCC input volumes and capacity in PADD 1 for facilities experiencing no major outages and running at high input levels.
Sources: March 2009 Short Term Energy Outlook, Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database.

4.2.2 PADD 2 Capacity Adequacy

PADD 2 outages shown in Chapter 3 were larger than typical in March, April, and May, but both available crude distillation and FCC unit capacity seems to be adequate to supply the potential demand in that region in 2009, as shown in Tables 15 and 16. This indicates that refineries not experiencing major outages would need to increase their throughput March through May to meet regional demand, without bringing in more product from other areas. Regardless, additional supply from PADD 3 would likely be available.

Table 15. PADD 2 Comparison of Maximum 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 (Regional = 0.215 U.S.)	Operable Distillation Capacity	Estimated Total Distillation Outages	Distillation Capacity Net of Outages	Potential Crude Inputs (Net Capacity * 0.984)	Potential Crude Inputs minus STEO Inputs
December Actual	3,154	3,658	47	3,611	NA	NA
January Actual	3,094	3,658	55	3,603	NA	NA
February Actual	3,155	3,658	115	3,543	NA	NA
March	3,025	3,658	505	3,154	3,103	78
April	3,121	3,658	298	3,360	3,306	186
May	3,170	3,658	63	3,595	3,538	367
June	3,152	3,658	33	3,625	3,567	415

Note: January and February crude inputs are based on weekly data through February 27. March through June data are STEO-projected crude inputs. The potential crude inputs are estimated by applying a factor (0.984) that represents the average observed difference between crude input volumes and capacity in PADD 2 for facilities experiencing no major outages and running at high input levels.
Sources: March 2009 Short Term Energy Outlook, Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database.

Table 16. PADD 2 Comparison of Maximum FCC Inputs from FCC Capacity Available After Outages with Estimated STEO-Projected FCC Input Needs (Thousand Barrels Per Day)

Month (December 08 Through March 09)	Actual and STEO Projected Crude Inputs	Actual and Projected FCC Inputs (FCC Pct Crude = 0.330)	Operable FCC Capacity	Estimated Total Outages	Capacity Net of Outages	Potential FCC Inputs (Net Capacity * 0.961)	Potential Inputs minus STEO Inputs
December Actual	3,154	978	1,293	23	1,270	NA	NA
January Actual	3,094	1,021	1,293	29	1,264	NA	NA
February Actual	3,155	1,041	1,293	14	1,279	NA	NA
March	3,025	998	1,293	82	1,211	1,163	165
April	3,121	1,030	1,293	105	1,188	1,141	111
May	3,170	1,046	1,293	100	1,193	1,146	100
June	3,152	1,040	1,293	10	1,283	1,233	193

Note: The FCC input volumes are estimated by multiplying crude inputs by a factor (0.330) that represents the average observed ratio between FCC and crude inputs for facilities experiencing no major outages. The potential FCC inputs are estimated by applying a factor (0.961) that represents the average observed difference between FCC input volumes and capacity in PADD 2 for facilities experiencing no major outages and running at high input levels.
Sources: March 2009 Short Term Energy Outlook, Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database.

4.2.3 PADD 3 Capacity Adequacy

PADD 3 had experienced large outages prior to March 2009. From March through June, outage levels are expected to be near or below typical levels. Because PADD 1 and PADD 2 might need some extra supply, PADD 3 supply is included in Tables 17 and 18 to show the extra crude and FCC inputs that might be available to the other regions. The last column in Tables 17 and 18 indicate that most of the U.S. capacity surplus shown in Tables 11 and 12 seems to be in PADD 3.

Table 17. PADD 3 Comparison of Maximum Crude Inputs from Crude Distillation Capacity Available After Outages with STEO-Projected Crude Input Needs (Thousand Barrels Per Day)

Month (December 08 Through March 09)	Actual and Projected STEO Crude Inputs (Regional = 0.480 U.S.)	Operable Distillation Capacity	Estimated Total Distillation Outages	Distillation Capacity Net of Outages	Potential Crude Inputs (Net Capacity * 0.991)	Potential Crude Inputs minus STEO Inputs
December Actual	7,145	8,416	245	8,171	NA	NA
January Actual	6,870	8,416	537	7,878	NA	NA
February Actual	6,669	8,416	897	7,519	NA	NA
March	6,749	8,416	408	8,008	7,935	1,186
April	6,963	8,416	250	8,166	8,092	1,130
May	7,073	8,416	228	8,188	8,114	1,041
June	7,032	8,416	146	8,269	8,195	1,163

Note: January and February crude inputs are based on weekly data through February 27. March through June data are STEO-projected crude inputs. The potential crude inputs are estimated by applying a factor (0.991) that represents the average observed difference between crude input volumes and capacity in PADD 3 for facilities experiencing no major outages and running at high input levels.
Sources: March 2009 Short Term Energy Outlook, Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database.

Table 18. PADD 3 Comparison of Maximum FCC Inputs from FCC Capacity Available After Outages with Estimated STEO-Projected FCC Input Needs (Thousand Barrels Per Day)

Month (December 08 Through March 09)	Actual and STEO Projected Crude Inputs	Actual and Projected FCC Inputs (FCC Pct Crude = 0.366)	Operable FCC Capacity	Estimated Total Outages	Capacity Net of Outages	Potential FCC Inputs (Net Capacity * 0.965)	Potential Inputs minus STEO Inputs
December Actual	7,145	2,565	3,118	216	2,902	NA	NA
January Actual	6,870	2,515	3,118	312	2,806	NA	NA
February Actual	6,669	2,441	3,118	578	2,540	NA	NA
March	6,749	2,470	3,118	198	2,920	2,818	347
April	6,963	2,548	3,118	130	2,988	2,884	335
May	7,073	2,589	3,118	124	2,994	2,889	300
June	7,032	2,574	3,118	110	3,008	2,903	329

Note: The FCC input volumes are estimated by multiplying crude inputs by a factor (0.366) that represents the average observed ratio between FCC and crude inputs for facilities experiencing no major outages. The potential FCC inputs are estimated by applying a factor (0.965) that represents the average observed difference between FCC input volumes and capacity in PADD 3 for facilities experiencing no major outages and running at high input levels.
Sources: March 2009 Short Term Energy Outlook, Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database.

4.2.4 PADD 5 Capacity Adequacy

Tables 19 and 20 show that, in spite of large crude distillation and FCC unit outages in PADD 5, available capacity net of outages should be available to run and process adequate crude and FCC feedstock to meet expected demand levels.

Table 19. PADD 5 Comparison of Maximum Crude Inputs from Crude Distillation Capacity Available After Outages with STEO-Projected Crude Input Needs (Thousand Barrels Per Day)

Month (December 08 Through March 09)	Actual and Projected STEO Crude Inputs (Regional = 0.169 U.S.)	Operable Distillation Capacity	Estimated Total Distillation Outages	Distillation Capacity Net of Outages	Potential Crude Inputs (Net Capacity * 0.878)	Potential Crude Inputs minus STEO Inputs
December Actual	2,436	3,195	55	3,140	NA	NA
January Actual	2,455	3,195	191	3,003	NA	NA
February Actual	2,534	3,195	147	3,047	NA	NA
March	2,374	3,195	166	3,029	2,659	286
April	2,449	3,195	198	2,997	2,631	183
May	2,488	3,195	107	3,088	2,711	224
June	2,473	3,195	73	3,122	2,741	268

Note: January and February crude inputs are based on weekly data through February 27. March through June data are STEO-projected crude inputs. The potential crude inputs are estimated by applying a factor (0.878) that represents the average observed difference between crude input volumes and capacity in PADD 5 for facilities experiencing no major outages and running at high input levels.
Sources: March 2009 Short Term Energy Outlook, Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database.

Table 20. PADD 5 Comparison of Maximum FCC Inputs from FCC Capacity Available After Outages with Estimated STEO-Projected FCC Input Needs (Thousand Barrels Per Day)

Month (December 08 Through March 09)	Actual and STEO Projected Crude Inputs	Actual and Projected FCC Inputs (FCC Pct Crude = 0.295)	Operable FCC Capacity	Estimated Total Outages	Capacity Net of Outages	Potential FCC Inputs (Net Capacity * 0.945)	Potential Inputs minus STEO Inputs
December Actual	2,436	601	891	90	801	NA	NA
January Actual	2,455	724	891	200	691	NA	NA
February Actual	2,534	748	891	145	746	NA	NA
March	2,374	700	891	77	814	769	69
April	2,449	722	891	18	873	825	103
May	2,488	734	891	3	888	839	105
June	2,473	730	891	22	869	821	92

Note: The FCC input volumes are estimated by multiplying crude inputs by a factor (0.295) that represents the average observed ratio between FCC and crude inputs for facilities experiencing no major outages. The potential FCC inputs are estimated by applying a factor (0.945) that represents the average observed difference between FCC input volumes and capacity in PADD 5 for facilities experiencing no major outages and running at high input levels.
Sources: March 2009 Short Term Energy Outlook, Industrial Info Resource (IIR) www.iirenergy.com, March 2, 2009 database.

5. Outage Impacts on Production

Chapter 4 assessed the adequacy of capacity relative to input requirements, as projected by the EIA *STEO*. 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 through June 2009. Because the mix of supply from imports, inventories, and production all may vary, this chapter explores the potential gasoline and distillate production that available capacity (net of outages) might produce.

Unit outages have varying impacts on production, but adequate statistical relationships exist to estimate 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.

In any given region, the underlying assumption is that refiners with available capacity can increase their throughputs and thus production to help fill in for capacity offline. The dynamics of this process, however, are influenced by current market conditions. With falling demand, declining margins, and available imports, refiners with available capacity may not respond immediately if the market begins to tighten. The price response is the signal to refiners to produce more supply, and in weak markets, refiners are unlikely to produce supply in advance of a potential supply problem. This means some price increase could occur before refiners increase production from available capacity.

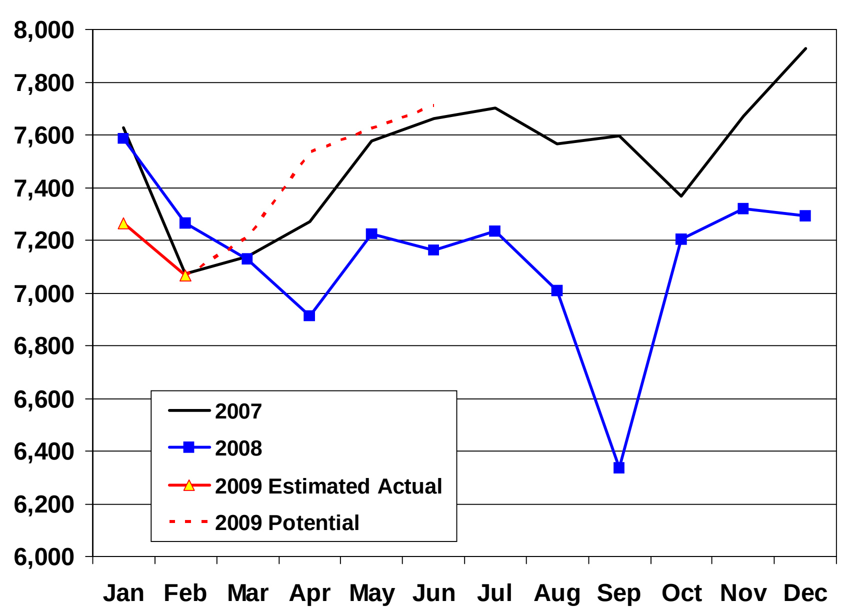
Figures 11 and 12 illustrate U.S. actual refinery gasoline and distillate production for 2007 and 2008, estimated production for January and February of 2009, and potential refinery production for March through June 2009. Potential production is derived using the models in Appendix A, assuming maximum inputs of crude and unfinished oils and maximum FCC inputs from available capacity net of outages.

Apart from the hurricanes, refinery inputs and associated product output in 2008 and January and February of 2009 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. That situation is expected to continue in 2009.

Gasoline production potential at the U.S. level is well above what was needed to meet 2008 demand. On a regional basis, PADD 5 has low gasoline inventories, but PADD 5 available capacity adjusted for outages should be adequate to meet demand, even with the loss of the Big West Bakersfield refinery. PADD 1 inventories, which had dropped substantially from the end of February through early March, have recovered to end in the typical range for this time of year. Large outages in PADD 1 during March have been countered to some extent with increased gasoline imports. PADD 1 is normally dependent on gasoline imports and products from PADD 3. As some of the PADD 1 outages spill into April, prices may have to increase some in order to attract the extra supply from these outside areas. PADD 2 is expected to have higher than normal outages in April and May, but extra capacity should be available from PADD 3 to meet PADD 2 demand. Some of the recent gasoline inventory increases in PADD 2 may indicate preparation for upcoming outages.

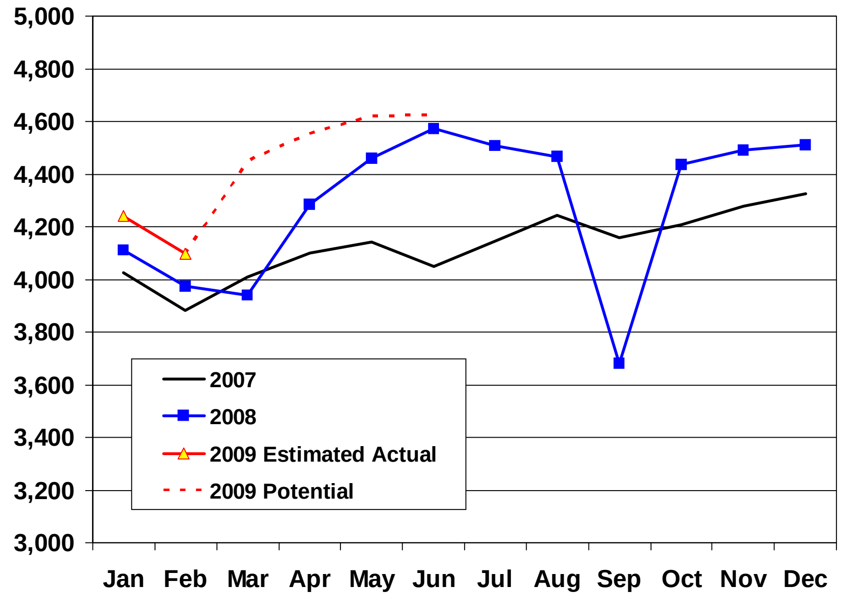
Distillate supply going into the summer appears ample. Inventories are high and the export market for distillate may be weakening over what occurred in 2008, which indicates distillate margins may be lower than margins last year. No outage-related problems are evolving on a regional basis through June 2009.

Figure 11. U.S. Monthly Refinery Gasoline Actual and Potential Production, 2007-June 2009 (Thousand Barrels Per Day)



Note: Refinery gasoline production represents finished gasoline and blending components excluding oxygenates, pentanes plus, and butane.
Source: Actual: 2006 – 2008, EIA *Petroleum Supply Monthly*, and January - February Estimated from actual crude runs; Potential – December 2008-March 2009 EIA projections based on available capacity.

Figure 12. U.S. Monthly Distillate Actual and Potential Production, 2007-June 2009 (Thousand Barrels Per Day)



Note: Refinery gasoline production represents finished gasoline and blending components excluding oxygenates, pentanes plus, and butane.
Source: Actual: 2006 – 2008, EIA *Petroleum Supply Monthly*, and January - February Estimated from actual crude runs; Potential – December 2008-March 2009 EIA projections based on available capacity.

6. Conclusion and Assessment

At the U.S. level, available capacity adjusted for outages is adequate to meet projected demand through June 2009. Although outages are higher than typical in some months, demand is expected to be lower than last year. As a result, we expect refiners generally will be running at input levels below capacity limits. Distillate capacity is expected to be adequate, but some regional shifts in gasoline production may be needed to cover for outages. The region with the tightest potential gasoline supply-demand balance is PADD 1 in March, when the level of planned and expected unplanned FCC outages leaves less local gasoline production than usual to meet projected demand. With low gasoline inventory levels, additional supply from PADD 3 and from imports is needed. Although this additional supply should be available, some price increases could occur to attract the extra volume.

In EIA's view, an effort to encourage greater coordination among refiners is unlikely to ameliorate the possible impacts of March planned outages in PADD 1, as they are underway. Perhaps the best preparation to minimize potential price impacts would be the recognition of less potential for opportunistic purchases, the arrangement for additional contracts, and thus the reduction in reliance on opportunistic supply. This report should help to alert wholesale buyers who normally rely on opportunistic supply 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. Planned outages in these areas should not result in supply shortages that would result in significant price increases in distillate or gasoline through June 2009.

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 gasoline and distillate production for the U.S., the estimation results for which are 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.

$$y_{D,t} = c + \sum_{i=0}^{1} \delta_i x_{t-i} + \sum_{i=1}^{3} \beta_i z_{i,t} + \sum_{i=1}^{11} \gamma_i m_i + \tau_1 T + \alpha_1 y_{D,t-1} + \varepsilon_t \qquad \text{Eqn. 1.}$$

$$y_{G,t} = c' + \alpha_1' w_t + \beta_1' z_{1,t-1} + \beta_3' z_{3,t} + \sum_{i=1}^{11} \gamma_i' m_i + \tau_1' C + \alpha_1' y_{G,t-1} + \varepsilon_t \qquad \text{Eqn. 2.}$$

Where

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

w_t refers to catalytic cracker inputs (gasoline) at time t;

x_t refers to refinery crude oil inputs (distillate) at time t;

z_{it} refers to margin i (z_{1t} = gasoline, z_{2t} = heating oil, z_{3t} = diesel) at time t;

m_i refers to monthly indicator variables;

T refers to a linear time trend;

C refers to a two-year cycle variable, with maxima in March of odd years;

ε_t refers to error term at time t.

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

The distillate equation was estimated using data from January 1995 through December 2008, while the U.S. gasoline began in January 2002. For the distillate output model, *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 model, 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. models are summarized in Tables A-1 and A-2.

As has been previously demonstrated (see "Market Assessment of Upcoming Planned Refinery Outages, December 2008 – March 2009," DOE/EIA-0641(2008)/2, http://www.eia.doe.gov/pub/oil_gas/petroleum/feature_articles/2008/outage2008/outage2008.pdf), 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 and providing good out-of-sample forecasts.

Table A-1. U.S. Distillate Production Model

Independent Variable: finish_distillate_US

Parameter	*Estimated Coefficient*	
C	-732.595	***
crude_input_US	0.296564	***
crude_input_US (-1)	-0.150271	***
margin_heatoil	4.50064	***
margin_diesel (-1)	2.16499	**
margin_mogas	-2.22481	***
Trend	0.638200	*
JAN	-20.5704	
FEB	93.6505	***
MAR	47.4728	
MAY	-4.68211	
JUN	-38.9552	
JUL	-27.5452	
AUG	22.7403	
SEP	37.5175	
OCT	135.680	***
NOV	86.9849	***
DEC	-34.0981	
finish_distillate_US(-1)	0.544749	***
adj. R Squared	0.961	
std. error of reg.	72.3	
mean of dep. variable	3681	
Note: *** indicates significance at 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.		

Table A-2. U.S. Gasoline Production Model

Independent Variable: finish_mogas_US

Parameter	*Estimated Coefficient*	
C	2153.43	***
FCCinput_US	0.808457	***
margin_mogas(-1)	4.17059	***
JAN	191.198	***
FEB	-22.5657	
MAR	-82.5653	
MAY	21.4293	
JUN	-5.66144	
JUL	-1.22477	
AUG	-48.2868	
SEP	43.7210	
OCT	56.5904	
NOV	307.564	***
DEC	392.324	***
finish_mogas_US(-2)	0.131480	**
Cycle (-2)	-65.5497	***
margin_diesel	-2.11856	***
adj. R Squared	0.919	
std. error of reg.	85.4	
mean of dep. variable	7495	
Note: *** indicates significance at 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.		