REMOVING MTBE FROM GASOLINE: IMPLICATIONS FOR THE NORTHEAST GASOLINE SUPPLY

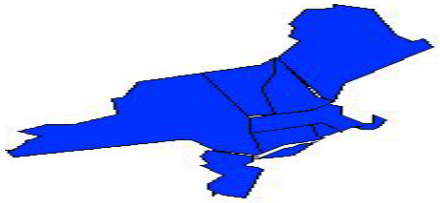
Volume II

White Paper for the Northeast MTBE Roundtable

Prepared by DAI Downstream Alternatives Inc.

April 2003

MTBE Bans, RFG Oxygen Requirements, and Renewable Fuel Standards
and
Their Potential Impact on the Supply and Distribution
of Transportation Fuels in CONEG States



Prepared for the CONEG Policy Research Center, Inc.

under
Contract No. NRBP-R2-1980

April 4, 2003 (B)

Note: This is a working paper and is not for public distribution

Prepared and Submitted by:

Robert E. Reynolds
President
Downstream Alternatives Inc.
2259 Harwood Street
South Bend, IN 46614
phone: (574) 250-2811
fax: (574) 231-8975
email: rreynolds-dai@earthlink.net

Downstream Alternatives Inc.

Disclaimer

Introduction and Overview

States encompassing major gasoline markets within the CONEG region are currently faced with several uncertainties about existing and pending fuel regulations which have the potential of impacting the supply and distribution of gasoline.

Under existing laws and regulations, the gasoline oxygenate methyl tertiary butyl ether (MTBE) is scheduled to be banned in New York (01/01/04) and Connecticut (10/01/03). Current federal regulations require that reformulated gasoline (RFG) sold in specified non-attainment areas contain an average of 2.0 weight percent (wt.%) oxygen. Refiners have traditionally met this requirement by adding a minimum of 11 volume percent (v%) MTBE to their gasoline. New York and Connecticut are currently required to sell RFG, as are several other CONEG states. If MTBE is banned and the oxygen requirement is maintained, the only widely available, competitively priced, alternative to MTBE is ethanol. Refiners would be required to add a minimum of 5.7 v% ethanol to meet the 2.0 wt% oxygen requirement. The addition of ethanol would require alterations to summer grade RFG to accommodate ethanol's impact on Reid Vapor Pressure (RVP). This will result in changes in gasoline composition requiring the use of greater volumes of low vapor pressure hydrocarbon components. In addition, because ethanol is usually blended into gasoline at the terminal, to maintain quality control, its use will require the availability of storage tanks and the addition of blending equipment at numerous terminals. Consequently both supply and distribution may be affected.

Potential changes to current regulations include delay of the MTBE ban in Connecticut and federal legislation that could rescind the oxygen requirement and ban MTBE nationwide. The State of Connecticut has introduced SB.840, a bill that would delay the MTBE ban. Such proposed delays add an element of uncertainty where refiners and terminal operators may delay modifications and investments pending the outcome of such bills. New York has not yet proposed any delay to its MTBE ban.

At the federal level, last year's proposed energy legislation contained a Renewable Fuels Standard (RFS) which would have removed the oxygen requirement, while requiring an increasing use in the volume of renewable fuels such as ethanol and biodiesel. The RFS provided for credit trading which would result in refiner flexibility to use ethanol only where they choose to do so. While the legislation did not pass, it is being reconsidered in this Congress. The RFS would reduce the impact on

refiners facing an MTBE ban because they would be able to use ethanol where they chose to do so, but its use would not be required. While refiners, based on current state laws, are faced with the certainty of MTBE bans in New York and Connecticut, the compliance strategy they choose will be based on whether or not there is a federal oxygen requirement for RFG.

If the oxygen requirement is not rescinded, each gallon of RFG sold in MTBE ban states would need to contain ethanol. Since this limits a refiner's course of action, it is generally thought that this scenario requires the greatest level of investments at both refineries and finished product terminals.

Conversely, if the oxygen requirement is rescinded, refiners could choose to meet the RFG requirements with or without the use of ethanol. Some refiners have, in the past, indicated they could make at least some RFG without the use of oxygenates. Consequently, it is generally thought that refiners would use less ethanol (or other oxygenates) if not required to do so. Instead they would modify refining processes and perhaps produce, or import, more alkylate. It is likely, however, that they would use ethanol in some portion of their RFG for octane purposes and toxics compliance. In this scenario investment requirements would likely be lower because refiners would choose where to utilize ethanol based on a combination of their compliance strategy and economics. This could result in lower investments at the refinery level. In addition, fewer terminals would need to be converted to ethanol, reducing investments at that level as well.

Further complicating compliance decisions is the issue of timing. Refiners must prepare to comply with MTBE bans within a matter of months, but it is as yet unclear if they will be required to use an oxygenate. Compliance decisions must be made soon, and perhaps without knowing the outcome of any federal energy legislation that might remove the oxygen requirement for RFG. If refiners delay making investments to utilize ethanol and the RFG oxygen requirement is not rescinded, they will not be prepared for the necessary change-over to ethanol. If they make investments now, to utilize ethanol, and the oxygen requirement is rescinded, they may have indeed made investments that could possibly have been avoided.

Another complicating factor is the ability of federal RFG opt-in areas to opt-out of the RFG program as of January 1, 2004. This includes most of the CONEG state markets other than the areas included in the New York City Consolidated Metropolitan Statistical Area (CSMA).

If the oxygen requirement is rescinded at the federal level, these states would be more likely to continue voluntary participation in the RFG program. However, if the oxygen requirement remains, along with the perceived uncertainties of replacing MTBE with ethanol, these states may choose to opt-out of the program. In doing so, it may be necessary to develop other strategies to obtain the emissions benefits of RFG for compliance with their State Implementation Plan (SIP). One such strategy would be for a state to require gasolines possessing some, but not all, of the properties of RFG such as low vapor pressure but no oxygen requirement. These fuels, typically referred to as "boutique fuels", fragment the fungibility of the petroleum distribution system, further complicating the supply and distribution chain.

The opt-out issue is also affected by the timing issue. States need to make decisions now to prepare for any opt-out, but they do not yet know if federal legislation will rescind the oxygen requirement, making an informed decision impossible.

This adds an additional element of uncertainty for refiners and terminal operators since they do not want to make modifications and investments to service the opt-in/opt-out areas if the fuel requirements might change.

Finally, it should be noted that some refiners and terminals serve both MTBE ban and non MTBE ban areas as well as both mandatory and opt-in RFG areas. Consequently, requirements in one state may impact which fuels a refiner/terminal operator chooses to offer in a nearby state. This is due to both economics and logistic considerations

This paper discusses the primary issues associated with MTBE bans in CONEG states and, when applicable, the ramifications of the alternatives that could be employed to replace MTBE. Note that a glossary of acronyms used in this report is included as Appendix A.

CONEG States - Gasoline Supply & Distribution

In order to consider ramifications of the MTBE bans and increased ethanol use, it is first important to have an understanding of gasoline supply sources and how gasoline is distributed in CONEG states. There are two general ways to assess gasoline demand. From Energy Information Administra-

tion (EIA) reports or Federal Highway Administration reports. The EIA generally reports data by Petroleum Administration for Defense Districts (PADD) while the FHA numbers report retail gasoline sales by state. FHA volumes tend to differ slightly from than EIA numbers because of reporting differences.

The following table lists each CONEG state and its gasoline sales for calendar year 2001 as reported by the FHA.

Table 1: CONEG States - Gasoline Sales Volumes 2001

Gasoline Sales (thousands of gallons)

State	Gasoline Sold
Connecticut	1,496,468
New York	5,679,011
New Jersey	3,998,940
Maine	611,865
Massachusetts	2,806,176
New Hampshire	690,660
Rhode Island	409,510
Vermont	342,691
Total	**16,035,321**

Source: Federal Highway Administration Table MF-33GA, October 2002

As can be seen in the table, total sales in the eight CONEG states were slightly over 16 billion gallons. The FHA numbers do not distinguish between RFG and conventional gasoline (CG), so for more detailed analysis EIA statistics are used. The following table lists state supplies of RFG, CG, and total RFG + CG by state for calendar year 2001.

Table 2: CONEG Area Gasoline Sales by State (BGY)

State	RFG	CG	Total
Connecticut (1)	1.48	0.00	1.48
New York (2)	3.19	2.48	5.67
New Jersey (3)	4.02	0.00	4.02
Maine	0.00	0.76	0.76
Massachusetts	2.66	0.00	2.66
New Hampshire (4)	0.43	0.18	0.61
Rhode Island	0.41	0.00	0.41
Vermont	0.00	0.31	0.31
Total	12.19	3.73	15.92

(1) The portion of Connecticut in the New York CMSA is a mandatory RFG area. The remainder of the state is an opt-in area.

(2) New York City CMSA (includes portions of NJ and CT) is a mandatory RFG area. Essex County non-attainment area is an opt-in area, remainder of state is conventional gasoline.

(3) The portion of New Jersey in the New York City CMSA is a mandatory RFG area. The remainder of the state is an opt-in area.

(4) The portion of New Hampshire in the Boston CMSA is an opt-in area. The remainder of the state is conventional gasoline.

Source: Energy Information Administration, Petroleum Supply Annual 2001, Volume 1, 2001, Table MF-44
Source: List of Federal Reformulated Gasoline Program Areas, EPA Office of Transportation and Air Quality

Total gasoline sales in the CONEG states for 2001 were 15.92 billion gallons, reasonably close to the FHA reported numbers. These slight differences occur because FHA reports are based on retail sales. EIA numbers are based on sales for resale and sales to end users (i.e., deliveries). Of the 15.92 billion gallons of gasoline delivered in 2001, 12.19 billion gallons were RFG while 3.73 billion gallons were CG. A total of 4.67 billion gallons of RFG was sold in the states of New York and Connecticut, both of which have upcoming MTBE bans and mandatory RFG areas. A total of 4.02 billion gallons of

RFG was sold in New Jersey, the New York City CMSA area being a mandatory area in that state. The remainder of the states with RFG sales are voluntary opt-in areas.

About 50% of the RFG consumed on the East Coast is produced by refiners located in PADD I while another 30% is shipped from the U.S. Gulf Coast.(1) The balance is supplied by foreign refiners.(2)

For conventional gasoline, PADD I refiners produce about 20% of the volume demand(3), while Gulf Coast refiners supply 70%(4), and foreign sources 10%,(5)

The refineries closest to the affected CONEG states would include those in New Jersey, the Philadelphia area, and Delaware. These refineries are listed in the following table.

(1) Energy Security Analysis Inc., 2003, Implications of a Connecticut and New York MTBE Ban, prepared for The National Taxpayers Union Foundation, February 3
(2) Ibid.
(3) Ibid.
(4) Ibid.
(5) Ibid.

Table 3: CONEG Area Refineries

State	Refinery	City	Capacity-Atmospheric Crude Oil Distillation bcd (1)	
			Operating	Idle
New Jersey	Amerada Hess	Port Reading	0	0
	Chevron	Perth Amboy	0	80,000
	Coastal Eagle Point	Westville	143,000	0
	Phillips 66	Linden	250,000	0
	Valero	Paulsboro	166	0
	Sub Total		**393,166**	**80,000**
Delaware	Motiva Enterprises	Delaware City	175,000	0
	Subtotal		**175,000**	**0**
Eastern Pennsylvania	Phillips 66	Trainer	180,000	0
	Sunoco	Marcus Hook	175,000	0
	Sunoco	Philadelphia	330,000	0
	Subtotal		**685,000**	**0**
	Total		**1,253,166**	**80,000**

(1) Refinery capacity is typically rated by Atmospheric Crude Distillation Capacity (crude capacity) in either barrels per calendar day (bcd) or barrels per stream day (bsd). Here capacity is listed as barrels per calendar day.

Source: Energy Information Administration, Petroleum Supply Annual 2001, Volume 1, 2001, Table 38. Capacity of Operable Petroleum Refineries by State as of January 1, 2002

In addition to the above refiners, the Colonial and Plantation Pipelines supply the East Coast with 327 mbd of RFG or approximately 5.0 bgy. The Plantation Pipeline terminates in the Washington DC area.(1) The Colonial Pipeline terminates in the New York Harbor,(2) a major source for distribution throughout the Northeast.

(1) Pennwell, 2001, Refined Products Systems Map
(2) Ibid.

There are also local pipelines serving interconnecting roles. In Connecticut there is the Buckeye 12" originating in New Haven Connecticut running north and terminating in southern Massachusetts, and the 6" ExxonMobil Pipeline originating in Providence Rhode Island running west and terminating in southern Massachusetts. There are also five pipelines transporting products in western New York and one in Maine (Portland to Bangor).

A large portion of gasoline for the CONEG states is received in the New York Harbor by pipeline from the U.S. Gulf Coast and by ship/tanker from both domestic and foreign sources. Gasoline is also shipped there from Mid-Atlantic refineries.

From the New York Harbor, product can be distributed by pipeline to the northwest and west. Product moving from the harbor to New England states would be shipped by barge.

Regardless of the mode of shipment, RFG and other petroleum products are shipped to finished product terminals in various end markets. It is also important to understand the scope of these operations.

In the case of the CONEG states, there are approximately 148 finished product terminals[1,2] that handle gasoline, of which 5 are closed. Of the operating terminals, 90 are serviced by pipeline and 101 have water delivery capability. Only 14 have rail access and 11 are currently handling ethanol. There are also 3 chemical terminals that could play a role in receiving ethanol for shipment to other terminals. The following table provides an overview of terminals in each CONEG state.

(1) OPIS Directories, 1999, Petroleum Terminal Encyclopedia, Tenth Edition, www.opisnet.com
(2) Independent Liquid Terminals Association, 2002, Terminal Member Directory, www.ilta.org

Table 4: Finished Petroleum Products Terminals - CONEG States

State	Total	Pipeline	Water	Rail	Ethanol	Closed	Chemical Terminal
CT	12	7	10	1	1		
NJ	40	33	33	3	3		4
NY	69	41	37	5	4	3	
MA	12	6	8	1	2	1	
ME	9	2	9	3			
RI	5		4	1	1	1	
VT	1	1					
Total	**148**	**90**	**101**	**14**	**11**	**5**	**4**

These terminals would be affected to different degrees depending upon their location, mode of product receipt, and markets serviced. The terminals servicing RFG markets in areas where MTBE use is prohibited would obviously be the ones most greatly affected, especially if the oxygen requirement for RFG is not rescinded.

Gasoline Supply Impact

The removal of MTBE from the RFG sold in CONEG states represents a significant loss of volume that will need to be made up by other sources. In order to reach the 2.0 wt.% oxygen requirement for RFG, refiners blend MTBE at a minimum of ~ 11.0 v%, and in some cases, as high as 15.0 v%. The minimum MTBE requirement for RFG for the CONEG RFG areas is 1.4 bgy or 89.7 mbd. The MTBE ban states of New York and Connecticut represent 0.51 bgy (33.5 mbd) of MTBE use.

Not only must the petroleum industry replace the volume represented by removing MTBE but they must replace it with products that collectively represent MTBE's blending octane value of 111 (R+M)/2, and that have favorable distillation and volatility characteristics. The finished RFG must meet both ASTM gasoline specifications and the parameters set forth in the RFG regulations. In addi-

tion, toxics must be controlled to comply with EPA's Mobile Source Air Toxics (MSAT) rule. These requirements limit the options available to the industry.

Most analysts have indicated that the volume lost from MTBE removal would be made up by a combination of alkylate/isooctane and ethanol. In addition, refiners may choose to drop the octane in their premium grade from the current 92-93 levels to the auto manufacturers recommended level of 91, thereby alleviating some of the octane demand. For instance, this has already happened in California.

The term alkylate is routinely tossed about in a rather generic fashion but there are actually different types of alkylates.

Alkylate is produced by a refinery process that converts branch chain paraffins/isoparaffins to reasonably high octane alkylates. Light olefins are reacted with isobutane in the presence of a catalyst. The type of alkylate depends on the olefin feedstock used to produce it. The five most common alkylates are ethylene, propylene, butylene, amylene, and isooctane. The price and availability of these products are also affected by their petrochemical values and use. For instance, propylene alkylate is a very good gasoline blendstock but its value as a petrochemical feedstock currently limits its use in gasoline. The most probable alkylates selected for gasoline use are likely to be butylene alkylate and isooctane. This is in part because existing (especially refinery captive) MTBE units lend themselves to conversion to these types of plants, and the feedstock used is also used to produce MTBE. Consequently, these feedstocks should become more readily available due to a reduction in the production and use of MTBE.

Butylene alkylate has a 2.6 psi vapor pressure while isooctane's vapor pressure is 1.8 psi. The octane of butylene alkylate is 94 (R+M)/2 while isooctane is 100 (R+M)/2.

These properties make alkylate ideal for blending. However, even if sufficient supply were available, on a 1 to 1 volume basis, alkylate cannot solely replace MTBE because MTBE's octane value is much higher than alkylate. It is more likely that, while alkylate alone could be used in some RFG (if regulations permitted), it will often be used in combination with ethanol. Fuel grade ethanol has a blending octane value of 112.5 (R+M)/2[1], slightly higher than MTBE. However ethanol's blending vapor pressure is ~ 17.0 psi[2]

(1) Downstream Alternatives Inc., 2003, Fuel Specification and Fuel Property Issues and Their Potential Impact on the Use of Ethanol as a Transportation Fuel, ww.afdc.doe.gov/pdfs/6968.pdf

(2) Ibid.

compared to MTBE's blending pressure of 8.0 psi. The use of alkylate is somewhat complimentary to the use of ethanol in that it can add product volume while reducing vapor pressure significantly. Ethanol will also add volume but will raise vapor pressure and increase octane. The following table compares the Blending Vapor Pressure (BVP) and the Blending Octane Value (BOV) of MTBE, ethanol, butylene alkylate, normal butane, and isobutane, to that of a finished unleaded regular grade RFG.

Table 5: BVP and BOV Comparison

	BVP	(R+M)/2
MTBE	8.0	111.0
Ethanol	17.0	112.5
Butylene Alkylate	2.6	94.0
N Butane	52.0	92.0
Isobutane	71.0	92.0
Gasoline	7.2	87.0

Generally speaking, isobutane, with its higher vapor pressure, is likely to be sent to the alkylation unit. So normal butane is the most likely component to be removed if it is necessary to lower fuel volatility.

In the case of a MTBE ban and a continued oxygenate requirement, ethanol would replace MTBE in the RFG gasoline pool since it is the only widely available alternative. Even if the oxygenate requirement is rescinded, ethanol would be used in some RFG to maintain octane quality. Based on the values in Table 5, a likely scenario for MTBE replacement is (A) removal of MTBE results in a volume loss of 11%; (B) in order to accommodate ethanol addition in summer grade gasoline, it would be necessary to remove 3%-4% butanes and pentanes resulting in a total volume loss of 14%-15%; (C) of this volume, 10% would be made up by addition of ethanol; and (D) the remaining 4% to 5% would likely come from alkylate. The alkylate would be required in the reformulated blendstock for oxygenate blending (RBOB) produced from early April to early September, or approximately five months. If all summer grade RFG sold in CONEG states was made in this manner, it would take in the range of

203 million gallons to 254 million gallons of alkylate annually. Connecticut and New York alone would only require 84 to 105 million gallons of alkylate annually for summer grade RFG.(†)

Since California's experience is often examined when looking at a state with a MTBE ban and an oxygen requirement, it is important to make some clarifications on the differences between the California experience and what is likely to happen in New York, Connecticut and the other CONEG states.

California's MTBE ban, originally scheduled for January 1, 2003 was delayed to January 1, 2004. However, most petroleum companies have already made the switch to ethanol. California state officials have said that by February 2003 approximately 65% of the gasoline sold in California contained ethanol and they expected that number to rise to over 80% by March(1). They also indicated the transition was relatively smooth and that no supply disruption or price spikes are expected as a result of the conversion from MTBE to ethanol.

Conversion from MTBE to ethanol in other RFG states banning MTBE would not be as difficult as California for a number of reasons. Refiners in California use the California Predictive Model (CPM) as their compliance tool. The CPM places a NOx penalty on higher oxygen levels. As a result, refiners limit ethanol addition to 5.7 v%. The EPA Complex Model contains no such NOx penalty thereby allowing ethanol to be blended at the 10v% level. This improves economics because no more butane needs to be removed to accommodate 10 v% ethanol than for 5.7 v% ethanol. The additional 4.3 v% ethanol also increases octane and aids in refiner compliance with MSAT regulations, since it nearly replaces the total volume of MTBE removed. Finally, it greatly aids in the balance of volume since the additional 4.3 v% ethanol contributes to the total volume of the gasoline pool, i.e., refiners in California need to make up 4.3 v% more than Northeastern states would, just because of the CPM NOx penalty. Finally, it should be noted that California's summer gasoline period is nine months (at retail) while the Northeastern states summer grade period is only 3.5 months long (at retail). In short, refiners

† Note these calculations represent near worst case scenarios in that they assume maximum back out of butane and pentane and replacement with only butylene alkylate.

(1) Renewable Fuels Association, Ethanol Report #177, 2003, "Meeting Examines California's Smooth Transition to Ethanol", P. 6, February 24

servicing the CONEG states have far fewer compliance restrictions, less supply loss, and a shorter period requiring summer grade RFG, than California. This should make conversion from MTBE to ethanol easier in the Northeast than it was in California.

Refinery Modifications

Refineries servicing the Northeast will likely make some processing changes to accommodate MTBE removal and ethanol addition. Looking at the California experience gives some clues to what types of modifications might be made at the refinery level.(1) Most of these will be directed at reducing RVP. Plans provided by southern California refiners for their refinery modifications to accommodate ethanol indicated such investments were relatively modest. These included such items as modifications to alkylation units (both to increase production and handle additional feedstocks), addition of columns to depentanizers and debutanizers, installation of depentanizers, or modifications to existing units, modifications to reformers/refractionators, and installation of C_4 isomerization units to support alkylation units. There were also changes in tanks, piping, and transfer pumps to accommodate various process changes. In the case of California some refiners also installed pentane spheres to accommodate storage of pentane removed from gasoline. While the extent of modifications required for refineries servicing the Northeast should be fewer and less expensive, this provides some idea of the types of investments that may need to be made. These investments would reduce the need for purchasing or importing alkylates which would likely occur during any initial change-over. While the magnitude of these investments are relatively small in refinery terms, they are, of course, additive to the numerous other investments being made to meet requirements for lower sulfur levels in gasoline and diesel, and other compliance requirements. It is impossible to offer exact investment cost estimates because refineries will choose different compliance strategies based on their current configurations. Detailed information on the current configuration of a refinery and plans for modification are generally treated as proprietary information.

(1) Colorado School of Mines, Dr. Michael Graboski, and Downstream Alternatives Inc., Robert Reynolds, 2001, Refining Industry Preparation for California CBG3, September

Impact on Distribution Terminals

As noted in the gasoline supply and distribution section, there are approximately 148 terminals servicing the CONEG markets. Those terminals servicing RFG markets with a MTBE ban would, in some cases, need to make investments in modifications to accommodate ethanol use. The number of terminals requiring such modification is dependent upon whether ethanol use is required to meet the federal oxygen standard, or its use is voluntary based on compliance strategy and economics. The types of modifications that could be required would include:

- Reassignment of tankage and associated piping changes
- Modification to existing tankage and associated piping (e.g., installation of fixed roof, new vents)
- Installation of new tankage and associated piping changes
- Installation of blending equipment
- Piping changes to accommodate ethanol delivery
- Installation of rail spurs at some terminals

There should be no need for additional gasoline storage if the RBOB is simply replacing the MTBE based gasoline. However since ethanol will, in most cases, be added at the terminal, it will be necessary to have a tank for ethanol storage. This may also necessitate changes in piping to and from various tanks. Some terminals will be able to reassign existing tankage (with or without modification), while others may require installation of a new tank. Tank installation requires lead time for permitting and construction. Those terminals handling ethanol will also need to install blending equipment (e.g., in-line blending units or sequential blending strategy). In some cases, it may also be necessary to install piping and a space to accommodate delivery of ethanol to the terminal. Finally, while a number of terminals would receive their ethanol supply by barge or truck, some may prefer to receive product by rail car, in which case a rail spur and headers to off-load the ethanol would need to be installed.

Some terminal operators may be able to delay or eliminate tank installation and other investments through the use of product exchanges. Product exchanges are routinely used in the petroleum

industry to reduce distribution difficulties and costs. A traditional exchange involves Company A lifting gasoline (or other petroleum products) from Company B's terminal (where Company A has no terminal). Company B would receive product back at one of Company A's terminals (where Company B does not have a terminal).

Similar exchanges could cross utilize area terminals to minimize logistic difficulties and investments. In this example Companies A and B might have terminals in the same market area, both of which handle gasoline, diesel fuel, and fuel oil. These companies could switch to a scenario where both companies use one terminal for all diesel and fuel oil and one terminal for gasoline (RBOB) and ethanol.

Studies have shown that when amortized over the useful life of the equipment, these costs could be as low as $0.0066 per gallon of ethanol used(1) or $0.00066 per gallon of gasoline ethanol blend(2). However it should be noted that these investments may represent significant capital expenditures when viewed from the perspective of the terminal operator. To provide some idea of the costs(3) associated with the aforementioned terminal modifications, the following discusses each category mentioned:

Tanks: Depending on the size, new tanks cost between $10-$15 per barrel of storage capacity. A typical 25,000 bbl tank would cost at least $250,000 to install.

Tank Conversion: In many cases, existing tanks can be reassigned and converted to ethanol usage. In some cases little of no modification will be necessary. In other cases, it may be necessary to install a fixed roof or floating internal cover which often equates to 20% of the cost of a new tank.

Blending Systems: Since ethanol is not widely blended in CONEG states, most terminals will need to install blending systems. For the typical terminal with two truck load-out racks, this could cost as much as $300,000.

(1) Downstream Alternatives Inc., 2002, Infrastructure Requirement for an Expanded Fuel Ethanol Industry, January 15
(2) Ibid.
(3) Ibid.

Rail Receipt Capabilities: While few terminals are likely to make modifications to receive rail cars, those that do can expect to pay $75-$95 per track foot for rail spurs and up to an additional $15,000 to install headers and piping to accommodate off-loading rail cars. As an example then, a terminal installing a 4,000 foot rail spur (approximately 3/4 mile) could expect costs to be $340,000.

Miscellaneous Expenses: The majority of terminals will likely experience some costs for piping modifications even if no new equipment, beyond blending equipment, is installed. These are to accommodate reassignment of tankage and incorporating blending systems between the storage tanks and loading racks, as well as modifications to receive ethanol deliveries. These minor modifications could easily approach $20,000 per terminal.

These modifications may, in some cases, only require a few months while in the case of tank installations could take 1-2 years depending on the permitting process.

Supply Sources and Reliability

The removal of MTBE from gasoline will result in some changes in supply sources.

RBOB and Alkylate Supply: It is likely that the RBOB supply will come from those refiners currently supplying the region. Some imported gasoline sources could change since importers may choose not to supply RBOB, or may not have the capability to do so. Refiners and importers of RBOB will need to replace any volume loss from butane/pentane removal with alkylate. Until investments are made to increase regional and U.S. alkylate capacity, it is likely that some alkylate would be imported. Butane and pentane removed from gasoline would either be stored and used in winter gasoline, sold into the petrochemical market or, depending on values, may be used as refinery fuel.

Ethanol: Ethanol would represent a change in sources for the gasoline pool because ethanol will be supplied by ethanol producers in the Midwest states, replacing MTBE supplied by domestic producers (refinery captive units and Gulf Coast) and imports. There is little question at this point that ethanol

supply is adequate and transportation capabilities exist to transport it to the CONEG states. Ethanol production capacity is currently 2.7 bgy(1) while actual production is expected to reach 2.5 bgy in 2003, up from a record 2.13 bgy in 2002. Idle production could supply 0.2 bgy. In addition, ten new plants representing 0.481 bgy(2) of production are currently under construction. Any temporary shortfall of ethanol would be covered by redistributing product from lessor valued markets(3, 4) such as the Midwest octane market. Ethanol would be transported to CONEG area terminals by a combination of water and rail. In the case of water shipments, ethanol would be transported from the Midwest to the Gulf Coast by barge. There, it would be staged to load onto ships/ship compartments for shipment to major water terminals in CONEG states. In some cases, these terminals may transship smaller quantities, by barge or truck, to other terminals. In the case of rail shipments, product would be shipped from Midwestern ethanol plants to those terminals capable of handling rail. Shipments could be as small as one to two cars, or as large as unit trains (e.g., 100 rail cars pulled by dedicated power) for those terminals capable of handling larger delivery quantities. The ethanol industry has numerous supply sources. Backup inventory is routinely maintained at plants, and at transshipment points, to eliminate any problems that could arise from distribution difficulties (e.g., freezing of the Mississippi or its tributaries). In addition, some ethanol producers, either directly or in conjunction with terminal operators/petroleum companies, could maintain backup inventory in the Northeast. Finally, if several terminals in the same area are handling ethanol there is always the potential to cross utilize supply, should the need arise. Based on the above, it is unlikely that there would be any disruption in ethanol supply.

Impact on Gasoline Prices

Eliminating MTBE from the gasoline pool may impact gasoline prices. Alkylate typically costs more than gasoline, so the addition of alkylate could add modestly to gasoline costs. Assuming alkylate would be at a 30¢ premium to gasoline, the 4% to 5% necessary alkylate addition to accommo-

(1) Renewable Fuels Association, 2003, Building a Secure Energy Future, February, www.ethanolrfa.org.
(2) Ibid.
(3) Downstream Alternatives Inc., 1999, The Use of Ethanol in California Clean Burning Gasoline-Ethanol Supply/ Demand and Logistics, February 5
(4) Downstream Alternatives Inc., 1999, RFG/MTBE Issues and Option in the Northeast, comments submitted to Northeast States for Coordinated Air Use Management, May 11

date ethanol's higher vapor pressure (summer grade only) would equate to a $0.012 to $0.015 per gallon increase. If larger volumes of alkylate were used to replace MTBE without ethanol use, the cost would increase. It should be noted that alkylate's prices premium to gasoline may increase temporarily in the initial period of the program, until more alkylate capacity is brought on line

Rejecting butane (and possibly pentane) to accommodate ethanol blending could add another 1¢ to 2¢ per gallon to finished RFG bringing the total cost to $0.022 - $0.035 per gallon. Ethanol is selling at a significant discount to MTBE, net of tax credits. Assuming a 30¢ net discount to MTBE prices (much less than the current discount), ethanol addition would reduce prices by 0.03 cents per gallon (at 10v%). Consequently, the net price increase for summer grade RFG could easily be less than 1.0¢ per gallon over the long term, with potentially no related increase in the cost of producing winter grade.

Last year Mathpro, Inc. (1) did an analysis comparing the current RFG regulations to an oxygenate repeal case and a case representing the Senate Energy Bill. The study concluded that under the fuels provisions in the Senate Energy Bill, repeal of the federal oxygen requirement, along with a renewable fuels requirement of five billion gallons per year would decrease the average gasoline production cost associated with a national MTBE phase down by about 0.2 cents per gallon compared with current requirements." The EIA has estimated that under the current case, i.e., state MTBE bans and no repeal of the oxygenate standard, that the cost associated with MTBE phasedown and continued oxygenate requirements would be 3.0 cents per gallon.

Impact of New York and Connecticut MTBE Bans on Other States

The MTBE bans in Connecticut and New York could impact other states in the region. First, the Connecticut ban precedes New York's by three months (note that as this report was prepared Connecticut was considering legislation to delay their MTBE ban to coincide with New York's). This may result in several terminals that supply both Connecticut and New York converting to RBOB and ethanol earlier than they would have solely for New York's MTBE ban.

(1) American Petroleum Institute, 2002, press release, "Senate Energy Bill Provision Less Costly Than Status Quo", September 19, www.api.org

In addition, New Jersey, especially the portion in the New York CMSA could be affected. If sufficient tankage does not exist to carry both MTBE based RFG and RBOB for ethanol, then portions of New Jersey may need to switch to RBOB/ethanol despite the fact that there is no MTBE ban in New Jersey.

New York and Connecticut RFG sales represent 38.3% of RFG sales in CONEG states. If New Jersey's RFG sales are added, this increases the total to 71% of total RFG sales. If large volumes of RFG in New Jersey need to be switched to RBOB/ethanol because of Connecticut and New York MTBE bans, this fuel would become the predominant RFG, and MTBE based RFG would become more of a specialty product.

Of course, the sheer gasoline volume of the Connecticut and New York markets, as well as the New Jersey and Massachusetts gasoline markets, may be sufficient to warrant special segregation of fuels, allowing New York and Connecticut to proceed with one fuel while other areas continue with another fuel.

On the other hand, New Hampshire and Rhode Island have relatively low RFG volumes and can be expected to handle whatever fuels are available in bordering states. (Note that New Hampshire has indicated they may opt-out of the RFG program January 1, 2004.)

The exact impact of a state's actions on fuel programs cannot be known exactly without knowledge of each fuel supplier's compliance strategy. For instance, terminal operators could utilize exchanges such that two terminals could exchange product, with one terminal carrying RFG containing MTBE while another handles RBOB and ethanol. This would allow both fuels to continue being offered where desired. Suffice it to say, however, that one state's actions can impact the transportation fuels offered in another nearby state or, at a minimum, alter the utilization of terminals and tanks.

Potential Impact of Alternative Options on Gasoline Fungibility

As discussed above, several of the CONEG states gasoline supplies are interrelated to those of Connecticut and New York. The compliance strategy selected by the suppliers of gasoline could reduce fungibility of the system. Obviously, product from neighboring states could not be sold in Connecticut or New York if they contained MTBE. Likewise, RBOB/ethanol based RFG could not be

commingled with MTBE based RFG. If RBOB/ethanol is offered in some market areas while MTBE based RFG continues to be offered in other areas, this could result in some terminals, or terminal groups, trying to handle three formulations of gasoline, i.e., RFG with MTBE, RBOB with ethanol, and CG (with or without MTBE). At two grades per formulation, this equates to six fuels for some terminals that are on the border of RFG and CG areas. It would probably be more ideal for interrelated market areas to carry only one type of RFG and, where necessary, one type of CG.

Aside from the alternative of switching from MTBE to ethanol for RFG compliance, some states have the opportunity to opt-out of the RFG program January 1, 2004. These areas include portions of Connecticut, New York, New Jersey, and all RFG areas in Massachusetts, New Hampshire, and Rhode Island. If a portion of these areas opt-out, this could also impact fungibility. If areas simply opt-out and go to CG, it is likely they could obtain CG from bordering CG markets. However, if states require their own unique gasoline formulation, this would represent a "boutique fuel" requiring special segregation in the distribution system and consequently, reduced fungibility. If states opting out required different boutique fuels among the states this would further fragment fungibility, creating islands of specialty fuels that would likely be of limited availability and low inventory. This would increase the potential for outages, or low inventory levels, and related price spikes.

Potential Impact of Alternatives on State Goals for Clean Gasoline

Which fuels a state chooses to require could affect their goals towards cleaner gasoline and cleaner air. If a state selects RFG, clean fuel and clean air goals are, of course, maintained. Whether RFG is made with MTBE or ethanol, it must meet the same standards for RFG and MSAT compliance. If a state opts-out of the RFG program and goes to a CG program, the benefits of the RFG program are lost. This results in greater emissions of hydrocarbons and toxics. It could also affect compliance with a state's State Implementation Plan (SIP). States utilize the emissions benefits of RFG when demonstrating compliance with their SIP. If a state, or area, using RFG ceases to do so, it would likely need to develop another mechanism to replace the emissions benefits of RFG. In some cases, offsetting emissions reductions could come from stationary source programs or other mobile source strategies. However, if it is necessary to obtain emissions credits from gasoline, some states could choose to

implement state specific fuel requirements, requiring some of the RFG provisions and eliminating others. Some states in other areas of the country have required such boutique fuels, usually requiring an RVP lower than CG but not requiring a minimum oxygen content. While such an approach recaptures some of emissions benefits of RFG, and sometimes at lower costs, it creates the gasoline fungibility problems described in the previous section. The logistic problems associated with boutique fuels cannot be overstated. The proliferation of boutique fuels presents serious problems for the petroleum industry and the potential for price spikes for consumers.(1)

Regional Coordination of Fuel Programs and Transition Efforts

Difficulties with changes in fuel programs in multiple states can be minimized through regional coordination. Such coordination would be beneficial in several areas including; a) fuel program selection/minimizing types of fuels; b) timing changes; c) dealing with implementation/transition issues; and d) information gathering.

Fuel Program Selection: Regional coordination of fuel programs keeps all involved states aware of the types of fuels being considered by other states. Working together, states could select similar fuel programs thereby reducing the number of fuels required.

Timing: Regional coordination of the implementation dates for changes to fuel programs would keep all involved states aware of implementation dates for fuel changes in other states, encouraging coordination of their efforts by adopting identical implementation dates. This would eliminate periods of uncertainty between states (e.g., differing MTBE ban dates in Connecticut and New York) during transition periods and help improve supply fungibility during such times.

Identical fuel programs, with identical implementation dates, will allow the petroleum refining industry, and related distribution industry, to determine what investments need to be made, and what actions need to be taken, in a more orderly fashion.

(1) U.S. Environmental Protection Agency, 2001, Staff White Paper, "Study of Unique Gasoline Fuel Blends ("Boutique Fuels"), Effects on Fuel Supply and Distribution and Potential Improvements, EPA420-P-01-004, October

Implementation/Transition Issues: Regional coordination of fuel programs would ensure that all states are implementing programs at the same time. This would allow the distribution and infrastructure systems in different states to be transitioned to new fuels at the same time, reducing potential product supply disruptions and price spikes sometimes associated with such change-overs.

Information gathering: State level legislators and regulators often find themselves attempting to determine the best course of action on fuel programs without the necessary information on actions taken by other states, or the likely compliance strategy the petroleum industry would pursue. Regional coordination can play an important role here. First, information gathering round tables could be held, bringing various affected segments of the industry together to provide an overview of the issues and likely solutions. Secondly, surveys could be sent out to individual companies to determine their compliance strategies.

States do not often have the time and resources to pursue such efforts and often do not get the desired level of information responses. Moreover, it is more difficult for them to frame such information in the context of the efforts and actions of other states.

Closure

The pending fuel changes resulting from MTBE bans, and the uncertainty surrounding what will happen with the federal RFG oxygen requirement, make compliance strategy decisions difficult for the regulated industry. This in turn creates uncertainties for states. Likewise, state decisions related to opting out of the RFG program are subject to the uncertainties of the federal RFG oxygen requirement which in turn creates still more uncertainties for the regulated industry, even more so if boutique fuels are introduced into the mix. Clearly both groups could benefit from an honest and open exchange of available information and a discussion of potential steps that could be taken to reduce any difficulties associated with fuel changes.

Appendix A - Report Glossary of Commonly Used Acronyms

ASTM: ASTM International formerly the American Society for Testing and Materials

bcd: Barrels per calendar day

bd: Barrels per day

bgy: Billion gallons per year

BOV: Blending octane value

bsd: Barrels per stream day

BVP: Blending vapor pressure

C_4: Four carbon hydrocarbons

CG: Conventional gasoline

CMSA: Consolidated metropolitan statistical area

CONEG: Coalition of Northeastern Governors

CPM: California predictive model

EIA: Energy Information Administration

EPA: Environmental Protection Agency

FHA: Federal Highway Administration

mbd: Thousand barrels per day

MTBE: Methyl tertiary butyl ether

MSAT: Mobile source air toxics rule

OPIS: Oil Price Information Service

RBOB: Reformulated blendstock for oxygenate blending

RFG: Reformulated gasoline

RFS: Renewable fuels standard

(R+M)/2: Antiknock Index, research octane number + motor octane number divided by 2 (also the octane rating appearing on the retail gasoline dispenser)

RVP: Reid vapor pressure

SIP: State implementation plan