Including the Emission Effects of Refinery Cases and Settlements in Projections for the EPA's CAAA Section 812 Analysis

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ABSTRACT

Through its refinery initiative, EPA has established consent decrees with most of the U.S. refinery companies to reduce their air pollution emissions. As part of the EPA's Second Section 812 Prospective, an analysis of the costs and benefits of the Clean Air Amendments is being performed, and this analysis includes emission projections to 2010 and 2020. Because the petroleum refinery consent decrees are expected to produce significant criteria pollutant emission reductions by 2010, it was important to include their effects in the point source emission projections. This was accomplished by reviewing the consent decrees to determine the expected company-specific emission reduction estimates, prioritizing the companies to evaluate the settlements with the largest expected emission reductions, and focusing on the companies, facilities, and units with the most significant expected emission changes. Because the refinery settlements most affect SO_2 and NO_x, this analysis focuses on the parts of the settlements that affect SO_2 and NO_x emissions. This paper describes how the consent decree provisions were translated into refinery and unit-specific SO_2 and NO_x control requirements for fluid catalytic cracking units, and process heaters and boilers, and incorporated in emission projection files for a national/regional modeling analysis.

INTRODUCTION

Section 812 of the Clean Air Act Amendments of 1990 (CAAA) requires the U.S. Environmental Protection Agency (EPA) to perform periodic, comprehensive analyses of the total costs and total benefits of programs implemented pursuant to the Clean Air Act (CAA). The first analysis required was a retrospective analysis, addressing the original CAA and covering the period 1970 to 1990. The retrospective was completed in 1997. Section 812 also requires performance of prospective cost-benefit analyses, the first of which was completed in 1999. The prospective analyses address the incremental costs and benefits of the CAAA. The first prospective covered implementation of the CAAA over the period 1990 to 2010.

EPA's Office of Air and Radiation (OAR) began work on the second prospective with the drafting of an analytical plan for the study. This analytical plan was reviewed by the EPA Science Advisory Board (SAB), and the SAB provided comments, which have been incorporated into the technical analysis planning. This paper describes the portion of the development of projection year emission estimates for 2010 and 2020 from a 2002 base year that incorporated the effects of EPA's Petroleum Refinery Initiative.

The scope of this analysis is to estimate future emissions of all criteria pollutants except lead: volatile organic compounds (VOCs), oxides of nitrogen (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter of 10 microns or less (PM_{10}), and particulate matter with an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$). Estimates of current and future year ammonia (NH_3) emissions are also included in this study because of their importance in the atmospheric formation of secondary particles.

BODY

EPA has judicial settlements with a number of companies that own U.S. petroleum refineries. For this analysis, Pechan incorporated the expected emission reductions and costs of these consent decrees in its *with-CAAA* scenario analyses for 2010 and 2020. The focus of the 812 emission projections is on criteria air pollutants, and because the refinery settlements most affect SO_2 and NO_x this analysis focuses on the parts of the settlements that affect SO_2 and NO_x emissions. Because of resource constraints, not all of the refineries affected by consent decrees are included in this analysis. Prioritization was established based on a ranking of the EPA-estimated criteria pollutant emission reductions by company. The companies with the largest expected emission reductions were included in this study. Table 1 lists the companies and individual refineries that were evaluated in this study. This table also provides information about the fluid catalytic cracking units (FCCUs) and heater/boiler emission control requirements for each refinery.

Because of the large number of refineries whose post-2000 emissions are affected by these settlements, we examined a sample of the settlements to determine where there might be common elements that could be combined into one or more model rules to most efficiently simulate the effect of the settlements. Knowing where there are differences among the settlement requirements as well as the parameters that determine the differences helped in designing an approach that would be used along with the 2002 EPA National Emission Inventory and future year activity indicators to estimate 2010 and 2020 refining emissions.

The five major refinery sources that are affected by the judicial settlements are:

1. FCCUs/Fluid Coking Units (FCUs)
2. Process Heaters and Boilers
3. Flare Gas Recovery
4. Leak Detection and Repair
5. Benzene/Wastewater

The control requirements and variations on this theme by these source types can be summarized as follows:

1. FCCU/FCU:

    a. SO_2 Option 1 – Install wet gas scrubbers
    Option 2 – Use catalyst additives
    Option 3 – Use existing wet gas scrubber

    b. NO_x Option 1 – Install selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR)
    Option 2 – Use catalyst additives

2. Heaters/Boilers

Control requirements apply to boilers and heaters that are 40 million British thermal units (MMBtu) per hour capacity or larger. Some emission source summaries list process heaters/boilers greater than 100 MMBtu per hour separately, but the requirements do not appear to be different from what is required for 40-100 MMBtus. In many cases, the consent decrees establish NO_x emission reduction objectives across a number of refineries that are owned by the same firm. Therefore, the companies have some discretion in deciding which individual boilers/heaters to control as well as the control techniques to apply.

- SO_2 Eliminate burning of solid and liquid fuels
- NO_x Install ultra-low NO_x burners (ULNB) or other technologies to reduce overall NO_x emissions from heaters and boilers greater than 40 MMBtu per hour

3. Flare Gas Recovery

Meet new source standards at all sulfur recovery plants and most hydrocarbon flares. Install flare gas recovery systems and take other actions to reduce emissions from process upsets. Reroute and eliminate sulfur pit emissions. Implement protocol to diagnose and prevent upsets that result in significant releases of SO_2 and other gases.

4. Leak Detection and Repair

Implement an enhanced program for identifying and repairing leaking valves and pumps, through more frequent monitoring, the use of more stringent definitions of what constitutes a leak, and regular auditing of each facility's leak detection and repair program.

5. Benzene/Wastewater

Develop an enhanced program for ensuring compliance with benzene waste management practices through comprehensive auditing, regular monitoring, and improved emission controls (e.g., secondary carbon canisters and water scrubbers).

Issues related to modeling the refinery settlement associated emission reductions are as follows:

1) Finding the FCCU/FCU records in the 2002 EPA NEI was straightforward in most situations because most refineries have one or two of these units and there are a limited number of associated SCCs. We did find one refinery where the FCCU emissions were zero, but the CO boilers had large estimated NO_x and SO_2 emissions. We applied the FCCU control requirements to the CO boiler emissions.

2) FCCU SO_2 control requirements were modeled as follows:

   - New wet gas scrubber – a 90 percent SO_2 control efficiency was applied or the specific control efficiency listed in the consent decree, which may be slightly different from 90 percent.

   - Catalyst additives – where required to reduce FCCU SO_2 emissions, a 70 percent control efficiency was applied. The 70 percent control efficiency was estimated from information in the literature about the expected SO_2 emission reductions of this control technique (EPA, 1989).

   - If there was no requirement, or an existing wet gas scrubber, no additional control efficiency was applied. This may underestimate the reductions at refineries with existing wet gas scrubbers that will have to make some upgrades to their scrubbers.

3) Heater/boiler SO_2 control requirements were not applied in this analysis because it was found that there were very few fuel oil burning heaters and boilers at refineries in the NEI.

4) Heater/boiler NO_x controls for the units to which they are applied were determined to be equivalent to meeting a 0.04 lbs per million Btu NO_x emission rate. Meeting this emission reduction requirement is expected to provide an average NO_x emission reduction of 50 percent from 2002 levels.

5) Some refineries in the 2002 NEI have provided estimates of their boiler and process heater capacities. When these estimates are provided, they are used to determine which units are subject to the boiler/heater SO_2 and NO_x control requirements (all units > 40 million Btu/hour with non-zero emissions are assumed to be subject to the control requirements). For refineries that do not provide the capacity values, controls were applied to all heaters and boilers with 2002 NO_x emissions above 10 tpy.

6) While the other requirements of the settlements are expected to produce additional emission reductions beyond those applied to FCCUs/FCUs and boilers and heaters, these emission reductions were not incorporated in our emission projections. The flare gas recovery, leak detection and repair, and benzene/wastewater requirements are expected to produce less significant changes in criteria air pollutant emissions, plus these are source types for which the 2002 NEI emissions estimates are expected to be much more uncertain than they are for the combustion categories.

CONCLUSIONS

One of the uncertainties in translating the requirements of each company-specific refining settlement into expected unit-specific emission reductions is that the NO_x emission constraint is often expressed as a company-wide limit. Each company has some discretion in determining the appropriate mix of NO_x-emitting boilers and heaters and NO_x control techniques to use in order to meet the company-wide targets.

States that expect to need further NO_x emission reductions from the stationary sources in and around their nonattainment areas are concerned about the potential uncertainty in how many refinery boilers and heaters will actually be controlled under the terms of the refinery settlements. This is an issue of concern in the Ozone Transport Commission States where NO_x emission reductions beyond what the consent decrees require may be needed from the petroleum refineries in Delaware, New Jersey, and Pennsylvania. The NO_x control factors developed for this study could be applied to fewer, or more boilers and heaters at these refineries to test the sensitivity of regional NO_x emissions to how the refinery companies implement the consent decrees.

Some of the primary SO_2 and NO_x sources at the petroleum refineries affected by cases and settlements may also be best available retrofit technology (BART)-eligible sources under EPA's regional haze rule. Therefore, the SO_2 and NO_x control technologies that are either required under the terms of the settlements, or are selected by each company for installation as part of their compliance plan (i.e., NO_x controls at heaters and boilers) are important considerations in determining BART for any individual source. It may be that the control techniques prescribed by the settlements establish an effective BART for these source types, or the required control techniques could effectively serve as a BART floor.

Very few States report the design capacities of their units. If they did so, it would be much simpler to identify the units that are likely to be controlled under the terms of these settlements.

In applying the expected effects of the settlements to individual sources at the affected refineries, there are alternative ways to express the expected emission changes. The NO_x and SO_2 control factors developed for this study were designed to be applied as percentage reductions to base year emission levels. While this approach may over- or under-estimate the emission reductions at any individual unit,

this approach is believed to be superior to ones that attempt to apply facility-wide emission reductions (expressed in tons per year) because the base or future year emission estimates may be inconsistent with the basis used for estimating the facility-wide values.

One of the limitations of this analysis is that it does not include refinery settlements that occurred after September 2005. Therefore, it does not include the future emission reductions associated with the Exxon-Mobil refinery settlement that was announced in October 2005. In total, EPA's Office of Compliance and Enforcement Assurance estimates that the national emission reductions associated with the refinery settlements as of September 2005 will be about 60 thousand tons per year of NO_x and 210 thousand tons per year of SO_2. These estimates are based on information that EPA received directly from each refining company as part of the settlement process.

REFERENCES

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KEY WORDS

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Table 1. Refinery-specific summary of consent decree requirements.

			FCCU Requirements		Heater/Boiler Requirements	
Company	**Location**	**State**	**SO_2**	**NO_x**	**SO_2**	**NO_x**
BP Amoco	Carson	CA	SO_2 catalyst additive	Low NO_x combustion promoter and NO_x adsorbing catalyst additive designed to achieve 20 parts per million volume displacement (ppmvd)	Elimination of oil burning and restricting H_2S in refinery fuel gas	Use qualifying controls to reduce NO_x emissions by 9632 tpy.
BP Amoco	Whiting	IN	FCU 500: Install wet gas scrubber; FCU 600: Use SO_2 adsorbing catalyst additive and/or hydrotreatment.	FCU 600: Install SCR; FCU 500: Low NO_x combustion promoter and NO_x adsorbing catalyst additive	Elimination of oil burning and restricting H_2S in refinery fuel gas	Use qualifying controls to reduce NO_x emissions by 9632 tpy.
BP Amoco	Mandan	ND	Install wet gas scrubber		Elimination of oil burning and restricting H_2S in refinery fuel gas	Use qualifying controls to reduce NO_x emissions by 9632 tpy.
BP Amoco	Toledo	OH	SO_2 catalyst additive	Install SNCR system	Elimination of oil burning and restricting H_2S in refinery fuel gas	Use qualifying controls to reduce NO_x emissions by 9632 tpy.
BP Amoco	Texas City	TX	FCCU3: Install wet gas scrubber; FCCU2: SO_2 catalyst additive; FCCU1: Continue hydrotreatment	FCCU 2: Install SCR to achieve 20 ppmvd or lower; FCCU 1 and FCCU 3: Low NO_x combustion promoter and NO_x adsorbing catalyst additive	Elimination of oil burning and restricting H_2S in refinery fuel gas	Use qualifying controls to reduce NO_x emissions by 9632 tpy.
BP Amoco	Salt Lake City	UT	Meet an SO_2 limit of 9.8 kg/1000 kg coke burnoff		Elimination of oil burning and restricting H_2S in refinery fuel gas	Use qualifying controls to reduce NO_x emissions by 9632 tpy.
BP Amoco	Yorktown	VA	Use SO_2 adsorbing catalyst additive		Elimination of oil burning and restricting H_2S in refinery fuel gas	Use qualifying controls to reduce NO_x emissions by 9632 tpy.
BP Amoco	Cherry Point	WA				
CITGO	Corpus Christi	TX	SO_2 reducing additives	FCCU1: Low NO_x combustion promoter (20 ppmvd limit); FCCU2: 23 ppmvd NO_x limit	Comply with NSPS Subparts A and J for fuel gas combustion devices. Eliminate fuel oil burning.	Use qualifying controls to reduce NO_x emissions from listed units by at least 50% of the revised baseline
CITGO Asphalt Refining Co.	Savannah	GA	No FCCU	No FCCU	Comply with NSPS Subparts A and J for fuel gas combustion devices. Eliminate fuel oil burning.	Use qualifying controls to reduce NO_x emissions from one heater or boiler
CITGO Asphalt Refining Co.	Paulsboro	NJ	No FCCU	No FCCU	Comply with NSPS Subparts A and J for fuel gas combustion devices. Eliminate fuel oil burning.	Use qualifying controls to reduce NO_x emissions from one heater or boiler
CITGO Global Refinery	Lemont	IL	New wet gas scrubber	Low NO_x combustion promoter (20 ppmvd limit)	Comply with NSPS Subparts A and J for fuel gas combustion devices. Eliminate fuel oil burning.	Use qualifying controls to reduce NO_x emissions from listed units by at least 50% of the revised baseline

Table 1 (continued).

			FCCU Requirements		Heater/Boiler Requirements	
Company	**Location**	**State**	**SO_2**	**NO_x**	**SO_2**	**NO_x**
CITGO Petroleum Company	Lake Charles	LA	Unit A - SO_2 reducing additives; Unit B - New wet gas scrubber; Unit C - New wet gas scrubber	Low NO_x combustion promoter (20 ppmvd limit)	Comply with NSPS Subparts A and J for fuel gas combustion devices. Eliminate fuel oil burning.	Use qualifying controls to reduce NO_x emissions from listed units by at least 50% of the revised baseline
Conoco Philips Global Refinery	Borger	TX	Install 2 new wet gas scrubbers (to achieve 25 ppmvd)	FCCUs 29 and 40: Enhanced SCR	Subject to NSPS Subparts A and J for fuel gas combustion devices	Use qualifying controls to reduce NO_x emissions from combustion units by 4951 tpy
Conoco Philips Global Refinery	Belle Chasse (Alliance)	LA	Install new wet gas scrubber (to achieve 25 ppmvd)	Scrubber-based NO_x emission reduction technology to achieve 20 ppmvd	Subject to NSPS Subparts A and J for fuel gas combustion devices	Use qualifying controls to reduce NO_x emissions from combustion units by 4951 tpy
Conoco Philips Global Refinery	Linden (Bayway)	NJ	Existing wet gas scrubber (25 ppmvd or lower)	Enhanced SNCR	Subject to NSPS Subparts A and J for fuel gas combustion devices	Use qualifying controls to reduce NO_x emissions from combustion units by 4951 tpy, plus install SCR on crude pipe still heater
Conoco Philips Global Refinery	Sweeny	TX	Hydrotreating the feed. SO_2 catalyst additives at FCCUs 3 and 27.	FCCU 27: Install an SCR system. By 2010, meet 20 ppmvd limit; FCCU 3: Catalyst additives and low NO_x combustion promoters	Subject to NSPS Subparts A and J for fuel gas combustion devices	Use qualifying controls to reduce NO_x emissions from combustion units by 4951 tpy
Conoco Philips Global Refinery	Carson	CA			Subject to NSPS Subparts A and J for fuel gas combustion devices	Use qualifying controls to reduce NO_x emissions from combustion units by 4951 tpy
Conoco Philips Global Refinery	Wilmington	CA	SO_2 catalyst additives	NO_x catalyst additives and low NO_x combustion promoters	Subject to NSPS Subparts A and J for fuel gas combustion devices	Use qualifying controls to reduce NO_x emissions from combustion units by 4951 tpy
Conoco Philips Global Refinery	Ferndale	WA	Existing wet gas scrubber (25 ppmvd or lower)	Enhanced SNCR	Subject to NSPS Subparts A and J for fuel gas combustion devices	Use qualifying controls to reduce NO_x emissions from combustion units by 4951 tpy
Conoco Philips Global Refinery	Rodeo	CA			Subject to NSPS Subparts A and J for fuel gas combustion devices	Use qualifying controls to reduce NO_x emissions from combustion units by 4951 tpy
Conoco Philips Global Refinery	Santa Maria	CA			Subject to NSPS Subparts A and J for fuel gas combustion devices	Use qualifying controls to reduce NO_x emissions from combustion units by 4951 tpy
Conoco Philips Global Refinery	Trainer	PA	Install new wet gas scrubber (25 ppmvd or lower)	Enhanced SNCR	Subject to NSPS Subparts A and J for fuel gas combustion devices	Use qualifying controls to reduce NO_x emissions from combustion units by 4951 tpy
Conoco Philips Global Refinery	Roxanna (Wood River)	IL	Install new wet gas scrubber (25 ppmvd or lower)	FCCU 1: Scrubber-based NO_x emission reduction technology to achieve 20 ppmvd	Subject to NSPS Subparts A and J for fuel gas combustion devices	Use qualifying controls to reduce NO_x emissions from combustion units by 4951 tpy
Conoco Philips Global Refinery	Hartford (Wood River)	IL	Install new wet gas scrubber (25 ppmvd or lower)	FCCU 2: Enhanced SNCR	Subject to NSPS Subparts A and J for fuel gas combustion devices	Use qualifying controls to reduce NO_x emissions from combustion units by 4951 tpy
Deer Park Refinery (Shell Oil Company)	Deer Park	TX	Install new wet gas scrubber (25 ppmvd or lower)	Install SCR designed to achieve 20 ppmvd	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Use qualifying controls to reduce NO_x emissions from combustion units

Table 1 (continued).

			FCCU Requirements	Heater/Boiler Requirements		
Company	**Location**	**State**	**SO_2**	**NO_x**	**Company**	**Location**
Equilon	Anacortes	WA	Install a wet gas scrubber (to achieve 25 ppmvd or lower on a 365-day rolling average basis)	Apply NO_x adsorbing catalyst additive and low NO_x CO combustion promoter	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Reduce overall NO_x emissions from the controlled heaters and boilers at the company's refineries by about 6,500 tpy. Reduction via NO_x controls, unit shutdowns, and acceptance of lower permitted emission levels.
Equilon	Bakersfield	CA	No FCCU	No FCCU	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Reduce overall NO_x emissions from the controlled heaters and boilers at the company's refineries by about 6,500 tpy. Reduction via NO_x controls, unit shutdowns, and acceptance of lower permitted emission levels.
Equilon	Martinez	CA	Optimize existing use of SO_2 Adsorbing Catalyst Additive. Incorporate lower SO_2 emission limits into operating permits.	Optimize existing SNCR system	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Reduce overall NO_x emissions from the controlled heaters and boilers at the company's refineries by about 6,500 tpy. Reduction via NO_x controls, unit shutdowns, and acceptance of lower permitted emission levels.
Equilon	Wilmington	CA	Optimize existing use of SO_2 Adsorbing Catalyst Additive. Incorporate lower SO_2 emission limits into operating permits.	Apply NO_x adsorbing catalyst additive and low NO_x CO combustion promoter	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Reduce overall NO_x emissions from the controlled heaters and boilers at the company's refineries by about 6,500 tpy. Reduction via NO_x controls, unit shutdowns, and acceptance of lower permitted emission levels.
Marathon Ashland Refinery	Robinson	IL	Existing wet gas scrubber	Catalyst additive	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Reduce overall NO_x emissions from the controlled heaters and boilers at MAP refineries by 4,000 tpy. Control methods can include: SCR or SNCR; ULNB; technologies to reach 0.040 lbs per MMBtu or lower; alternate SO_2 single burner technology to achieve 0.055 lbs per MMBtu or lower; unit shutdowns.
Marathon Ashland Refinery	Catlettsburg	KY	New wet gas scrubber on unit 1; catalyst additive on other unit	Apply NO_x adsorbing catalyst additive plus SNCR	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Reduce overall NO_x emissions from the controlled heaters and boilers at MAP refineries by 4,000 tpy. Control methods can include: SCR or SNCR; ULNB; technologies to reach 0.040 lbs per MMBtu or lower; alternate SO_2 single burner technology to achieve 0.055 lbs per MMBtu or lower; unit shutdowns.

Table 1 (continued).

			FCCU Requirements	Heater/Boiler Requirements		
Company	**Location**	**State**	**SO_2**	**NO_x**	**Company**	**Location**
Marathon Ashland Refinery	Garyville	LA	Existing wet gas scrubber	Catalyst additive	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Reduce overall NO_x emissions from the controlled heaters and boilers at MAP refineries by 4,000 tpy. Control methods can include: SCR or SNCR; ULNB; technologies to reach 0.040 lbs per MMBtu or lower; alternate SO_2 single burner technology to achieve 0.055 lbs per MMBtu or lower; unit shutdowns.
Marathon Ashland Refinery	Detroit	MI	SO_2 catalyst additive	Catalyst additive	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Reduce overall NO_x emissions from the controlled heaters and boilers at MAP refineries by 4,000 tpy. Control methods can include: SCR or SNCR; ULNB; technologies to reach 0.040 lbs per MMBtu or lower; alternate SO_2 single burner technology to achieve 0.055 lbs per MMBtu or lower; unit shutdowns.
Marathon Ashland Refinery	St Paul Park	MN	New wet gas scrubber on unit 1; catalyst additive on other unit	Catalyst additive	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Reduce overall NO_x emissions from the controlled heaters and boilers at MAP refineries by 4,000 tpy. Control methods can include: SCR or SNCR; ULNB; technologies to reach 0.040 lbs per MMBtu or lower; alternate SO_2 single burner technology to achieve 0.055 lbs per MMBtu or lower; unit shutdowns.
Marathon Ashland Refinery	Canton	OH	SO_2 catalyst additive	Catalyst additive	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Reduce overall NO_x emissions from the controlled heaters and boilers at MAP refineries by 4,000 tpy. Control methods can include: SCR or SNCR; ULNB; technologies to reach 0.040 lbs per MMBtu or lower; alternate SO_2 single burner technology to achieve 0.055 lbs per MMBtu or lower; unit shutdowns.

Table 1 (continued).

			FCCU Requirements	Heater/Boiler Requirements		
Company	**Location**	**State**	**SO_2**	**NO_x**	**Company**	**Location**
Marathon Ashland Refinery	Texas City	TX	New wet gas scrubber	Catalyst additive plus SNCR	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Reduce overall NO_x emissions from the controlled heaters and boilers at MAP refineries by 4,000 tpy. Control methods can include: SCR or SNCR; ULNB; technologies to reach 0.040 lbs per MMBtu or lower; alternate SO_2 single burner technology to achieve 0.055 lbs per MMBtu or lower; unit shutdowns.
Montana Refining Co.	Great Falls	MT	SO_2 catalyst additive	Use NO_x reducing catalyst additive and low NO_x combustion promoters	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	No large heaters/boilers here
Motiva	Convent	LA	New wet gas scrubber	Catalyst additive	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Reduce overall NO_x emissions from the controlled heaters and boilers by about 6,500 tpy. Various control methods.
Motiva	Delaware City	DE	New wet gas scrubber	SNCR at FCU; Catalyst additives at FCCU	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Reduce overall NO_x emissions from the controlled heaters and boilers by about 6,500 tpy. Various control methods.
Motiva	Norco	LA	Existing wet gas scrubber plus lower SO_2 emission limit (25 ppmvd)	SNCR at FCCU	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Reduce overall NO_x emissions from the controlled heaters and boilers by about 6,500 tpy. Various control methods.
Motiva	Port Arthur	TX	Existing wet gas scrubber plus lower SO_2 emission limit (25 ppmvd)	Catalyst additive or meet 20 ppmvd on a 365 day rolling average basis	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Reduce overall NO_x emissions from the controlled heaters and boilers by about 6,500 tpy. Various control methods.
Navajo Refining	Artesia	NM	New wet gas scrubber (meet 25 ppmvd)	Use NO_x reducing catalyst additive and low NO_x combustion promoters (NO_x rate $\leq$ 34.916/hr)	Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Achieve 0.06 lbs/MMBtu at Boiler B-7 and B-8
Premcor Refining (formerly Clark Refining)	Hartford	IL	Install new wet gas scrubber to meet 25 ppmvd SO_2		Accept NSPS Subpart J applicability for heaters and boilers and reduce or eliminate fuel oil firing	Install a combination of current and next generation ULNBs on identified units
Premcor Refining Group	Blue Island	IL	2001 closure	2001 closure	2001 closure	2001 closure
Sunoco Petroleum Refinery	Toledo	OH	Install new wet gas scrubber to meet 25 ppmvd SO_2	Install SCR systems or alternate technology to meet 20 ppmvd	Accept NSPS Subpart J applicability and reduce or eliminate fuel oil burning	
Sunoco Petroleum Refinery	Tulsa	OK			Refining fuel gas to meet the H_2S limits in 40 CFR 60.604(a) and (b)	

Table 1 (continued).

			FCCU Requirements	Heater/Boiler Requirements		
Company	**Location**	**State**	**SO_2**	**NO_x**	**Company**	**Location**
Sunoco Petroleum Refinery	Philadelphia	PA	Install new wet gas scrubber to meet 25 ppmvd SO_2	1232 FCCU: Install SCR system to meet 20 ppmvd	Accept NSPS Subpart J applicability and reduce or eliminate fuel oil burning	Use qualifying controls to reduce NO_x emissions greater than 40 MMBtu/hr by at least 2,189 tpy
Sunoco Petroleum Refinery	Marcus Hook	PA	Install new wet gas scrubber to meet 25 ppmvd SO_2	Install SCR systems or alternate technology to meet 20 ppmvd	Accept NSPS Subpart J applicability and reduce or eliminate fuel oil burning	Use qualifying controls to reduce NO_x emissions greater than 40 MMBtu/hr by at least 2,189 tpy
Valero Eagle Refinery	Texas City	TX	Use existing wet gas scrubber (achieve 25 ppmvd)	Install LoTOx system or alternative technology from each FCCU (to achieve 20 ppmvd)	Discontinue fuel oil burning. Subject to NSPS Subparts A and J for fuel gas combustion devices.	