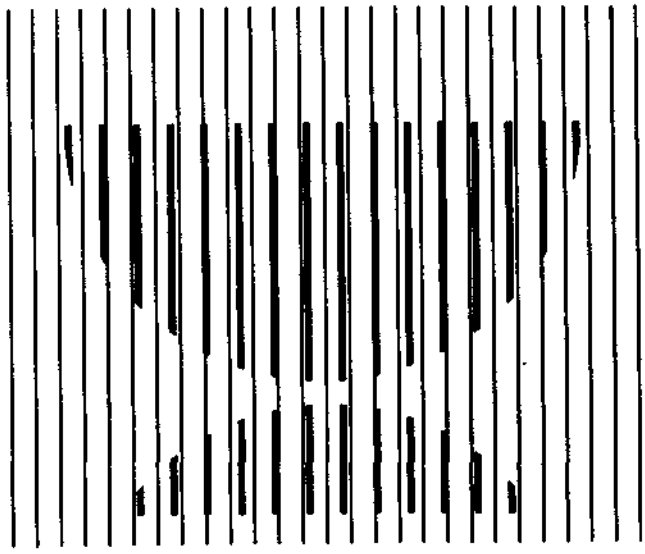
CBO STAFF MEMORANDUM

CLEAN FUELS FOR CONVENTIONAL VEHICLES:
IMPLICATIONS OF PROPOSED STANDARDS

SEPTEMBER 1990



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This staff memorandum was prepared in response to requests for information from the Senate Energy and Natural Resources Committee about proposed changes to the Clean Air Act that affect the quality of motor gasoline.

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This memorandum reports on the economic effects of the mobile source provisions of S. 1630 and H.R. 3030 (the Clean Air Act Amendments). Of particular concern in this analysis are the effects of required changes in the formula for gasoline to be used in conventional vehicles. These changes are part of the provisions for fuel volatility, oxygenated fuels, and reformulated gasoline.

The memorandum addresses the effects on gasoline prices and supply capabilities, requirements for alcohol additives, and oil imports. National market effects were analyzed for four scenarios: two different market conditions (assuming a 22 percent and a 56 percent market share for reformulated gasoline), and two different years (1992 and 1996) reflecting increasingly stringent standards. (See the table on page 5.)

The Senate and House bills are very similar with respect to changes in gasoline; therefore the conclusions presented here apply equally to both. The Senate version specifies a higher oxygen content (3.1 percent versus 2.7 percent) for oxygenated fuels to be sold in regions that do not attain national carbon monoxide standards. The House version establishes carbon monoxide standards that are more rigorous, so that more cities (52 versus 44) would be affected by the new standards.

Nationwide consequences of differences between Senate and House treatment of oxygenated fuels are negligible; in fact, each would add less than 0.1 percent to the average oxygen content of the nation's gasoline. The effects of these two provisions are minimal because so many of the areas with carbon monoxide problems that would be affected also have ozone problems and are already covered by the oxygen standards for reformulated gasoline.

GASOLINE PRICES

The provisions of both bills related to reformulated gasoline, oxygenated fuels, and fuel volatility would add 6 cents to 9 cents per gallon to gasoline prices nationwide. Distribution costs to more isolated markets requiring the new fuels could raise prices in those markets even higher, especially if the new oxygen standards are met mainly by ethanol blending. Moreover, premium grades may become more costly nationwide, since the average octane level for all grades may be as much as 0.5 points lower. (Appropriate adjustments were made to the national cost estimates to reflect additional regional transportation and storage needs.)

GASOLINE SUPPLY CAPABILITIES AND ALCOHOL REQUIREMENTS

Gasoline suppliers should be able to produce sufficient volumes of gasoline meeting the new standards, but supply capabilities may be strained in 1992. The main constraints on supply in 1992 relate to the oxygen content of gasoline. (Ethanol supply may need to increase as much as 150 percent in that year.) Other standards for aromatics, benzene, and volatility can be accommodated.

In 1996, the supply of oxygenates should be adequate, but some difficulties may arise in meeting the aromatics standard. Maintaining current octane levels in all years would be increasingly difficult, but past experience suggests consumers may easily shift to lower octane products.

Minimum Requirements for Reformulated Gasoline

The key uncertainty underlying supply difficulties relate to how many regions will require reformulated gasoline beyond the serious and extreme ozone nonattainment regions that both bills would mandate.

If only the serious and extreme ozone regions, accounting for about 22 percent of the nation's demand, adopt reformulated gasoline, industry can meet the new standards with:

- Relatively modest changes to current refinery operations (mainly the catalytic reformers used to upgrade low-octane gasoline),

- Additions to downstream refining capacity (mainly the isomerization and alkylation units used to make high-octane, low-aromatics gasoline), and

- No additions to the production capacity of oxygenates beyond those industry has already planned and announced. Oxygenates include ethanol and the octane-enhancing additive, methyl tertiary butyl ether (or MTBE).

With the reformulated gasoline market share at 22 percent nationwide, oxygen standards can be met so long as MTBE production grows as planned to 200,000 barrels per day, and current ethanol supplies of 50,000 barrels per day are fully dedicated to regions with clean air problems. Further MTBE capacity increases by then are probably not possible in any case. It is an open question, however, as to how much ethanol supply could grow between now and 1992 if current ethanol capacity remains dedicated to Midwest gasohol sales.

Maximum Requirements for Reformulated Gasoline

If, in addition, marginal and moderate ozone regions adopt the standards for reformulated gasoline, demand for the new fuel may rise to 56 percent of the nation's total gasoline demand. In this case, there could be some difficulty in supplying oxygenated fuels and higher octane grades in 1992. If the reformulated sales took over half the market and MTBE capacity remained constrained to currently planned levels, oxygen standards could only be met by increasing ethanol supply from 50,000 barrels per day now to 125,000 barrels per day by 1992. Continuing additions to MTBE capacity would remove this bottleneck by 1996.

Existing and planned ethanol and MTBE capacity must be fully used on a year-round basis--regardless of whether the market share for reformulated gasoline is 22 percent or 56 percent. Moreover, ethanol supply now used for gasohol in the Midwest should be redirected to regions with clean air problems; otherwise 1992 oxygen standards cannot be met. MTBE will continue to be the refiners' oxygenate of choice for two reasons. First, MTBE costs less. Second, ethanol blending beyond the levels assumed here conflict with new standards for vapor pressure, since ethanol has very high vapor pressure. (Needed changes in refinery activities and oxygenated fuels supply for 1992 and 1996 are summarized in the box on pages 6 and 7.)

OIL IMPORTS

On net, petroleum imports and energy security would not be significantly affected by changes to gasoline standards. The biggest change to refinery output would entail a shift from gasoline production to production of aromatics and petrochemical feedstocks.

Factors That Lower Oil Imports. One factor is increased oxygenates use. A second is the small gain in gasoline volume that would result from changes to refinery processes. Together, these factors could lead annual gasoline imports to drop by 150,000 to 175,000 barrels per day from current levels. This drop would represent less than 2 percent of total petroleum imports.

Gasoline refined from crude oil will be replaced with oxygenates produced from natural gas (MTBE) or biomass (ethanol). Increased oxygenates blending (beyond current levels) will make up 2.5 percent to 5 percent of total gasoline supply by 1996. But two-thirds of MTBE production will be based on domestic petroleum feedstocks, and some finished MTBE will be imported. As a result, only a maximum of 1.5 percent to 2 percent of total gasoline supply will be displaced by the increased supply of oxygenates.

The refinery gain in gasoline volume will result from changes to catalytic reforming activities that are needed to lower the aromatics content of gasoline. This will add another 0.5 percent to gasoline supply (albeit of lower octane).

Factors That Raise Oil Imports. One factor is the increased requirement for fuel at refineries, as they use more energy-intensive processes to make up the octane lost by restricting aromatics and butane use. This increase could add 40,000 barrels per day to imports. A second factor is the small increase in agricultural petroleum use to produce ethanol, which could add another 10,000 barrels per day to imports.

There is a third consideration. Methanol and MTBE imports are not currently counted in government statistics as petroleum products. Methanol accounts for 33 percent of the higher MTBE volume. Most of this methanol and some MTBE would

be imported. Including these volumes would raise imports by another 75,000 to 100,000 barrels per day.

The total increase in imports resulting from greater refinery fuel needs, agricultural demand, and methanol/MTBE imports would be between 125,000 barrels and 150,000 barrels per day.

KEY ASSUMPTIONS

The analysis on which the foregoing conclusions are based makes a number of assumptions about the future performance of gasoline markets. Specifically, CBO's analysis looked at the domestic refining industry's total capability to produce gasoline that meets minimum performance criteria for octane and volatility, while at the same time meeting the new regional standards for aromatics, benzene, and oxygen, and implied requirements for olefins. That is, the new requirements for those regions not in compliance with ozone and carbon monoxide standards were averaged with the current needs of those regions in compliance.

The capabilities of different refiners to produce gasolines meeting the new standards differ widely, which could present regional marketing problems. In each scenario, CBO assumed the marketplace would perform efficiently in selling and blending the gasoline components produced at different refineries and in distributing finished gasoline around the country.

Effective operation of a nationwide market for gasoline blending components including oxygenates will be necessary to avoid major supply disruptions. Such a market would provide incentives for seasonal product storages and regional movements as needed. (Increased storage to facilitate full year-round use of refinery, MTBE, and ethanol production capacity will be needed.)

Oxygen-credit trading may contribute to this needed market efficiency, depending on how it is set up. As oxygenate supplies grow tight in 1992, the market must help redirect virtually all ethanol from gasohol sales in theMidwest to other parts of the country with clean air problems. Further, by 1996, the market in other gasoline components must help allocate increasingly tight supplies of low-aromatic gasoline.

Table 1. Gasoline Properties: Current National Average, Proposed Standards for Nonattainment Regions, and Resulting National Averges for Different Reformulated Gasoline Market Sizes, 1989-1996

		1992			1996		
			National Average (Percent of New Market)			National Average (Percent of New Market)	
	1989	New Standard	22 %	56 %	New Standard	22 %	56 %
				Numbers			
Octane[a]	89.7	--	89.7	89.7	--	89.7	89.7
Volatility[b]	9.7	9.0	9.0	9.0	9.0	9.0	9.0
				In Percents			
Aromatics (%)[c]	31.1	30.0	30.8	30.5	25.0	29.6	27.5
Benzene (%)[c]	2.0	1.0	1.8	1.5	1.0	1.8	1.5
Olefins (%)[c]	12.2	10.5	11.8	11.4	10.5	11.8	11.4
Oxygen (%)[d]	0.6	2.0	0.7-0.9	1.3-1.4	2.7	0.8-0.9	1.6-1.7

SOURCE: 1989 summer average, survey by the National Petroleum Refiners Association.

[a] (Research + Motor) / 2.

[b] Reid Vapor Pressure.

[c] Percent by volume.

[d] Percent by weight. High end of range assumes either Senate's higher 3.1 percent oxygen standard for carbon monoxide (CO) nonattainment regions, or House's broader definition of CO nonattainment.

BOX

Actions That Would Ensure Compliance with New Gasoline Standards

	1992
Oxygenate Supply	Industry need only follow through on current plans to expand domestic MTBE capacity from 115,000 to 200,000 barrels per day. Available capacity must be fully used year round. MTBE imports must increase to as much as 30,000 barrels per day. All ethanol production (currently 50,000 barrels per day) must be redirected to nonattainment regions. No further increase is needed if reformulated demand is limited to 22 percent of the market. With a 56 market share, total ethanol supply must increase as much as 150 percent.
Refinery Activities	Catalytic reformer severity should be lowered (by 1 percent to 3 percent to reduce aromatics (including benzene) output. Redirect between zero and 5 percent of catalytic cracker operations away to reduce the benzene and olefins content, while directing more output to distillate production. Cut butane blending by 50 percent to 75 percent to reduce volatility. Drop up to 100 percent of pyrolysis gasoline and other aromatics with high benzene content. (These contribute little to total gasoline supply.) Increase use of specialized octane producing processes such as isomerization (up to 40 percent) and alkylation (up to 5 percent) to replace octane lost from reformer/cracker changes and reduced butane blending. Support other refinery changes by increasing the use of hydrogen treatment, fractionation, and solvent recovery to help remove aromatics and benzene.

Actions That Would Ensure Compliance with New Gasoline Standards (continued)

	1996
Oxygenate Supply	Industry must follow through on current plans to expand domestic MTBE capacity to 275,000 barrels per day in 1994 and add another 50,000 barrels in 1994 and 1995. Available capacity must be fully used year round. MTBE must increase to 60,000 barrels per day. Ethanol production need only double from current levels to 100,000 barrels per day, but all available supplies must be redirected to nonattainment regions. Further increases would conflict with vapor pressure standards.
Refinery Activities	The severity of catalytic reformer operations should be lowered (by 1 percent to 3 percent to reduce aromatics (including benzene) output. Redirect 5 percent to 10 percent of catalytic cracker operations to reduce the benzene and olefins content, while directing more output to distillate production. Cut butane blending by 50 percent to 75 percent to reduce volatility. Drop up to 100 percent of pyrolysis gasoline and toluene/xylene and other aromatics. (These contribute little to total gasoline supply.) Increase use of specialized octane producing processes such as isomerization (up to 40 percent) and alkylation (up to 5 percent) to replace octane lost from reformer/cracker changes and reduced butane blending. Support other refinery changes by increasing the use of hydrogen treatment, fractionation, and solvent recovery to help remove aromatics and benzene.