MEMORANDUM

Date: October 22, 2001

Subject: Emission Inventory Impact Analysis of the Long-Term Fuel Control Options to Address Boutique Fuels

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U.S. Environmental Protection Agency

To: The Record

EPA was directed by the Vice President's National Energy Policy Development group to study opportunities to maintain or improve the environmental benefits of state and local "boutique" clean fuel programs while exploring ways to increase the flexibility of the fuels distribution infrastructure, improve fungibility, and provide added gasoline market liquidity. An important criterion of this study was the maintenance or improvement of current air quality benefits in the future.

In its boutique fuel study, EPA developed a number of various alternatives to the current mix of unique fuels occurring in various urban areas and across the U.S. as a whole. The impact of these fuel options on motor vehicle related emissions are developed below. The pollutants considered include volatile organic compounds (VOC) and nitrogen oxides (NOx). Both exhaust and evaporative sources of VOC emissions were considered. This memorandum summarizes both the methodology used to conduct this analysis and its results.

I. Executive Summary

The draft MOBILE6 motor vehicle emission model (MOBILE6) was used to estimate in-use emissions for a baseline fuel of 9 RVP and 30 ppm sulfur. MOBILE6 was also used to project the impact of low RVP fuels and Federal reformulated gasoline (RFG) on VOC and NOx emissions. Six fuel options were evaluated for their impact on emissions:

1) 3-Fuel Option; whereby states can select from Federal reformulated gasoline (RFG), or conventional gasoline meeting either a 7.8 Reid vapor pressure (RVP) or 9.0 RVP specification. Gasoline sold under the 9.0 RVP standard is allowed a 1.0 RVP waiver if it contains 10 volume percent (vol%) ethanol.[1]
2) The same 3-fuel option as described under 1), but with a 2.4 volume percent renewable

[1] California is assumed to continue to receive gasoline meeting the California CBG specifications under all four options.

fuel mandate in lieu of the RFG oxygen mandate.[2]

3) 2-Fuel Option; whereby states can select from Federal RFG, or conventional gasoline meeting a 9.0 RVP specification. Gasoline sold under the 9.0 RVP standard is allowed a 1.0 RVP waiver if it contains 10 volume percent (vol%) ethanol.

4) The same 2-fuel option as described under 3), but with a 2.4 volume percent renewable fuel mandate in lieu of the RFG oxygen mandate.

5) Nationwide Federal CBG whereby all fuel sold nationwide outside of California must meet the Federal RFG specifications, with the exception of the oxygen mandate.

6) Nationwide California CBG; whereby all fuel sold nationwide must meet the California CBG specifications.

The first two options were also evaluated with a renewable fuel mandate in lieu of the RFG oxygen mandate. Within the scope of this analysis, this difference does not affect emissions of fuels certified to the Federal or California RFG or CBG specifications. However, the renewable fuel mandate would affect emissions from conventional gasoline, if some of the increased ethanol use were to occur in conventional gasoline.

The impacts of these four fuel options on emissions are shown in Tables 1 and 2 below. Emission impacts in areas which currently receive RFG or boutique fuels are shown in Table 1, while Table 2 shows the emission impacts for the entire nation. The emission factors used to project these annual emission reductions represent summer conditions (i.e., RVP controlled). Summertime emission reductions were assumed to occur year-round, in order to be comparable to other VOC and NOx control programs, most of which are annual or are expressed on an annual basis.

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[2] An inter-refiner credit trading program is also assumed to apply with the renewable fuel mandate.

Table 1: VOC and NOx Emission Reductions in RFG and Boutique Fuel Areas (tons year)				
	RFG Oxygen Mandate		Renewable Fuel Mandate	
	VOC	NOx	VOC	NOx
Calendar Year 2006				
3-Fuel Option	4,365	-	4,365	-
2-Fuel Option	68,314	-	68,314	-
Nationwide Fed RFG	Not applicable	Not applicable	68,140	-
Nationwide CA CBG	Not applicable	Not applicable	63,442	57,609
Calendar Year 2010				
3-Fuel Option	3,192	-	3,192	-
2-Fuel Option	46,463	-	46,463	-
Nationwide Fed RFG	Not applicable	Not applicable	46,457	-
Nationwide CA CBG	Not applicable	Not applicable	43,726	43,016
Calendar Year 2020				
3-Fuel Option	1,876	-	1,876	-
2-Fuel Option	20,534	-	20,534	-
Nationwide Fed RFG	Not applicable	Not applicable	19,557	-
Nationwide CA CBG	Not applicable	Not applicable	21,750	20,283
Calendar Year 2030				
3-Fuel Option	1,756	-	1,756	-
2-Fuel Option	20,344	-	20,344	-
Nationwide Fed RFG	Not applicable	Not applicable	20,336	-
Nationwide CA CBG	Not applicable	Not applicable	18,904	16,337

Table 2: Nationwide VOC and NOx Emission Reductions (tons year)				
	RFG Oxygen Mandate		Renewable Fuel Mandate	
	VOC	NOx	VOC	NOx
Calendar Year 2006				
3-Fuel Option	4,365	-	(31,786)	-
2-Fuel Option	68,314	-	32,163	-
Nationwide Fed RFG	Not applicable	Not applicable	675,180	11,432
Nationwide CA CBG	Not applicable	Not applicable	680,743	150,145
Calendar Year 2010				
3-Fuel Option	3,192	-	(20,394)	-
2-Fuel Option	46,463	-	22,877	-
Nationwide Fed RFG	Not applicable	Not applicable	482,920	9,019
Nationwide CA CBG	Not applicable	Not applicable	482,065	116,039
Calendar Year 2020				
3-Fuel Option	1,876	-	(7,515)	-
2-Fuel Option	20,534	-	11,143	-
Nationwide Fed RFG	Not applicable	Not applicable	259,234	5,509
Nationwide CA CBG	Not applicable	Not applicable	275,581	64,941
Calendar Year 2030				
3-Fuel Option	1,756	-	(9,551)	-
2-Fuel Option	20,344	-	9,037	-
Nationwide Fed RFG	Not applicable	Not applicable	268,365	5,128
Nationwide CA CBG	Not applicable	Not applicable	274,243	57,936

These emission impacts should be considered to be first order estimates for a number of reasons. First, a number of secondary, yet important factors which can affect the in-use emissions from various fuels were not included in this analysis. These factors include changes in CO emissions and their effect on ambient ozone formation, differences in the permeation of various VOCs from vehicular fuel systems, the effect of commingling of ethanol and non-ethanol blends on evaporative VOC emissions, the impact of driveability index on emissions, etc. Second, some of the fuels, such as Phase 3 California CBG have not yet been produced and Phase 2 RFG has only been produced for a couple of years (only one year of survey data available). Therefore, the composition of these fuels is somewhat uncertain and the emissions from the actual fuels which would be produced in the future could be different from those projected here. This is particularly true for relative VOC emissions from Federal and California CBG. The emission projections in Table 1 indicate that Federal CBG would reduce VOC emissions slightly more than California CBG. The difference is small and should be considered to be essentially zero, since small changes in the composition of these fuels (e.g., 0.1 RVP) could eliminate or reverse the direction of these differences.

These MOBILE6-based emission impacts were also compared to those from several emission models which were recently developed by EPA when evaluating California's request for a waiver of the Federal RFG oxygen requirement (hereafter referred to as the EPA Predictive Models). The EPA Predictive Models were used to project the impact of California Clean Burning Gasoline (CBG) on emissions. In general, the emission impacts projected by MOBILE6 and the EPA Predictive Models are very consistent, with one exception, conventional gasoline containing 10 volume percent ethanol. MOBILE6 projects that splash blending ethanol into 9 RVP gasoline will decrease exhaust VOC emissions by 6% and will not affect NOx emissions. In contrast, the EPA Predictive Models project that splash blending ethanol into 9 RVP gasoline will decrease exhaust VOC emissions by 2-3% and will increase NOx emissions by 7%. The reasons for this are complex and should be evaluated further.

This issue primarily affects areas assumed to receive 9 RVP fuel under the 2-fuel and 3-fuel options with the renewable fuel mandate where ethanol blends are not currently used, or where ethanol use increases. It is difficult to project these areas today, since there are economic reasons for using ethanol in conventional gasoline in the Midwest, as well as in Federal or California CBG on the East and West Coasts. Thus, the impact could be quite small if the new ethanol were used primarily in CBG, or could reach as much as 4,400 tons per year VOC and 15,000 tons per year NOx in 2006, if the ethanol were used primarily in conventional gasoline. These impacts would decrease over time as the overall VOC and NOx emission inventories decrease in the future. Clearly, the impact of blending ethanol into gasoline should be investigated further.

II. Fuel Control Options

This analysis estimates the emission impacts of six fuel options. Each option consists of one or more sets of fuel specifications which provide various levels of emission control. The way in which states might select from among the various sets of fuel specifications is discussed in the main report. In short, states were assumed to switch to the least stringent fuel which provided the same or greater VOC emission benefit as their current fuel.

Currently, there are several Federal gasolines being sold in the U.S. There are two basic types of RFG, northern and southern. In addition, RFG containing 10 volume percent ethanol sold in the Chicago and Milwaukee areas receives a 0.3 RVP adjustment in meeting the applicable VOC performance standard. Therefore, there are actually three sets of Federal RFG specifications. There are two sets of Federal specifications for conventional gasoline, one with a 9.0 RVP cap and the other with a 7.8 RVP cap.

Most of the areas requiring the sale of RFG are required to do so by the Clean Air Act, as amended in 1990 (CAA). Some have opted into the program. Other ozone nonattainment areas in the southern U.S. receive the 7.8 RVP conventional gasoline, while the 9.0 RVP conventional gasoline is allowed everywhere else (per Federal regulation).

State fuel programs outside of California primarily differ from the Federal fuel requirements in terms of RVP. A number of northern ozone nonattainment areas, such as Pittsburgh and Detroit, impose a 7.8 RVP cap, instead of the otherwise mandated 9.0 RVP cap. A couple of more southern areas (East St. Louis and Kansas City) impose 7.0-7.2 RVP gasoline caps. Finally, Birmingham and Atlanta impose a 7.0 RVP cap, as well as sulfur limits of 30-150 ppm. Since the time frame of this analysis is 2006 and beyond, when sulfur will be limited to 30 ppm across most of the U.S., state-specific sulfur limits become moot for the purposes of this study. Therefore, the Atlanta and Birmingham fuel programs are assumed to differ from Federal requirements only in terms of RVP.

California's gasoline specifications are much more complex than those of other states. The CA CBG program addresses eight fuel parameters, as does the Federal RFG program. These eight parameters are RVP, sulfur content, oxygen content, aromatics content, olefin content, benzene content, and two points from a fuel's distillation curve. The Federal RFG program uses the percentages of fuel evaporated at 200 and 300 degrees F (E200 and E300, respectively). The California CBG program utilizes the 50% and 90% distillation points (T50 and T90, respectively). However, the overall stringency of California's requirements are much greater than those of the Federal RFG program, generally further restricting the practical combinations of the various fuel parameters which qualify for sale.

In addition to existing fuels, this analysis includes one additional fuel not currently sold in the U.S. That fuel is a Federal CBG. This fuel would have to meet the current VOC and toxic emission performance standards for Federal RFG, as well as the applicable benzene content limits. However, this fuel would not be required to contain 2.0 weight percent oxygen.

Six fuel options were evaluated as part of this study. All assume that California retains its current program. All but one of the options continues to allow Federal RFG as an option. The only option which does not do so would require California CBG to be sold nationwide. The Federal RFG in these options would meet a single set of specifications, those currently applicable to southern RFG. No VOC adjustment would be applied to RFG containing 10 volume percent ethanol.

The other options differ in the number of conventional gasolines which can be selected, ranging from zero to two. These differ in terms of RVP, as do most state-specific fuel programs today. Finally, for those fuel options which include the continued sale of conventional gasoline, the addition of an average limit of 0.95 vol% benzene has been evaluated.

The six options are described below:

1) 3-Fuel Option: whereby states can select from Federal reformulated gasoline (RFG), or conventional gasoline meeting either a 7.8 Reid vapor pressure (RVP) or 9.0 RVP specification. Gasoline sold under the 9.0 RVP standard is allowed a 1.0 RVP waiver if it

contains 10 volume percent (vol%) ethanol.[3]

2) The same 3-fuel option as described under 1), but with a 2.4 volume percent renewable fuel mandate in lieu of the RFG oxygen mandate.

3) 2-Fuel Option: whereby states can select from Federal RFG, or conventional gasoline meeting a 9.0 RVP specification. Gasoline sold under the 9.0 RVP standard is allowed a 1.0 RVP waiver if it contains 10 volume percent (vol%) ethanol.

4) The same 2-fuel option as described under 3), but with a 2.4 volume percent renewable fuel mandate in lieu of the RFG oxygen mandate.

5) Nationwide Federal CBG whereby all fuel sold nationwide outside of California must meet the Federal RFG specifications, with the exception of the oxygen mandate.

6) Nationwide California CBG; whereby all fuel sold nationwide must meet the California CBG specifications.

Table 3 indicates our projections of the fuels which each local area would receive under the 2-fuel and 3-fuel options. The nation has been divided according to the fuel which it currently receives. Area 9 deserves some further explanation. This area represents those 9 RVP areas which current receive a significant amount of ethanol blending. We examined data from the Energy Information Administration which indicates what fraction of gasoline sold in each state contained ethanol. We found that ethanol blending typically occurs at either a very low level (0-5%) of all gasoline marketed within a state, or at a relative high level (e.g., 20-40%). Rather than attempt to model the emissions of each area separately with slightly different gasohol blending percentages, we broke 9 RVP areas into two groups. One group was assumed to receive gasoline without any ethanol and the other received a mix of 70% ethanol-free gasoline and 30% gasohol. The percentage of 9 RVP falling into each category was determined by matching total ethanol consumption in the two areas to that occurring in 9 RVP fuel based on EIA data.

[3] California is assumed to continue to receive gasoline meeting the California CBG specifications under all four options.

Table 3: Fuels by Area Under 2-Fuel and 3-Fuel Options				
Area	Fraction of Fuel Sold outside of California	Current Fuel	Fuel Under 2-Fuel Option	Fuel Under 3-Fuel Option
1	3.5%	7.0 RVP	Federal RFG	Federal RFG
2	0.2%	7.2 RVP	Federal RFG	Federal RFG
3	14.7%	7.8 RVP	Federal RFG	7.8 RVP
4	30.8%	9.0 RVP	9.0 RVP	9.0 RVP
5	12.5%	Northern RFG	Federal RFG	Federal RFG
6	9.7%	Southern RFG	Federal RFG	Federal RFG
7	3.6%	Northern RFG with Ethanol	Federal RFG	Federal RFG
8 [4]	0.7%	California CBG	Federal RFG	Federal RFG
9	24.4%	9.0 RVP with 30% gasohol	9.0 RVP with 30% gasohol	9.0 RVP with 30% gasohol

III. Methodology

Estimates of the emission impacts of the six fuel options were developed using EPA's draft MOBILE6 motor vehicle emission model and an updated version of EPA's Complex Model. MOBILE6 was used to estimate VOC and NOx emissions for 2006 "baseline" gasoline (i.e., 9 RVP conventional gasoline containing 30 ppm sulfur). MOBILE6 was also used to estimate the impact of RVP on non-exhaust VOC emissions. This model was recently released for public review and comment and includes a significant number of modifications relative to the previous version, MOBILE5b. These modifications include updated estimates of the impact of sulfur on exhaust VOC and NOx emissions, including those from low emission vehicles, and the impact of RVP on emissions.

MOBILE6 projects VOC, CO and NOx emission impacts of RFG and low RVP fuels, but it does not address the impact of California CBG. Thus, we used an updated version of the Complex Model to address these two issues.

In addition, another set of recently developed emission models were used to project the impact of fuel quality on exhaust VOC and NOx emissions (three models for each pollutant).

[4] Arizona requires that fuel sold in the Phoenix area meet either the CA CBG or Federal RFG specifications. We have assumed that 60% of Phoenix's fuel is CA CBG and will remain so under all of the options analyzed herein.

These models are similar to California's Predictive Model and, as mentioned above, were developed by EPA as part of its consideration of California's request for a waiver of the Federal RFG oxygen mandate. These models were developed using advanced statistical tools from essentially the same emission database which was used by California to develop its recent Phase 3 Predictive Model. For both exhaust VOC and NOx emissions, three statistical models were selected from a larger number of models which were determined to have somewhat better predictive power than the remaining models. Here, the average of the predicted emission change from the three models is used as a single predictor. These models will hereafter by referred to as the EPA Predictive Models.

Many of the inputs to the Complex Model were based on MOBLIE5, particularly the fraction of in-use emissions being emitted from normal emitting vehicles and high emitting vehicles. (This distinction is important, as the impact of some fuel parameters varies depending on the state of a vehicle's emission control system.) Thus, these estimates were updated based on figures from MOBILE6. The original and revised figures are shown below.

Table 4: Normal and High Emitter Fractions (Phase 2 Model)

	Normal Emitters	High Emitters
VOC: Original	44.4%	55.6%
VOC: Revised	64%	36%
NOx: Original	73.8%	26.2%
NOx: Revised	83%	17%

As can be seen, MOBILE6 projects that a greater fraction of fleet-wide emissions will come from normal emitters than MOBILE5.

The other update to the Complex Model involved the presumed breakdown of the in-use gasoline vehicle fleet into the 9 technology groups used in developing the model. The technology group breakdown in the Complex Model represents that of the 1990 model year light-duty vehicle and light-duty truck fleet. The model focused on the 1990 model year fleet in order to comply with the direction of the Clean Air Act regarding the certification of qualifying reformulated gasolines. However, the engine and emission control technologies predominant in the in-use fleet in 2006 and beyond differs dramatically from those predominant in the 1990 model year. For example, port fuel injection (PFI) has dominated new vehicle sales since the early 1990's, while it only represented 66% of the vehicles sold in 1990.

Because of this predominance of PFI for nearly 20 years, we assumed that the 2006 and later in-use fleet will be essentially 100% PFI. Thus, the sales fractions of all non-PFI technology groups were set to zero in the updated Complex Model. The sales fractions for the three remaining PFI technology groups (#1, #2, and #5) were all set to 0.333. These three technology groups differ in terms of whether the vehicle utilizes exhaust gas recirculation (EGR) or an oxidation catalyst in addition to the standard three-way catalyst. MOBILE6 does not track technologies to this level of distinction. Also, the differences in the emission coefficients between these three technologies are very slight. Thus, assuming that in-use vehicles are spread evenly between the three technology groups should be satisfactory. Finally, this is consistent with the approach taken to update the Complex Model when it was used to project emissions of air toxics emissions in support of the Tier 2 and mobile source air toxics rulemakings.

In order to represent emissions across the nation (outside of California), the country was divided into 9 areas. The distinction between the 9 areas was based primarily on differences in the type of fuel currently being sold in the area. Ambient temperatures and the stringency of any inspection and maintenance (I/M) program were matched to the type of area generally receiving the fuel type in question. Table 5 summarizes the basic MOBILE6 inputs to the 9 areas.

Table 5: MOBILE6 Inputs for Baseline Cases

Area	Current Fuel Program	I/M Program	Ambient Temperature (F)
1	7.0 RVP	Best	69-94
2	7.2 RVP	Low	69-94
3	7.8 RVP	Low	69-94
4	9.0 RVP	None	72-92
5	N. RFG	Best	72-92
6	S. RFG	Best	69-94
7	N. RFG with Ethanol	Best	72-92
8	CA CBG	Best	69-94
9	9.0 RVP with 30% gasohol	None	72-92

IV. Fuel Compositions

MOBILE6 projects the emission effects of low RVP fuels and RFG simply by naming these fuels. However, both the Complex Model and EPA Predictive Models require that the actual fuel composition be input into the model. The composition of the various baseline and control option fuels were estimated as much as possible using the results of Alliance of Automobile Manufacturers (AAM) in-use fuel surveys. Tables 6 and 7 present our estimates of the composition of the conventional and reformulated gasolines and indicates the source of the estimate. Despite their being based on fuel surveys, these compositions should be considered to be approximate for a number of reasons. One, the number of cities surveyed is limited, particularly for some fuel types. Two, the number of samples taken in each city is small. Three, new production of a particular fuel type may differ from current production, especially if it occurs in a different refining region. Thus, some of the fuel survey results were adjusted to reflect relative differences which were consistent with the primary features of the fuel (e.g., RVP).

Table 6: Composition of Conventional Gasolines					
	7 RVP	7.2 RVP	7.8 RVP	9 RVP	9 RVP w/ ethanol
RVP (psi)	6.8	7.0	7.6	8.8	9.7
T50 (F)	222	222	220	218	180
T90 (F)	329	329	329	329	320
Aromatics (vol%)	32.0	32.0	32.0	32.0	25
Olefins (vol%)	13.0	13.0	13.0	13.0	12
Oxygen (wt%)	0	0	0	0	3.5
Sulfur (ppm)	30	30	30	30	30
E200 (%)	39.1	39.1	40.1	41.1	59.7
E300 (%)	83.1	83.1	83.1	83.1	85.1

Table 7: Composition of Reformulated Gasolines				
	Federal RFG			California CBG*
	Northern MTBE	Southern MTBE	Northern Ethanol	
RVP (psi)	6.8	6.8	6.8	6.8
T50 (F)	205	203	210	203
T90 (F)	322	331	322	295
Aromatics (vol%)	22.7	21.9	17.9	22
Olefins (vol%)	11.4	11.7	4.3	4
Oxygen (wt%)	2.1	2.1	3.5	2
Sulfur (ppm)	30	30	30	15
E200 (%)	47.6	48.6	46.2	48.4
E300 (%)	84.9	83.6	86.2	90.6

* Based on specifications for Phase 3 CBG assuming compliance on average.

The composition of California Phase 3 CBG is based on the certification specifications assuming compliance on average. EPA's recent assessment of the emission performance of the non-oxygenated and ethanol CBG identified a number of second order differences between the emission performance of these fuels, such as CO emissions and their role in ozone formation, over-compliance of the NOx emission performance standard by non-oxygenated CBG, greater permeation of ethanol blends through elastomers in the fuel system and commingling of ethanol and non-oxygenated CBG. Consideration of these factors are beyond the scope of this study.

Also, ethanol and MTBE Federal RFGs currently have different average properties. However, given the MSAT rule, if ethanol RFG were to replace MTBE RFG in Federal RFG areas, they would generally need to meet a higher toxics emission performance standard than ethanol RFGs are currently meeting in the Midwest. Thus, this difference in the performance of these two types of RFG would disappear. Non-oxygenated RFG, as would be allowed if the RFG oxygen mandate were rescinded, would also have to meet the same toxics performance standard. Therefore, no differences in the toxic emission performance of different Federal RFGs will be assessed here. The other differences in the emissions and environmental impacts of ethanol and MTBE containing RFG fall into the categories mentioned above for California CBG and again, are not addressed here.

Finally, EPA recently granted RFGs containing 10 volume percent ethanol sold in the Chicago and Milwaukee areas a 0.3 psi RVP adjustment in determining compliance with the VOC performance standard. This was due to the fact that these ethanol blends reduce CO emissions relative to RFGs with 2.0 weight percent oxygen and these CO emission reductions were shown to have a significant effect on ozone in these areas. Also, ethanol blends dominate these markets, so there is no commingling to offset the CO emission benefit. This VOC adjustment has not been extended in this analysis. One reason is simplicity. The other reason is that this adjustment was based on local ozone modeling which showed an equivalence between the increased VOC emissions and reduced CO emissions. This modeling has not been done for other local areas. Third, we do not expect 10 volume percent ethanol blends to dominate the RFG market in most areas in the future. Ethanol demand will increase dramatically with the RFG oxygen mandate and the state MTBE bans. This is projected to increase ethanol prices significantly. Also, many of these RFG areas are also quite distant from the Midwest, adding significant transportation costs to the local price of ethanol. Therefore, under these circumstances, ethanol is more likely to be used at lower levels (e.g., 5.7 or 7.8 volume percent). If the RFG oxygen mandate were to be replaced with a renewable fuel requirement, we would expect that ethanol RFG would not dominate RFG markets outside of the Midwest. Therefore, commingling effects would occur, mitigating or eliminating the benefit of reduced CO emissions.

V. Projected Emission Effects

The emission effects of the fuels described in the previous section from MOBILE6 and the EPA Predictive Models are summarized in Table 8.

Table 8: Effect of Fuel Type on Exhaust VOC and NOx Emissions				
	VOC		NOx	
	MOBILE6	EPA Predictive Models	MOBILE6	EPA Predictive Models
9 RVP	Base	Base	Base	Base
7.8 RVP	-2%	0.1%	-0.7%	-1%
7.2 RVP	-2%	0.4%	-0.7%	-2%
7.0 RVP	-0.1%	-0.2%	-0.7%	-2%
Federal RFG/CBG	-9.5%	-10% to -12%	-0.7%	-2%
California CBG	-11.5%	-13%	-5.7%	-5%
9 RVP w/ 10% ethanol	-6.3%	-2% to -3%	0%	7-8%

As can be seen from Table 8, MOBILE6 and the EPA Predictive Models project very similar emission effects for both exhaust VOC and NOx emissions for all fuels except the 9 RVP ethanol blend. For this last fuel, the EPA Predictive Models project a 3-4% smaller exhaust VOC emission benefit than MOBILE6. Also, the EPA Predictive Models project a 7-8% NOx emission increase compared to no effect in MOBILE6.

To further investigate these differences, we also used the updated EPA Complex Model to project the emission effects for the 9 RVP ethanol fuel. The updated EPA Complex Model projects a 1-2% reduction in exhaust VOC emissions and essentially no change in NOx emissions for this fuel. Thus, MOBILE6 projects that splash blending ethanol will reduce exhaust VOC emissions to a greater extent than either the Complex Model or the EPA Predictive Models. And, MOBILE6 and the Complex Model project that splash blending ethanol will not increase NOx emissions, while the EPA Predictive Models predict a sizeable increase.

There are a number of possible reasons for these differences. The EPA Predictive Models and the Complex Model are both based on only a subset of vehicle technology (roughly 1990 model year vehicles), while MOBILE6 includes emission effects for both older and newer vehicles. Also, MOBILE6 and the Complex Model predict different emission effects for normal and high emitters in the fleet, while these differences were found to be not significant in the development of the EPA Predictive Models.

The amount of 9 RVP fuel with ethanol changes primarily with the assumption of a renewable fuel mandate in lieu of the RFG oxygen mandate. In these cases, ethanol use increases significantly. This increase may occur in RFG or conventional gasoline or both, but is likely to include at least some increased use in conventional gasoline. Therefore, there appears to be a significant probability that NOx emissions in these areas could increase. This possibility should be investigated further.

This significant difference in model predictions does not show up when comparing RFGs containing ethanol and MTBE, as long as both contain 2% oxygen. It is only when oxygen levels exceed this level significantly that the EPA Predictive Models show NOx emissions increasing more dramatically.

VI. Emission Predictions

Two steps were involved in projecting the emission impacts of the various fuel control options. First, VOC and NOx emission inventories from gasoline-fueled vehicles were estimated for the reference case (i.e., current fuel quality requirements (RFG and RVP programs), plus Tier 2 sulfur standards, MSAT standards, and state MTBE bans). To do this, MOBILE6 was first run for four calendar years (2006, 2010, 2020, 2030) for each of the nine areas. Sulfur levels were assumed to be 30 ppm in each area. Both VOC and NOx emissions were determined assuming 8.7 RVP fuel (the typical RVP level under a 9 RVP cap). Higher sulfur levels in 2006 in the geographic phase in area, as well as small refiner provisions, were not considered in this analysis. Small refiners, by definition, represent a very small fraction of fuel produced in the U.S. With the exception of Salt Lake City, boutique fuels are not an issue in the geographic phase in area.

We then estimated the impact of the current fuel quality requirements on VOC and NOx emissions. MOBILE6 was used to estimate the impact of the RFG and RVP programs specific to each area. Compared to emissions with a nominal 9 RVP fuel with 30 ppm sulfur, the current set of state and Federal requirements will reduce VOC emissions by 287,000 tons per year and NOx emissions by 6800 tons per year (outside of California) in 2006.

Moving to the impact of the fuel control options, the MOBILE6-based changes in exhaust VOC and NOx emissions described in the previous section were applied to the 8.7 RVP exhaust emissions baseline estimated using MOBILE6. The resulting emission impacts are shown in Tables 9 and 10 below.

Table 9: VOC and NOx Emission Reductions in RFG and Boutique Fuel Areas (tons year)				
	RFG Oxygen Mandate		Renewable Fuel Mandate	
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Table 10: Nationwide VOC and NOx Emission Reductions (tons year)				
	RFG Oxygen Mandate		Renewable Fuel Mandate	
	VOC	NOx	VOC	NOx
Calendar Year 2006				
3-Fuel Option	4,365	-	(31,786)	-
2-Fuel Option	68,314	-	32,163	-
Nationwide Fed RFG	Not applicable	Not applicable	675,180	11,432
Nationwide CA CBG	Not applicable	Not applicable	680,743	150,145
Calendar Year 2010				
3-Fuel Option	3,192	-	(20,394)	-
2-Fuel Option	46,463	-	22,877	-
Nationwide Fed RFG	Not applicable	Not applicable	482,920	9,019
Nationwide CA CBG	Not applicable	Not applicable	482,065	116,039
Calendar Year 2020				
3-Fuel Option	1,876	-	(7,515)	-
2-Fuel Option	20,534	-	11,143	-
Nationwide Fed RFG	Not applicable	Not applicable	259,234	5,509
Nationwide CA CBG	Not applicable	Not applicable	275,581	64,941
Calendar Year 2030				
3-Fuel Option	1,756	-	(9,551)	-
2-Fuel Option	20,344	-	9,037	-
Nationwide Fed RFG	Not applicable	Not applicable	268,365	5,128
Nationwide CA CBG	Not applicable	Not applicable	274,243	57,936

As mentioned above, the above projections are based on MOBILE6 emission impacts. The potential impact of increased use of ethanol in conventional gasoline was also estimated using the emission effects from the EPA Predictive Models. As mentioned above, it is difficult to estimate what fraction of the increased ethanol use would occur in CBG and what fraction would occur in conventional gasoline. For the purpose of this study, we simply assumed that ethanol use in conventional gasoline would double. This means that the current fraction of conventional gasoline ethanol blends, 7.3%, would double to 14.6%. This would mean that 9.4% of U.S. gasoline would contain ethanol and meet either Federal or California CBG specifications. In this case, NOx emissions in these conventional gasoline areas would increase by 15,000 tons per year in 2006, decreasing to a 6800 ton per year increase in 2030, compared to the NOx emission impacts shown in Table 10 above. Similarly, VOC emissions in these conventional gasoline areas would increase by 4400 tons per year in 2006, decreasing to a 2500 tons per year increase in 2030 compared to emission impacts shown in Table 10 above. These potential impacts should be considered preliminary and only indicative of the degree of impact which might occur should ethanol use increase in conventional gasoline areas. Further study of this issue is warranted.