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VOC Adjustment Rule: Response to Comments

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Transportation and Regional ProgramsDivision
Office of Transportation and Air Quality
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I. COST

A. References

Information in the proposed rule regarding the cost of producing MTBE and ethanol RFG was derived from previous cost studies. These studies are included in Docket A-99-32:

II.D-1: March 17, 1999 report prepared by Jerry Hadder of Oakridge National Laboratory (ORNL) estimating the economic impacts of Phase 2 gasoline reformulation on the value of ethanol.

II.D-2: June 14, 1999 memo from Jerry Hadder of ORNL regarding the impact of Phase 2 gasoline reformulation requirements on the cost of using ethanol in PADD II.

We also used information contained in EPA's Final Regulatory Impact Analysis for Reformulated Gasoline (December 13, 1993).

B. The cost of complying with the Phase II VOC standard for ethanol RFG

1. Background

Section 211(k)(3) of the Clean Air Act requires that for the year 2000 and beyond, EPA's regulations for RFG must include a VOC performance standard which must be at least equal to a 25 percent reduction from baseline emissions. An exception to the 25 percent reduction can be allowed for factors such as technical feasibility and cost, but in no case can the reduction be less than 20 percent.

According to the cost study on ethanol RFG blends conducted by DOE (referenced in Section I.A), the change in average manufacturing cost of reducing the RVP of blendstock intended for ethanol-blended RFG to a level that ensures compliance with the current Phase II VOC performance standard is approximately $0.01 per gallon of RFG for refiners currently using ethanol. Based on DOE's modeled 1.4 psi increase, this cost reflects the 1.4 psi RVP reduction necessary to offset the RVP increase associated with the use of ethanol as an oxygenate. (DOE derived its cost impact estimates by comparing the cost of reducing the RVP in Phase I RFG with 10 volume percent ethanol, to the RVP level necessary to comply with the Phase II RFG performance standard for VOC.)

Based on the above, it would cost refiners approximately $0.01 per gallon to reduce the RVP of blendstock used to make ethanol RFG by 1.4 psi. Since our adjustment of the VOC performance standard by 2.0 percentage points is equivalent to an increase in RVP of approximately 0.3 psi of the blendstock, we calculate the reduction in cost associated with this adjustment as follows: the ratio of the 0.3 psi to 1.4 psi is 21.4 percent; this ratio is then applied to the $0.01 per gallon to yield a cost reduction of approximately $0.002 per gallon.

2. Comments on cost

Comments stated that the adjustment (at an equivalent increase in RVP of 0.2 psi, as proposed) would be too small to offer relief to refiners. One commenter suggested that an adjustment equivalent to as much as 1.0 psi would not result in a change in ambient ozone that could be detected via monitoring or photochemical modeling. The commenter stated that since the Clean Air Act allows EPA to adjust the performance standard downward to as low as 20 percent, taking into account technical feasibility and cost, that such an adjustment could be allowed. Other commenters also raised the 20 percent lower limit as a possibility that EPA should consider.

We do not agree, in light of the serious air quality consequences associated with such an adjustment, that cost considerations related to making RFG with ethanol justify an adjustment equivalent to a 1.0 psi RVP increase. The statutory basis for the adjustment, per Sections 211(k)(1) and 211(k)(3), authorizes EPA to consider the additional cost associated with making Phase II RFG with 10 volume percent ethanol and the water quality impacts of any potential increase in use of MTBE, and EPA believes it also appropriate to consider the impact of any such adjustment on the air quality benefits that are the primary aim of the RFG requirements.[1] Thus, the amount of the adjustment should be limited by considerations related to the impact that an adjustment might have on the air quality benefits of the Phase II RFG program. As discussed in Section III below, we believe that the adjustment should be no larger than that which can be reasonably expected to result in overall air quality benefits comparable to the benefits achieved

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[1] Unlike EPA’s renewable oxygen requirement (see Am. Petroleum Inst. v. Browner, 52 F.3d 1113, (D.C. Cir 1995)), today’s rulemaking does not impose any additional restrictions on RFG. Rather, today’s action preserves the goals of the RFG program while taking into consideration the factors enumerated in sections 211(k)(1) and (k)(3) to identify the appropriate VOC reduction requirement for certain types of fuels.”

by Phase II of the RFG program generally. We believe that a downward adjustment of 2.0 percentage points (rather than the proposed 1.0 percentage point) from the current standard is appropriate, based largely on photochemical modeling that Illinois Environmental Protection Agency (IEPA) submitted to EPA.

With respect to the comment that the 1 percentage point adjustment was too small, we note that during last summer, refiners supplied RFG with ethanol to the Chicago and Milwaukee RFG areas. The ethanol industry originally feared that the increased stringency of the Phase II VOC standard would result in ethanol being “locked out” of the RFG market. Last summer’s RFG market proved otherwise, however. This suggests that with economic conditions similar to last summer’s the current Phase II standard should not prevent refiners from making RFG with ethanol. More importantly, however, it suggests that an adjustment will offer increased flexibility to refiners. Thus even if market conditions change, we believe an adjustment will provide an incentive to make more RFG with ethanol than without such adjustment. Finally, one refiner commented that the 1 percentage point adjustment would result in that refiner making approximately 5 percent more RFG with ethanol than without the adjustment. We believe, therefore that the 2 percentage point adjustment will allow even greater flexibility to refiners supplying RFG to Chicago and Milwaukee.

C. Market effects of an adjustment in the Midwest

While ethanol maintained its market share in the Chicago and Milwaukee RFG programs during the summer of 2000, for the future it continues to be difficult to predict with certainty the geographic distribution of specific oxygenates in the Phase II RFG program. EPA wishes to ensure the stability of the RFG program in the Midwest and to avoid any significant disincentive for the use of ethanol. Related to this, one refiner supplying the Chicago area commented that the VOC adjustment could result in an increase at the commenter's refinery of approximately one to two thousand barrels per day of ethanol-RFG during the summer blending season. Although this is a nominal increase, it was an estimate made on the basis of the proposed adjustment of 1.0 percentage point. We believe that today's adjustment of 2.0 percentage points will provide an incentive for the continued use of ethanol in Chicago and Milwaukee.

D. Market effects of an adjustment outside the Midwest

Outside the Midwest**,** where MTBE is the predominant oxygenate used in RFG, we agree with commenters who suggested that an adjustment to the VOC performance standard may have little or no impact on ethanol use. This is because ethanol use outside of the Midwest is influenced primarily by ethanol availability and cost. While an adjusted standard, if it were to apply in such areas, could provide some cost relief to refiners choosing to make ethanol-RFG, it would probably not provide sufficient incentive to cause refiners who would not otherwise do so to switch from MTBE to ethanol. Therefore, to the extent that conditions favorable to increased ethanol use arise in areas outside of the Midwest, refiners may decide to switch to ethanol, but any such decisions are unlikely to be strongly influenced by a small adjustment to the VOC standard. Even if an adjustment of the VOC performance standard would result in some additional ethanol use in these areas, however, we believe that in areas where there is current ethanol use would not preserve the benefits of the RFG program. This is discussed in further detail in Section II.H.4. below on commingling effects.

II. SELECTION OF ADJUSTMENT LEVEL AND EXPECTED AIR QUALITY IMPACTS OF THE RULE IN THE MIDWEST

In deciding to promulgate the final VOC adjustment rule, we concluded that in the Chicago and Milwaukee RFG areas the adjustment would preserve the air quality benefits of the RFG program and provide an incentive for continued use of ethanol. In this section we discuss how we established the adjustment level, and compare the emission impacts of the rule to that of a “no-rule” scenario. We believe that the overall effect of the adjustment on emissions will not adversely impact the overall benefits of Phase II RFG. While there will be greater mass VOC emissions with the rule than without it, RFG with 10 volume percent ethanol (3.5 weight percent oxygen) achieves significantly greater CO emission reductions than RFG with 2.0 weight percent oxygen. We believe that the ratio of CO reduction to VOC increase associated with ethanol use provides a reasonable degree of assurance that the ozone air quality impacts of RFG in Chicago and Milwaukee will result in benefits similar to those generally expected from the Phase II RFG program.

A. Background and summary

RFG blended with10 percent ethanol by volume, the typical blending level of ethanol, achieves significant reductions in CO emissions compared to non-ethanol RFG blends because of higher oxygen content (3.5 weight percent oxygen vs. 2.0 weight percent oxygen). It is well recognized that CO contributes to ozone formation. CO is present in ambient concentrations due in large part to the large volume of emissions from mobile sources. The Urban Airshed Model (UAM), relied on by states in their State Implementation Plan (SIP) submissions, includes inventories of CO emissions as well as volatile organic compounds (VOC) and oxides of nitrogen (NOx). While the role of CO in the formation of ozone is limited when compared to the effect of VOC and NOx, the volume of CO emissions from motor vehicles is comparatively large and therefore is not ignored in photochemical modeling demonstrations.

RFG with 3.5 weight percent oxygen results in a level of CO emission reductions that is greater than at 2.0 weight percent – the minimum amount of oxygen required by the statute – with correspondingly greater ozone benefits. Thus, at appropriate levels an adjustment to the VOC performance standard for such blends can still preserve the level of ozone air quality benefits generally expected to be achieved by the statutory RFG program. We have concluded that such an adjustment is appropriate in this case, based on cost and water quality considerations, so long as we can be reasonably confident that the expected benefits of the RFG program will be preserved. We are therefore adjusting the VOC performance standard by 2.0 percentage points for 10 volume percent ethanol RFG in the Chicago and Milwaukee areas. In order to provide reasonable assurance that the benefits of the RFG program will be preserved, we used the following process to determine the appropriate level for the adjustment:

1) We calculated the CO decrease in tons per day for Chicago and Milwaukee (the RFG areas that use ethanol) associated with the increase from 2.0 to 3.5 weight percent oxygen in the fuel;
2) We calculated the VOC increase in tons per day in Chicago and Milwaukee associated with varying increases in RVP in increments of 0.1 psi;

3) We calculated the ratio of CO decrease to VOC increase for each of the RVP increments for both Chicago and Milwaukee;
4) We selected the RVP increment yielding a ratio of CO decrease to VOC increase that we believe will result in similar ozone air quality benefits as currently achieved by the Phase II RFG program in the Chicago and Milwaukee areas.

The first three steps are detailed in the draft Technical Support Document (see Document II-B-2 in Docket A-99-32). The fourth step involved using the results of photochemical modeling that Illinois Environmental Protection Agency (IEPA) conducted for the Chicago region, and which was submitted to EPA for our consideration.

The proposed adjustment to the VOC performance standard of 1.0 percentage point (equivalent to an increase in RVP of approximately 0.2 psi) would have resulted in a ratio of CO emission decrease to VOC emission increase of 45:1. At the time, EPA was generally confident that this level of adjustment would protect the air quality benefits of the RFG program. Comments criticized and questioned our selection of this adjustment value; some commenters believed that the adjustment was not large enough and others believed it could result in adverse ozone air quality impacts.

In the proposed rule we solicited comment on a photochemical modeling analysis that IEPA provided to EPA. IEPA submitted an analysis that it believed supported an adjustment equivalent to an increase in RVP of 0.5 psi in the Chicago area. (A report analyzing IEPA’s submission is Document IV-A-1 in Docket A-99-32.) While we do not accept the adjustment level of 0.5 psi for reasons detailed below, we believe that the photochemical modeling that IEPA conducted provides information about the relationship between CO and VOC emissions and ozone formation that reasonably supports a VOC adjustment equivalent to 0.3 psi in the Chicago and Milwaukee areas.

The IEPA analysis suggests the ratio of CO decrease to VOC increase necessary to maintain similar ozone air quality benefits is lower than the 45 to 1 ratio upon which we based the proposed adjustment. Specifically, for the modeled region, the ratios of CO decrease to VOC increase suggested by IEPA's modeling range from 12:1 to 23:1, for the four episode days modeled.

As explained in further detail in Section II.B. below, EPA believes that based upon IEPA's photochemical modeling, the proposed 0.2 psi equivalent adjustment level would be overly conservative. EPA is reasonably confident that an adjustment equivalent to 0.3 psi will maintain similar ozone air quality benefits as the current Phase II RFG program.

B. Description of IEPA photochemical modeling analysis

IEPA performed an analysis of the ozone impacts of CO and VOC emissions from motor vehicles in the lower Lake Michigan area. (See Documents II-D-4, 5 and 6 in Docket A-99-32). IEPA ran the Urban Airshed Model-Version V (UAM-V) for a four day episode in 1991. The analysis compared the reduction in peak predicted ozone concentrations from assumed reductions of CO and VOC emissions from motor vehicles.

The baseline emissions inventory for IEPA's modeling analysis was the most recent inventory developed by the Lake Michigan Air Directors Consortium (LADCO) for the Chicago area for the year 2007. The inventory reflected all mandated CAA controls, motor vehicle emissions at NLEV and RFG-II levels, and a NOx emissions rate of 0.25 lb/MMBTU for large electric generating units. IEPA then ran a baseline scenario using the 2007 inventory and meteorological and air quality data bases developed for the 16-21 July 1991 LMOS/OTAG episode. We believe that this episode corresponds to the most prevailing type of episode for Chicago and generally provides a reasonable basis for evaluating air quality impacts in this areas.

In addition to the year 2007 baseline, IEPA simulated additional hypothetical emissions scenarios. These involved runs in which IEPA first reduced motor vehicle CO emissions, producing an ozone differential of approximately 1 ppb. IEPA then used an iterative process to determine how much VOC reductions in the on-road vehicle inventory in the greater Chicago region in northeastern Illinois would be needed in the model to give the same ozone response. No other changes to the modeling input files (including initial and boundary conditions) were made.

IEPA next analyzed UAM-V results; i.e, ground level ozone concentrations for the 2007 baseline, the CO reduction scenario, and the VOC reduction scenario. For each modeling day, IEPA tabulated the peak 1-hr ozone concentration predicted anywhere in the grid domain for the baseline and the two hypothetical scenarios. IEPA normalized the impact of CO and VOC emissions on ozone formation by computing, on a daily basis, the change in ozone (in ppb) for each 1000 tons of CO and VOC emissions reduced. The result of the analysis was a table listing the computed ratio of CO to VOC ozone changes per 1000 tons of emissions reductions.

IEPA concluded that the amount of ozone formed by CO emissions is 4 to 8 percent of that for VOC for the episode modeled. The actual CO/VOC ratios of ozone formation derived from UAM-V modeling for Chicago were 8.61, 4.30, 6.56 and 7.86 percent for the individual days during the 18-21 July 2007 simulation period. IEPA used this modeling, in combination with certain emission assumptions (as described below), to conclude that EPA should adopt an adjustment to the VOC performance standard equivalent to 0.5 psi.

C. EPA’s reasons for not accepting the adjustment of 0.5 psi

After evaluating IEPA’s analysis, EPA has decided that the IEPA study does not reasonably support an adjustment of 0.5 psi RVP for RFG containing ethanol . IEPA’s methodology was internally inconsistent and used inaccurate emission estimates.

IEPA compared the emissions (expressed in mg/mi) of a “complying fuel” (assumed to have an RVP of 6.8 psi and 2.0-- see Document II-D-6 in Docket A-99-32) with an alternative fuel consisting of a 7.3 psi RVP and 3.5 weight percent oxygen. IEPA calculated the ozone impact from the “complying fuel” versus the 7.3 psi fuel using the ratios of CO and VOC ozone formation derived from the photochemical modeling described above. Using this technique, IEPA calculated that the ozone impact of complying fuel would be 4,289 mg ozone/mi and that the ozone impact of the 7.3 psi fuel (with accompanying CO reductions due to the 3.5 weight percent oxygen) would be 4,291 mg ozone/mi—comparable amounts.

We found several deficiencies in the emission calculations which IEPA used in its justification of a 0.5 psi adjustment. Specifically, the motor vehicle VOC emission rates were taken from the EPA Complex Model and represent emissions from solely 1990 model year vehicles rather than those of the in-use fleet post-2000. IEPA then obtained the emission factor for CO by multiplying the Complex Model-derived VOC emission factor by a ratio of nationwide CO to VOC emissions for onroad vehicles, taken from the 1997 EPA Emissions Trends report rather than using values contained in the emission inventory for this region. This method is highly inaccurate, in that it represents a blend of emissions in areas with conventional and reformulated gasoline, summer and winter conditions**,** and a wide range of local emission control programs, such as I/M, rather than the specific conditions existing in Chicago during the ozone episodes. Finally, IEPA's estimate that 10 volume percent ethanol RFG (3.5 weight percent oxygen) would provide a 10 percent reduction in CO emissions from motor vehicles (compared to 2.1 weight percent oxygen RFG) is overstated. Using draft MOBILE6[2] methodology, (described in the above referenced draft Technical Support Document) we estimate a reduction of approximately 7 percent. We found that while the application of the modeling results was mathematically correct, the emissions inventory assumptions that they used to apply the results were inaccurate and inconsistent and therefore did not support an adjustment to the VOC standard of 3.7 percentage points (0.5 psi).

Notwithstanding the inaccuracies of the inventory used, IEPA also relied upon the use of relative reactivity factors for exhaust and evaporative VOC emissions. EPA does not support the use of relative reactivity factors, for reasons stated in the preamble of the NPRM. See 65 FR 42924.

D. How IEPA's photochemical modeling supports an adjustment equivalent to an increase in RVP of 0.3 psi

While we do not accept IEPA's recommendation for an adjustment equivalent to an increase in RVP of 0.5 psi, we find that the photochemical modeling that IEPA conducted does

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[2] MOBILE is an integrated set of FORTRAN routines for use in the analysis of the air pollution impact of gasoline-fueled and diesel-powered highway mobile sources. MOBILE is used in the preparation of all projection year emission inventories required by the Clean Air Act Amendments of 1990 for non-California areas. MOBILE calculates emission factors for gasoline-fueled light-duty vehicles (LDGVs), light-duty trucks (LDGTs), heavy-duty vehicles (HDGVs), and motorcycles. MOBILE also contains provisions for modeling the impact on emission factors of oxygenated fuels (i.e., gasoline/alcohol and gasoline/ether blends) and of participation in the reformulated gasoline (RFG) program under the 1990 Clean Air Act Amendments.

support a larger adjustment to the VOC standard than we originally proposed when more recent information on emissions inventory of CO and VOC from onroad vehicles is used.

As described in the above referenced draft Technical Support Document, we calculated changes in emissions associated for each 0.1 psi increment of RVP above complying fuel as determined via the Mobile Model.[3] (Table 1 provides a summary of the VOC emission increases and ratios of CO decrease to VOC increase for Chicago and Milwaukee for RVP values from 6.7 to 7.7 in increments of 0.1 psi; Table 2 provides a summary of the VOC emission reductions calculated by the Complex Model as a function of these varying RVP levels, with all other parameters held constant. Table 2 is included here as a reference to show how the ratio of CO decrease to VOC increase of 15:1 relates to a downward adjustment to the VOC performance standard by 2.0 percentage points.) As shown in Table 1, at a 0.2 psi adjustment level, the reduction of CO emissions relative to the increase in VOC emissions is 45:1. At a 0.3 psi adjustment, the ratio of CO decrease to VOC increase drops to 15:1. Having determined the CO and VOC emission consequences of different levels of adjustment, we evaluated what the ozone consequences might be, in order to identify a level of adjustment at which we could be generally confident that the ozone benefit of Phase II RFG would be preserved in the Chicago and

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[3] Mobile 6 is currently under review and has not as yet been released to the public. As a result, we felt that the computation of VOC increases associated with the adjustment should be based on Mobile 5b, which is publicly available. The equations for computation of CO in Mobile 6, however, were peer reviewed and available to the public. We chose to use the Mobile 6-derived equation for CO, rather than relying on Mobile 5b, primarily because newer and more relevant data was used in Mobile 6 to arrive at the relationship between fuel oxygen and CO. MOBILE5b oxygen-based CO benefits have been questioned for some time because dispersion modeling of Mobile 5b-derived CO inventories have not matched monitored ambient CO levels. Mobile 5b overestimates the CO reduction benefit due to fuel oxygen, while Mobile 6, based on new data, shows a reduction in oxygen-based CO benefits for many vehicle classes and essentially a zero-benefit for post-tier 1 (1994 and later) vehicles. Therefore because of the public availability of the CO calculation method for Mobile 6 and the increased accuracy in prediction of oxygen-based CO benefits, we felt the Mobile 6 estimation method for CO provided a better more conservative estimate for these emissions than Mobile 5b.

Milwaukee areas.

The single episode UAM analysis performed by IEPA indicated that, ton for ton, CO would form 4.30, 6.56, 7.86 and 8.61 percent as much ozone as VOC, respectively**,** over the four days of the modeled episode. The mean value of the CO to VOC ozone formation ratios obtained from IEPA's analysis is 6.8 percent, at which level the ratio of CO reductions to VOC increase needed to maintain ozone levels is 14.7:1. Moreover, looking at the IEPA modeling results on a daily basis, the results indicate that for each ton of VOC increase, the decreases in CO emissions necessary to maintain ozone levels are 23, 15, 13, and 12 tons, respectively. Thus, on two of the days that IEPA modeled, the ratio was better than the 15:1 associated with a VOC adjustment equivalent to 0.3 psi (an ozone benefit), and on one of the days the modeled ratio was approximately 15:1 (ozone neutral). On only one of the four days modeled was the ratio worse (i.e., greater) than 15:1. Significantly, the modeled day producing the ratio of 15:1 yielded the highest ozone concentration of the four days modeled. Because the highest ozone concentration is associated with the 15:1 ratio, adjustments based on lower ratios (i.e., 12:1 and 13:1) should not be used. We believe, therefore, that IEPA's analysis provides reasonable assurance that the 0.3 psi adjustment level is appropriate and would tend to preserve the ozone air quality benefits of the Phase II RFG program.

Finally, we note that the photochemical analysis for Chicago can be said to be generally representative of the Milwaukee area to due to the similarity in fuel formulations (100 percent ethanol blended RFG), their geographical proximity (less than 100 miles apart), and the fact that lake effects on local meteorology would be expected to be similarly important in the formation of ozone in these two areas.

E. Consideration of other approaches

Both the Renewable Fuels Association (RFA) and the National Corn Growers Association (NCGA) submitted comments on the proposed rule, suggesting that a larger adjustment be adopted. (See items IV-D-10 and IV-G-01 in Docket A-99-32). RFA's analysis was based in part on reactivity factors, as well as photochemical modeling runs. We do not accept the use of reactivity factors as discussed in further detail below. RFA's consultant prepared the photochemical modeling analyses for RFA, and also prepared photochemical analyses for IEPA which they used in the studies which they submitted to EPA. The report prepared by our consultant on IEPA's study addresses the photochemical modeling conducted by RFA's consultant (see document IV-A-1 in Docket A-99-32). Briefly, for the reasons stated in the report on IEPA's analysis, we believe that assumptions and approach adopted by RFA's consultant in the photochemical modeling analysis contain similar technical problems as those that were in the consultant's analyses for IEPA. We found that IEPA's own photochemical analysis, however, while possessing some problems, were generally valid for use in establishing the adjustment that we are promulgating.

NCGA's analysis was based entirely on the use of reactivity factors to support a larger adjustment. Our position on the use of reactivity factors is the same as we stated in the proposed rulemaking. Specifically, we agree with the National Research Council in its 1999 report (page 5) in which it states ‘‘So-called reactivity factors * * * are often uncertain and of limited utility for comparing similar RFG blends.’’ EPA continues to believe that the reactivity factors that have been developed to date may not accurately reflect actual photochemical reactivity of various ozone precursors. In recent regulatory decisions, EPA has expressed these concerns and others related to the use of relative reactivity factors [63 FR 48792, September 11, 1998]. In particular, EPA is concerned that the factors do not represent the wide variation in atmospheric conditions that exist across the country or across any individual airshed and which have a large influence on ozone formation.

F. Calculation of ratios of CO emission decreases to VOC increases

Some commenters criticized the procedure we used to establish ratios of CO emission decreases to VOC increases for the various incremental RVP values and questioned our use of Mobile 5b for calculation of VOC emissions while using an equation derived from Mobile 6 for calculating CO decreases. At this time, the Mobile 6 equation for CO has been peer reviewed and is thus appropriate for use, while the equations for VOC in Mobile 6 are still undergoing review. We do not believe that use of Mobile 5b for VOC and the Mobile 6 equation for CO represents an inconsistency. Rather, Mobile 6 provides a more accurate method for estimating CO as a function of oxygen in the fuel. Mobile 5b would have overestimated the CO decrease, suggesting an inappropriate adjustment for VOC. Thus, while we believe that there is no inconsistency in our approach, we note that any potential effect of using Mobile 6 to evaluate CO emissions would tend to make our analysis more accurate.

G. Other comments on the adjustment level

The California Air Resources Board (CARB) commented on our proposed rule and stated that our ratio of CO decrease to VOC increase associated with the adjustment (45:1) is similar to theirs, but “must not be further decreased.” While we had proposed a nationwide adjustment to the VOC performance standard, we believe for the reasons explained in the preamble to the rule that the adjustment should be restricted to the Chicago and Milwaukee areas. Thus, while CARB's comment might have merit for a rule of national applicability, it is not specifically relevant to Chicago and Milwaukee and does not provide a basis for rejection of IEPA's photochemical modeling results for the modeled region.

Another comment suggested that the effect on ozone from an adjustment equivalent to an RVP increase of 1.0 psi would be impossible to detect via monitoring or modeling and therefore the adjustment should be made at such level. We agree that the effect of small VOC adjustments on ozone generally would be too small to be measured via ambient ozone monitoring or modeling due to the lack of sensitivity of such measurement and predictive tools. Given the numerous factors (e.g., other stationary and mobile source air quality control strategies, meteorology, traffic patterns, geography and other factors) that affect ambient air measurements, it is difficult to discern the impact of any one air quality control strategy through ambient monitoring or photochemical modeling. Notwithstanding the difficulty of discerning the changes due to any one air quality strategy, this does not mean there is no impact on ozone or that a 1.0 psi adjustment would preserve the benefit of the Phase II RFG program. This benefit comes from the actual impact of the RFG emissions reductions on ozone and the role these reductions play in combination with many other necessary regulatory programs to obtain overall reductions in ozone. We do not believe that the size of the CO reduction relative to a VOC increase associated with a 1.0 psi adjustment would preserve the benefit of the Phase II RFG program. Furthermore, we do not consider the benefits of the Phase II RFG program to be inconsequential.

H. Discussion of the emissions impact of the VOC adjustment

1. NOx and permeation

Some commenters raised issues regarding the impact of the proposed VOC adjustment on NOx emissions and permeation. Commenters stated that the higher oxygen levels associated with the use of ethanol in RFG at 10 volume percent (3.5 weight percent oxygen) lead to increased NOx emissions, and result in a loss of overcompliance with the NOx performance standard. Commenters also suggested that the proposed VOC adjustment would result in an increase in permeation. Specifically, commenters observed that soft fuel components of automotive fuel systems tend to be more permeable to ethanol than to other hydrocarbons in gasoline. Thus, they argued, any increase in ethanol use attributable to an adjustment of the VOC performance standard would be accompanied by an increase in permeation-related emissions. .

There is a high level of uncertainty regarding the overall impact of the VOC adjustment on NOx emissions, given the variety of other fuel parameters such as aromatics, olefins, and other gasoline components that can affect NOx emissions. Specifically, there is no adequate basis to conclude what the effect on NOx would be absent information about what impact this rule–or oxygen levels–will have on how refineries reformulate their gasoline for all of the fuel parameters relevant to NOx. There is also uncertainty regarding permeation since currently there is little information on the level of permeation emissions associated with ethanol. The California Air Resources Board is undertaking a study to quantify permeation losses, but the study will not be released until the fall of 2001. Moreover, because the rule is restricted to the Chicago and Milwaukee RFG areas, in which the penetration of ethanol-RFG is 100 percent, the NOx and permeation emissions would not change from their current levels if there is no change in ethanol use.

2. Comparison of emission impacts with and without the adjustment

We believe that without the VOC adjustment a limited potential exists for refiners to use more MTBE in RFG in the Chicago and Milwaukee areas than with the adjustment. Accordingly, we have examined the effect of the adjustment on emissions for both scenarios (i.e., rule and no rule) and compared the results. We believe that the ratio of CO reduction to VOC increase associated with ethanol use will remain at a level that provides a reasonable assurance that the benefits of the Phase II RFG program will be preserved, even with the adjustment. Therefore, the rule will not sacrifice the general benefits of Phase II RFG.

Table 3 summarizes the emission impacts of today's action, as compared to the emission consequences of no action, in both the Chicago and Milwaukee RFG areas with respect to CO and VOC. The no-rule scenario assumes that the VOC standard remains as it is currently, and that there would be a 5 percent market penetration of MTBE as an oxygenate for RFG in the Chicago and Milwaukee areas.[4] Table 4 provides a detailed breakdown of the emission effects for the rule and no-rule scenarios for commingling and nonroad vehicles.

Calculation methods and assumptions are described in the sections below. Also discussed below is the effect on the parameters of commingling, nonroad vehicles, and toxics.

3. Calculation of onroad VOC and CO emissions for the "rule" and "no-rule" scenarios

The above-referenced draft Technical Support Document for the proposed rulemaking contains the calculation procedures that we used to estimate the CO reduction associated with 3.5 weight percent oxygen in the gasoline, and the VOC emission changes as a function of RVP increases associated with an adjustment to the VOC performance standard.

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[4] We believe that this 5 percent level is a conservative estimate of the most MTBE-blended RFG we might expect to see in Chicago and Milwaukee over the short term. We use this level for purposes of this analysis to illustrate the potential impact of today's rule if the rule has the intended effect.

For the no-rule scenario, there would be no VOC increase since there would be no adjustment. The calculation of CO for the no-rule scenario assumes that 5 percent of the ethanol-RFG market share is displaced by MTBE-RFG. This increase in MTBE use would result in a loss of some of the CO reduction benefits associated with 10 volume percent ethanol RFG.

Specifically, for the 5 percent share of ethanol RFG that is displaced, the oxygen content of the RFG decreases from 3.5 to 2.1 weight percent; it is necessary then to calculate the CO emissions increase for that market share. CO emissions at 2.1 weight percent oxygen are approximated by the Mobile 6-derived equation used in the draft Technical Support Document. We converted the CO emission rate (10636.7 mg/mi) to tons/day and multiplied by the MTBE market share (5 percent) and the VMT for Chicago and Milwaukee to yield 76.39 tons/day and 18.6 tons/day, respectively. We then compared these values with CO emissions assuming 3.5 weight percent oxygen in the fuel, also approximated by the Mobile 6-derived equation. Using this same approach we estimate these emissions to be 9906 mg/mi which, based on the Vehicle Miles Traveled (VMT) for each area, equates to 71.14 and 17.28 tons/day for Chicago and Milwaukee, respectively. Thus we estimate the increase in CO from a displacement of 5 percent of ethanol RFG at 3.5 weight percent oxygen by MTBE RFG at 2.1 weight percent oxygen to be 5.25 tons/day (76.39 - 71.14) and 1.27 tons/day (18.6-17.28), for Chicago and Milwaukee, respectively.

4. Commingling

a. Background

In comparing the rule and no-rule scenarios, a model that estimates commingling effects (described in more detail below) suggests that the adjustment will have a modest beneficial impact on VOC emissions because the adjustment would preserve the current 100 percent penetration of ethanol RFG in the Chicago and Milwaukee areas. Therefore, no emission increases associated with the mixture of ethanol and non-ethanol blends of gasoline in automobile gasoline tanks would occur in the rule scenario. Since the presence of ethanol causes an increase in the volatility of gasoline (as measured by Reid Vapor Pressure or RVP), such commingling in automobile gas tanks would contribute to an increase in VOC emissions in the no-rule scenario.

When ethanol is mixed with gasoline, a non-linear increase in RVP occurs. For example, if gasoline with an RVP of 8.0 psi is mixed with non-denatured ethanol (which alone has an RVP of 2.4 psi) in a 90 percent gasoline/10 percent ethanol mixture, the RVP of the resulting mixture is approximately 9.1 psi, a 1.1 psi RVP increase.[5] Because of this RVP boost associated with ethanol blending, a blendstock with a sufficiently low RVP must be used to achieve the desired RVP in the ethanol-blended gasoline.

An RVP boost will also occur when ethanol-blended gasoline is mixed with non-oxygenated or ether-oxygenated gasoline. For example, the RVP of a mixture containing equal volumes of a 7 psi ethanol-oxygenated RFG blend and a 7 psi non-oxygenated RFG blend would

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[5] SAE paper 940765, “In-Use Volatility Impact of Commingling Ethanol and Non-Ethanol Fuels” Peter J. Caffrey and Paul A. Machiele, US EPA.

be greater than 7 psi. When an ethanol-oxygenated gasoline is mixed with an MTBE-oxygenated gasoline the resulting increase in RVP is somewhat smaller than it is when an ethanol-oxygenated gasoline is mixed with a non-oxygenated gasoline. Mixing of ethanol-oxygenated gasoline with other gasoline is called commingling and the associated RVP boost is called the commingling effect. While federal regulations prohibit or restrict commingling in the distribution system, these restrictions do not apply to commingling in vehicle fuel tanks.

Several models exist to assist in estimating the commingling effect under differing input assumptions about the amount of ethanol used, base RVP of the fuels, and consumer refueling habits. Perhaps the most important factors in predicting the commingling effect in an ethanol/MTBE market are brand loyalty (i.e., the extent to which consumers refuel with one brand, several brands, or many brands)[6], and the market share of ethanol-blended RFG in that market.

EPA developed a model (SAE paper 940765; see footnote 2) that predicts emission increases based on commingling. The California Air Resources Board developed a similar probability model, formulated by Dr. D.M. Rocke of University of California at Davis. Both models indicate that when “loyalty” is held constant, the commingling effect peaks at or near 50 percent ethanol market share. With the EPA model, the commingling effect peaks at 30 to 50 percent market share, depending on the model parameters selected Increases in the ethanol RFG

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[6] The significance of brand loyalty in prediction of the commingling effect is the underlying assumption that oxygenate usage would be consistent within a given brand in a given area. Thus a specific brand of oxygenated gasoline sold in a given area would be entirely ether-oxygenated or entirely ethanol-oxygenated. While this is generally true, we have seen some exceptions to this assumption, although extremely limited. If the assumption of dedicated oxygenate use per brand is not generally valid, then significant commingling could occur even in vehicles whose owners do not switch brands, and the emission increase associated with commingling would be even higher than what the models predict.

market share above the critical mixing point for commingling would reduce the RVP increase that occurs from commingling. These models also show that as loyalty decreases at a constant market share (i.e., as consumer refueling choices become more random), the commingling effect increases.

The commingling effect can result in an overall increase in the RVP of the gasoline pool ranging from 0.1 to 0.3 psi. (Such increases in RVP would be beyond the equivalent RVP increase of 0.3 psi associated with this rule.) Increases in the ethanol RFG market share in an area where ethanol is already used at or above the critical percentage for commingling (e.g., above 50 percent market share) could reduce commingling-related emissions, however.

Although these models may accurately predict the magnitude of the commingling effect for a given set of input conditions, the conditions that would be specifically applicable to RFG areas in any given area of the country outside of Chicago and Milwaukee are unknown. Outside Chicago and Milwaukee, it is more difficult to predict market share. However, states and state associations expressed concern about the possibility of increased VOC emissions due to commingling. For example, the Northeast States for Coordinated Air Use Management pointed out that where both MTBE- and ethanol-blended RFG are available, commingling in automobile gasoline tanks cannot be controlled by regulation and will result in VOC increases. The California Air Resources Board similarly expressed concern that EPA’s proposal did not address commingling.

b. Further evaluation of commingling in response to comments

For the “no rule” scenario, we assumed a 95 percent market penetration of ethanol RFG and 5 percent penetration of MTBE RFG. The blend not containing ethanol would then be subject to a commingling RVP increase due its presence in a market along with ethanol RFG. . The above-referenced EPA commingling model estimates an increase in RVP of 0.08 psi (0.07 to 0.09 psi) for a displacement of 5 percent of RFG using ethanol by RFG using MTBE.

Emissions of VOC are derived from the RVP increase by using results from EPA's MOBILE 5b model. MOBILE 5b yields emissions of VOC as a function of fuel RVP. Estimates of the VOC emission increases resulting from the adjustment rule were calculated for RVP levels varying from 6.7 to 7.7 in increments of 0.1 psi for Chicago and Milwaukee. (See Table 3.) Using these values, we then calculated the effect of commingling for the "no-rule" scenario, by prorating the tonnages in Table 3. Specifically, we calculated the VOC emission increase associated with an RVP of 6.78 psi, which represents the baseline RVP with the additional increase due to commingling (0.08 psi). We estimated the increase in VOC emissions associated with an increase in RVP of 0.08 psi (i.e., an increase from 6.7 to 6.78 psi) due to commingling to be 0.7 tons/day for Chicago and 0.17 tons/day for Milwaukee.

5. Toxics

Comments suggest that an adjustment would result in an increase in toxics because of the slight increase in VOC; although there is a toxics performance standard, commenters were concerned that toxics overcompliance would be lost.

Since the time that the VOC adjustment rule was proposed, EPA promulgated a final rule (66 FR 17230; March 29, 2001) to prevent backsliding of air toxics. The rule establishes a performance standard for toxics that must not exceed the average toxics performance for years 1998, 1999 and 2000 on a refinery by refinery basis. Thus, commenters' concerns that the VOC adjustment would result in a diminishing of toxics overcompliance is addressed in large part by the new rule which would assure that refiners maintain whatever toxics overcompliance has been achieved based over the above mentioned three year period. There is a possibility of additional overcompliance in the absence of the VOC adjustment of 2 percentage points (i.e, equivalent increase in RVP of 0.3 psi) but we believe this would have been very small.

Given the size of the VOC adjustment, we believe that the resulting increase in VOC emissions will not make it noticeably more expensive to comply with the new toxics standard. We believe that the impact of VOC emission increases on toxics performance will not diminish any cost benefit associated with the VOC adjustment rule.

6. Nonroad emissions

Comments suggested that emissions from off-road vehicle would increase as a result of the VOC adjustment. We have calculated and accounted for the emission changes associated with both increased oxygen and the VOC adjustment for the scenario in which the rule is implemented compared to no rule. The results of this analysis were considered in our overall calculation of the ratio of CO decrease to VOC increase resulting from the rule. Inclusion of nonroad vehicles results in a ratio greater than that for onroad vehicles only (19:1 versus 15:1). Given the greater uncertainty associated with predicting nonroad compared to onroad emissions in order to ensure that VOC adjustment still preserves the air quality benefits of the RFG program, we relied upon the lesser ratio in establishing the adjustment level of 2.0 percentage points (equivalent to an RVP increase of 0.3 psi).

a. Effect of VOC adjustment on VOC nonroad emissions

We employed EPA’s nonroad model to estimate the VOC increase which would be attributable to an 0.3 psi adjustment by setting the fuel RVP model inputs at 6.7 and 7.0 psi. The model estimated VOC emissions of 27.97 t/d and 11.9 t/d for Chicago and Milwaukee, respectively, at 6.7 psi and estimated VOC emissions of 28.78 t/d and 12.64 t/d at 7.0 psi for these respective areas. The difference in emissions between the varying RVP values, 0.81 t/d and 0.74 t/d for Chicago and Milwaukee, respectively, therefore provides an estimate of the VOC emission increase which would be directly attributable to nonroad emissions for an adjustment of 0.3 psi in fuel RVP.

For the no-rule scenario, there would be no increase in VOC because the current Phase II VOC standard would continue to apply for ethanol RFG.

b. Commingling effect for off-road emissions

For the rule scenario, we assumed that there will be no mixed market; hence, there would be no commingling effect.

For the no-rule scenario, we assumed 5 percent market displacement of ethanol with MTBE. EPA’s commingling model (section III.H.2 above) for onroad emissions predicted an RVP increase of 0.08 psi for a 5 percent market displacement. We then applied the predicted onroad RVP increase (0.08 psi) for commingling to the VOC emission estimates from nonroad engines for Chicago and Milwaukee using the results from EPA’s nonroad model as described above (Section III.H.5.a). We estimated the difference in VOC emissions associated with the commingling effect (0.08 psi RVP increase) to be 0.7 tons/day for Chicago and 0.19 tons/day for Milwaukee.

c. Effect of rule on CO nonroad emissions

We estimated the nonroad CO emissions using data for 2-cycle and 4-cycle nonroad engines from the 1996 emission inventories. Based on a weighting of 2 stroke and 4 stroke engines, and using EPA’s nonroad model, we derived a mathematical formula developed for emissions as a function of the percent change oxygen increase (see Section III.H.5 above). We calculated a decrease of 6.33 percent CO emissions for each percent increase in fuel oxygen. We then adjusted the emissions contained in the 1996 emission inventories from 3.5 to 2.0 oxygen by weight, using the above mathematical relationship.

We estimated nonroad CO emissions of 1051 t/d and 261.1 t/d at 3.5 weight percent oxygen for Chicago and Milwaukee, respectively. Employing the above oxygen-CO relationship for nonroad engines, we calculated emissions of 1151 t/d and 285.9 t/d for Chicago and Milwaukee, respectively, for the baseline of 2.0 percent by weight oxygen. The estimated decrease in CO emissions from nonroad engines, previously unaccounted for, is therefore 100 t/d and 24.8 t/d, respectively.

The no-rule scenario assumes 5 percent market displacement of ethanol RFG containing 3.5 percent by weight oxygen with MTBE RFG containing 2.0 percent by weight oxygen. In the no-rule scenario, the 5 percent market penetration results in a reduction of the unaccounted for CO benefit of 5.0 tons/day and 1.24 tons/day (0.05*100 t/d and 0.05*24.8t/d) for Chicago and Milwaukee, respectively.

III. EXPECTED AIR QUALITY IMPACTS (OUTSIDE MIDWEST)

This section addresses why we are restricting the adjustment to the Chicago and Milwaukee areas. The reasons for restricting the adjustment to these areas is twofold: 1) the IEPA photochemical modeling upon which the 0.3 psi equivalent RVP adjustment was selected is representative only of the Chicago/Milwaukee areas, and cannot be extended to other areas, and 2) a VOC adjustment outside these areas may not preserve the air quality benefits of the RFG program, due to emissions increased associated with commingling.

Outside Chicago and Milwaukee, it is more difficult to predict market share. For example, New York has enacted a ban on MTBE that will take effect in 2004. At the present time, New Jersey has not enacted a ban on MTBE. Assuming New York's ban is implemented as planned, we would expect that the market share of ethanol for RFG sold in the New York City RFG area will be 100 percent starting in 2004, however, we don't know what it will be between now and 2004, or the ethanol share for RFG sold in New Jersey. Assuming a worst case of 30 to 50 percent in those states, using the commingling procedure discussed in Section II.H.2 above, the increase in VOC emissions will be approximately equivalent to an increase in the RVP of 0.1 to 0.3 psi. In the New York City area, at 0.3 psi, the RVP increase from commingling could increase VOC in an amount similar to the VOC adjustment–specifically VOC could increase approximately 12 tons/day beyond the increase associated with the VOC adjustment alone. While we cannot say with certainty what portion of the 30 to 50 percent of the market share might be attributable to the adjustment to the VOC performance standard, increases in VOC from commingling would likely be exacerbated by such a rule.

In addition to questions regarding the effect on emissions that a VOC adjustment would have regarding its potential effect on changes in market share and current and future levels of commingling, all these localities lack the photochemical analysis of CO and VOC ozone formation necessary to determine a ratio of CO to VOC emissions changes appropriate to preserve the expected benefits of the RFG program. We therefore believe that the rule could cause an inappropriate level of VOC increases compared to CO emissions which could have adverse environmental effects on ozone in areas outside of the Midwest.

IV. EFFECT OF NEWER VEHICLES AND LOW SULFUR GASOLINE ON ADJUSTMENT VALUE

The rationale for selecting an VOC adjustment of 2.0 percentage points is the reduction in CO emissions associated with the oxygen level of RFG containing 10 volume percent ethanol. Some commenters pointed out that as newer vehicles enter the vehicle fleet, advanced engine technology may reduce baseline CO emissions, so that the decrease in such emissions from the use of ethanol RFG could be diminished. Additionally, the Tier 2/low sulfur gasoline regulations which will take effect in future years, could also reduce CO emissions.

We agree with the commenters who pointed out that there might be changes in the ratio of CO decrease to VOC increase because of new technology and the effect of lower sulfur on CO emissions. The change in technology in the fleet over time could also affect the level of VOC emissions associated with a change in the VOC performance standard for RFG. Comments did not provide specific data to support a termination of or changes to the adjustment at any particular time. We will continue to evaluate the potential impact of new technology and low sulfur gasoline on the CO benefits associated with oxygen in gasoline as well as the performance of the vehicle and the resulting ratios of CO decrease to VOC increase.

V. OTHER COMMENTS

A. Applicability of adjustment to ethanol RFG at less than 10 volume percent

Some commenters objected to the adjustment not applying to RFG that might contain less than 10 volume percent ethanol and suggested that lower adjustment levels apply, based on the amount of ethanol. We understand that in areas outside Chicago and Milwaukee, refiners may choose to blend less than 10 volume percent ethanol in RFG due to the supply and cost. This point has become less of an issue since we are restricting the applicability of the adjustment to the Chicago and Milwaukee areas, in which 10 volume percent is the prevailing amount of ethanol in RFG. Notwithstanding the restriction of the adjustment to these areas, introducing variable adjustment levels that correspond to different levels of ethanol in RFG would be difficult to implement and enforce.

B. Stranded cost of investments to comply with Phase II RFG

Some of the refiners who commented expressed concern that the proposed change in the VOC standard represents a change in the RFG II requirements that refiners relied upon when making their investment decision. As such, refiners who fully invested to maintain RFG production levels would not be able to benefit from the relaxation to as great an extent as refiners who did not invest as fully since a portion of their costs for the new equipment would be “stranded”.

We believe that the rule will not represent stranded costs for refiners. The purpose of the adjustment is to provide refiners with greater flexibility in producing RBOB. The adjustment of the VOC standard by 2.0 percentage points would reduce the cost of making Phase II RFG by approximately 21 percent. As such, the reduction in costs associated with this greater flexibility should enhance the opportunity for refiners to recover that portion of their investment that might be stranded.

Table 1:

VOC emission increases and ratios of CO decrease to VOC increases for Chicago and Milwaukee as a function of RVP

Increases in Chicago based on Mobile Runs

RVP (psi)	**6.7**	**6.8**	**6.9**	**7**	**7.1**	**7.2**	**7.3**	**7.4**	**7.5**	**7.6**	**7.7**
RFG: VOC increase (tons/day)[a,b]	0.00	1.22	2.61	8.00	13.39	18.95	24.34	29.90	35.47	41.20	47.12
RFG: Ratio of CO/VOC:[c]	n/a	97.78	45.63	14.88	8.89	6.28	4.89	3.98	3.36	2.89	2.53

Increases in Milwaukee based on Mobile Runs

RVP (psi)	**6.7**	**6.8**	**6.9**	**7**	**7.1**	**7.2**	**7.3**	**7.4**	**7.5**	**7.6**	**7.7**
RFG: VOC increase (tons/day)[a,b]	0.00	0.13	0.28	0.84	1.41	2.00	2.57	3.16	3.74	4.35	4.97
RFG: Ratio of CO/VOC:[c]	n/a	97.4	45.45	14.82	8.85	6.26	4.87	3.96	3.34	2.88	2.52

[a] The VOC emissions were calculated by first generating emission factors using the Mobile5b model. In running Mobile 5b, default values for vehicle mix and I/M programs were used. The Mobile model can be run in a conventional gasoline mode or RFG mode. In the RFG mode, the model automatically assumes that the oxygen content is 2.0 weight percent and RVP cannot be varied. In order to represent RFG with an oxygen content of 3.5 weight percent, for varying RVP values, Mobile was run in conventional gas mode, with oxygen content set at 3.5 weight percent, varying the RVP from 6.7 to 7.7 by increments of 0.1 psi. We then ran Mobile in RFG mode and compared the exhaust VOC emissions with those from Mobile in conventional gasoline mode. In conventional gasoline mode, Mobile yields 0.919 g/mi exhaust VOC; in RFG mode it yields 0.878. The difference, 0.041, was subtracted from the total VOC emissions from the Mobile runs assuming 3.5 weight percent oxygen to yield total VOC reflecting exhaust VOC associated with RFG and evaporative VOC reflecting varying RVP values.

[b] To calculate tons/day emissions, the VOC emission factors in grams per mile (g/mi) were multiplied by the average summer day Vehicle Miles Traveled (VMT) for Chicago and Milwaukee, which were 1.58×10^8 and 1.67×10^7 , respectively. To convert to tons/day, the product was multiplied by (lb/454 g) x (ton/2000 lb). This yielded total emissions for each RVP level. To calculate increases, the emissions at the 6.7 psi level were subtracted from the emissions for each RVP level.

[c] The ratio of CO/VOC was calculated by dividing the reduction in CO for each location by the respective VOC increase for each of the RVP increments. CO decreases would be constant for each locale, since they are based on oxygen content of the fuel and are independent of RVP values. As stated on page 7 of this document, the CO decrease for Chicago and Milwaukee is calculated to be 119 and 12.5 tons/day, respectively.

Table 2:

VOC emission reductions calculated by the Complex Model as a function of RVP

RVP (psi)	**6.7**	**6.8**	**6.9**	**7.0**	**7.1**	**7.2**	**7.3**	**7.4**	**7.5**	**7.6**	**7.7**
VOC emission reduction[a]	-27.4	-26.7	-26.0	-25.3	-24.5	-23.7	-22.9	-22.0	-21.0	-20.1	-19.0
Difference from Phase II VOC standard[b]	0	0.7	1.4	2.1	2.9	3.7	4.6	5.4	6.4	7.4	8.4
Incremental RVP increase (psi)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

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[a] Calculated using the Complex Model, holding all parameters except RVP constant. The constant parameters are: Ethanol (wt% oxygen): 3.5; MTBE: 0; TAME: 0; Sulfur (ppm): 150; E200(%): 46.9; E300(%): 83.3; Aromatics (vol%): 25.4; Olefins (vol%): 11.1, Benzene (vol%) 0.8.

[b] The Phase II standard for VOC is 27.4% emission reduction for northern areas.

Table 3: Comparison of emissions with and without the rule in Chicago and Milwaukee

	EMISSIONS (TONS/DAY)					
	CHICAGO			MILWAUKEE		
	Rule	No-rule	Change due to rule	Rule	No-rule	Change
CO	-219	-209	-10	-54	-51	-3
VOC	8.7	0.93	7.8	2.6	0.4	2.2

Table 4: Detailed breakdown of emissions with and without the rule in Chicago and Milwaukee

	EMISSIONS (TONS/DAY)					
	CHICAGO			**MILWAUKEE**		
	Rule	**No-rule**	**Change due to rule**	**Rule**	**No-rule**	**Change due to rule**
CO Emissions[a]						
Onroad	-119	-114	-5	-29	-28	-1
Nonroad	-100	-95	-5	-25	-23	-2
Total	-219	-209	-10	-54	-51	-3
VOC Emissions						
Adjustment effect on onroad vehicles	8.00	0.0	8.00	1.94	0.0	1.94
Adjustment effect on nonroad engines	0.81	0.0	0.81	0.74	0.0	0.74
Commingling-onroad	0.0	0.7	-0.7	0.0	0.17	-0.17
Commingling-nonroad	0.0	0.21	-0.21	0.0	0.19	-0.19
Total	8.7	0.93	7.8	2.6	0.4	2.2

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[a] Represents decreases in CO emissions that were unaccounted for when the RFG program started in 1995 and oxygen levels in these areas increased from 2.0 to 3.5 weight percent. For the no-rule scenario, the unaccounted for decreases in CO are adjusted by that portion of the fuel market (5 percent) which would use MTBE and for which oxygen levels would decrease from 3.5 to 2.0 weight percent.