New and Prospective Regulatory Standards Affecting U.S. Gasoline and Diesel Fuel

David S. Hirshfeld
MathPro Inc.

301 951 9006
www.mathproinc.com

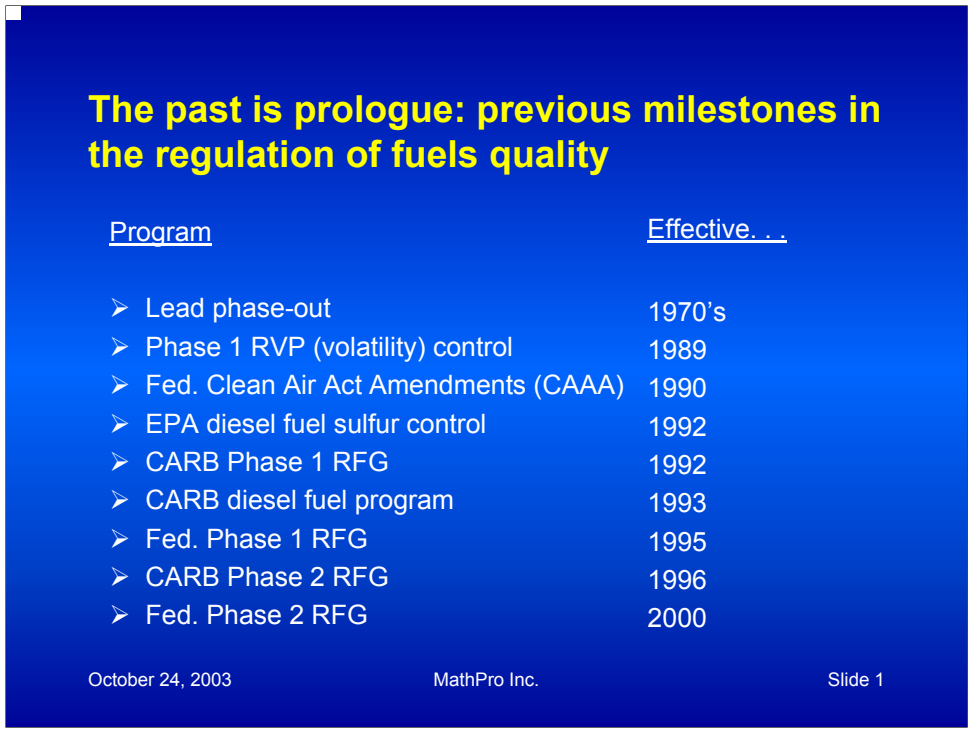
International Petroleum Executive Seminar
October 23-24, 2003

➢U.S. refiners continue to face what some in the industry call a “regulatory avalanche”. This avalanche is and will continue to be one of the most important forces acting on the refining industry and shaping its future.

➢Many elements of the regulatory avalanche are air quality regulations affecting transportation fuels, especially gasoline and diesel fuel.

➢This presentation offers an overview of the most important new and prospective regulatory programs bearing on gasoline and diesel fuel.

➢In the interest of brevity, the discussion does not address either (1) the other forces for change that interact with fuels regulations – such as the changing quality of the crude oil barrel, advances in technology, and changes in domestic and foreign markets – or (2) the implications of these regulations on the capital requirements, economics, and structure of the refining industry.



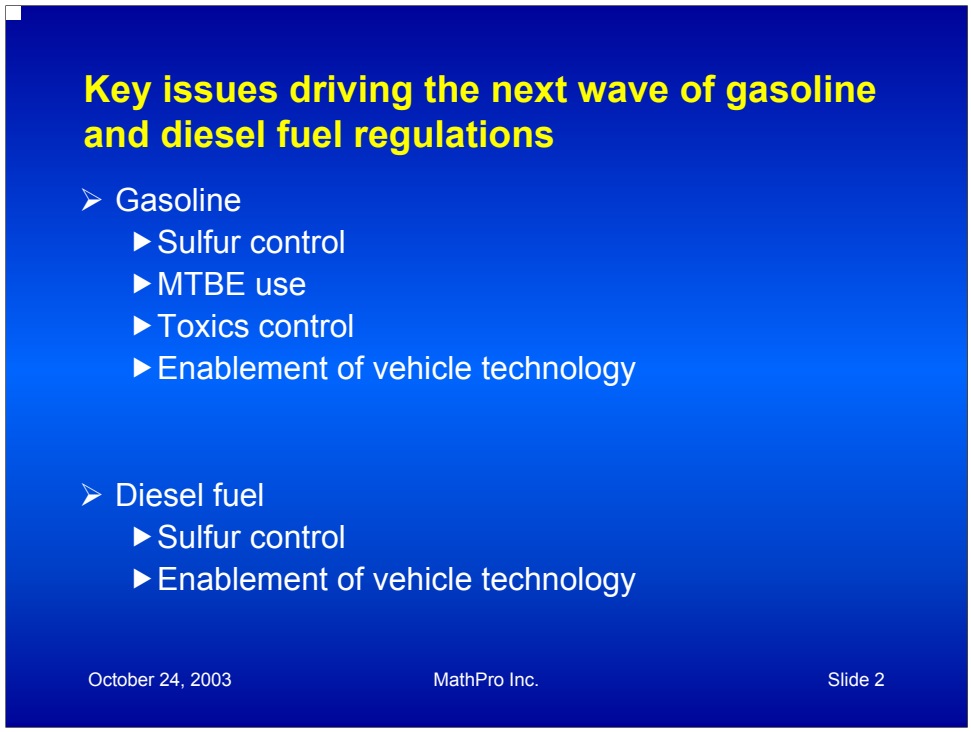
➢Lead phase-out was the first boulder in the regulatory avalanche. It was a highly successful program, achieving its objective in a timely and orderly manner, incurring modest refining costs, and providing the first demonstration of the use of marketable credits for emissions control – in this instance, lead credit trading and lead banking.

➢However, lead phase-out induced refiners to make compensating changes in gasoline properties, some which of had adverse air effects on vehicle emissions. This situation provided much of the impetus for the federal RFG program, one of the key provisions of the Clean Air Act Amendments of 1990.

➢Establishment of the federal RFG program was a critically important event for the refining industry. The RFG program denoted Congress's acceptance of the notion that desired air quality goals could be achieved by "cleaning up" – reformulating – conventional transportation fuels (e.g., gasoline), rather than by shifting to alternative fuels (e.g., methanol, ethanol, CNG, etc.). Since passage of the CAAA, interest has waned in alternative fuels, except as supplements to gasoline and diesel fuel in niche markets.

➢Environmental regulation of diesel fuel began in 1992 with the EPA diesel program, which established a 500 ppm cap on the sulfur content of highway diesel fuel.

➢In addition to the federal clean fuels programs indicated here, the 90's witnessed the establishment of many state-level clean fuels programs – not only the California programs but also the various cleaner-burning gasoline programs that have led to the "boutique fuel" phenomenon indicated in Slide 3.



➢Gasoline sulfur control reduces NOx emissions, as well as toxics and particulates. It is proving to be relatively inexpensive.

➢Seventeen states have enacted up-coming MTBE bans. Three of these matter: California, New York, and Connecticut. The others receive little or no MTBE-blended gasoline, even without an MTBE ban.

➢Substitution of ethanol for MTBE has significant effects on gasoline production capacity and cost.

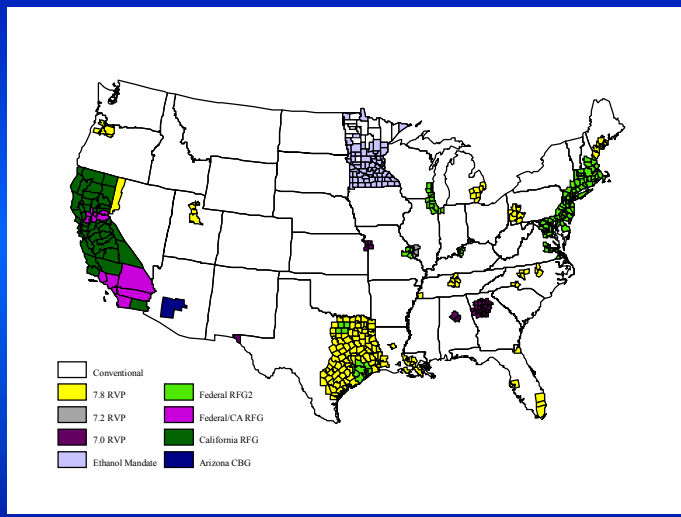
➢Toxics control continues to be of keen interest to EPA. In general, toxics control is relatively inexpensive now, but its effects and costs are refinery-specific.

➢Interactions between the effects of an MTBE ban and toxics control can pose significant difficulties for some refineries, especially on the East Coast.

➢Diesel sulfur control reduces NOx and particulate emissions, mainly by preventing degradation of emission control systems.

➢The automobile industry advocates more stringent gasoline and diesel fuel standards to enable vehicle and engine technologies aimed at meeting tough new emission standards and improving customer satisfaction (especially for light-duty diesel vehicles).

Areas covered by current U.S. gasoline programs



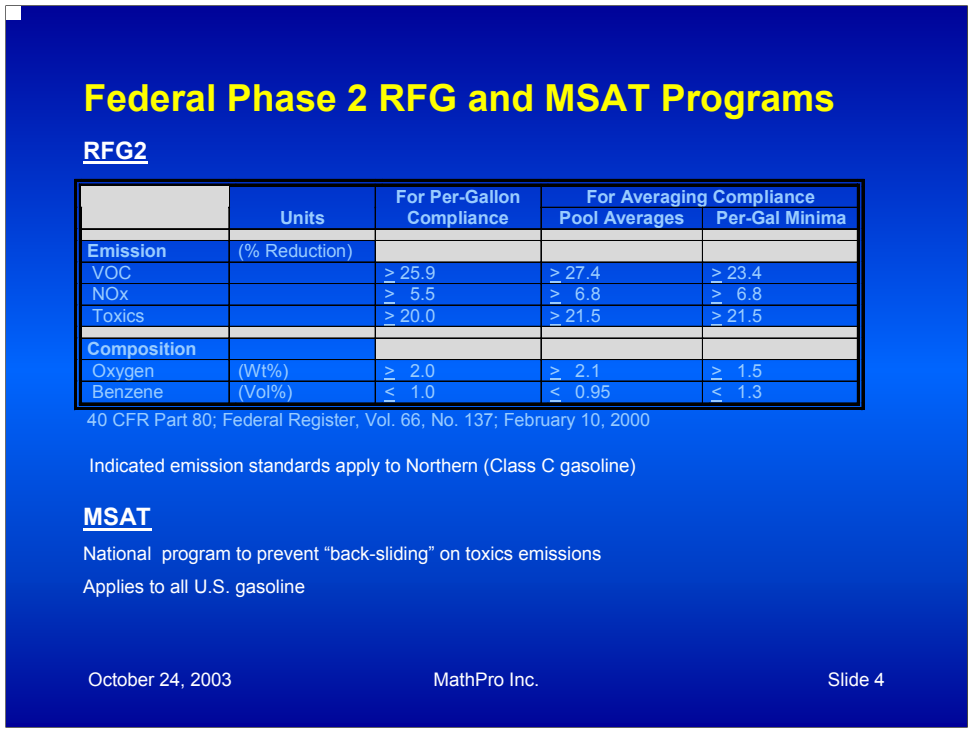
October 24, 2003 MathPro Inc. Slide 3

➢The federal and California RFG programs cover about 1/3 of all U.S. gasoline consumption.

➢In addition, the Mobile Source Air Toxics (MSAT) program covers all U.S. gasoline consumption.

➢The map shows the nature of the “boutique fuels” issue – the proliferation of regional “islands” of special gasoline quality specifications to deal with local air quality issues.

➢Typically, a boutique fuel is called for in relatively small volume and has fewer suppliers than the conventional gasoline (CG) called for in surrounding areas.



➢The RFG2 and CaRFG3 programs cover about 1/3 of U.S. gasoline volume. Some RFG areas are "statutory" – specified in the CAAA – while others have "opted-in" to the program, as provided in the CAAA.

➢The RFG2 emissions reduction targets are relative to a national baseline fuel, with properties corresponding to the average properties of the 1990 U.S. gasoline pool.

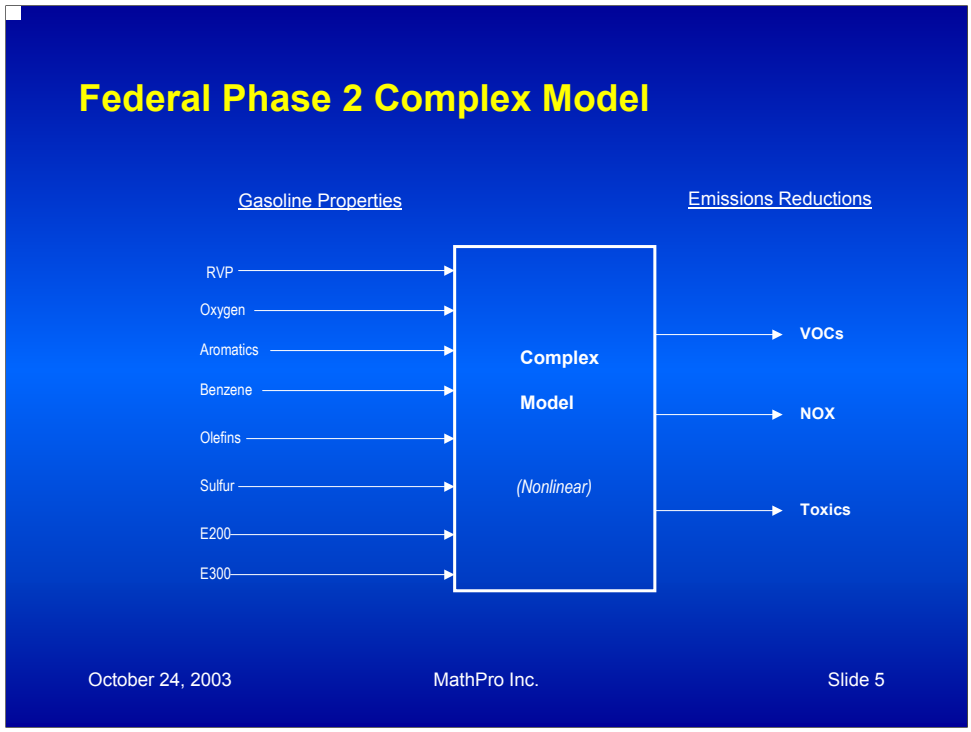
➢Achieving RFG2 emissions targets requires sulfur control (≈ 120 – 150 ppm) and RVP control (6.8 – 7 psi).

➢The MSAT program took effect in 2002 and covers all U.S. gasoline.

➢MSAT uses year-round averaging, is refinery-specific, and is based on refinery's 1998-2000 baseline.

➢MSAT imposes a more stringent toxics standard than the RFG program, aimed at "locking-in" the nearly universal over-compliance with the toxics emission standard demonstrated during the '90's and thereby preventing toxics "back-sliding."

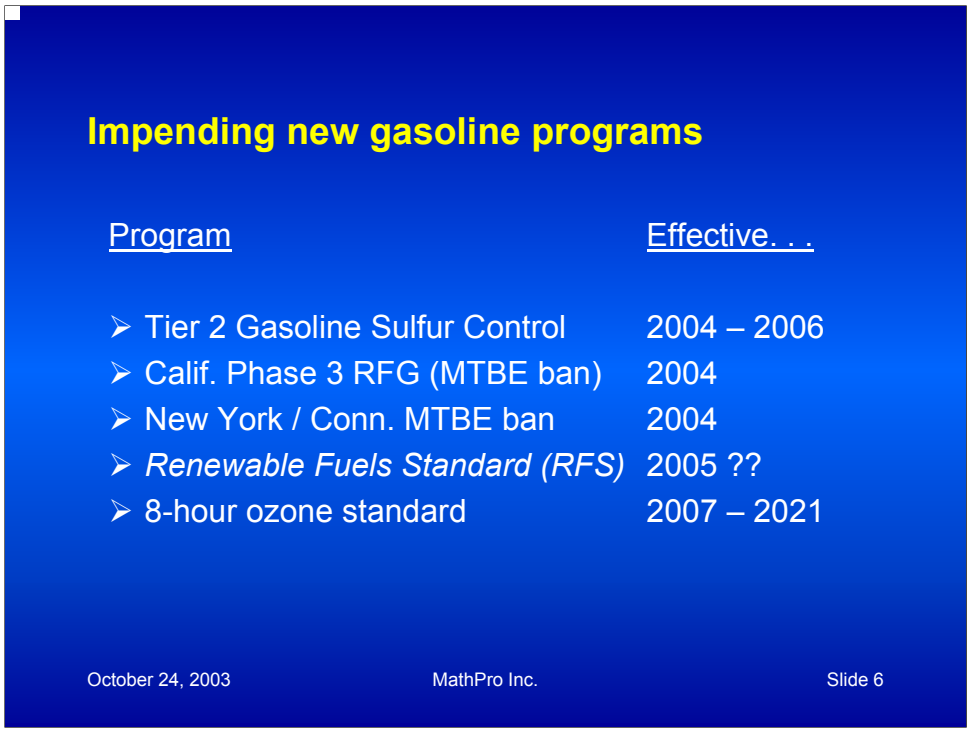
➢MSAT illustrates the dictum: *"No good deed goes unpunished."*



➢The Complex Model is used to certify each gasoline batch's compliance with the RFG2 and MSAT emissions standards.

➢The Complex Model is a nonlinear model that accepts as input measured values of eight gasoline properties and returns estimated reductions in VOC, NOx, and toxics emissions (relative to corresponding emissions from baseline gasoline).

➢The California Predictive Model is similar to the Complex Model and plays the same role in the California RFG program.

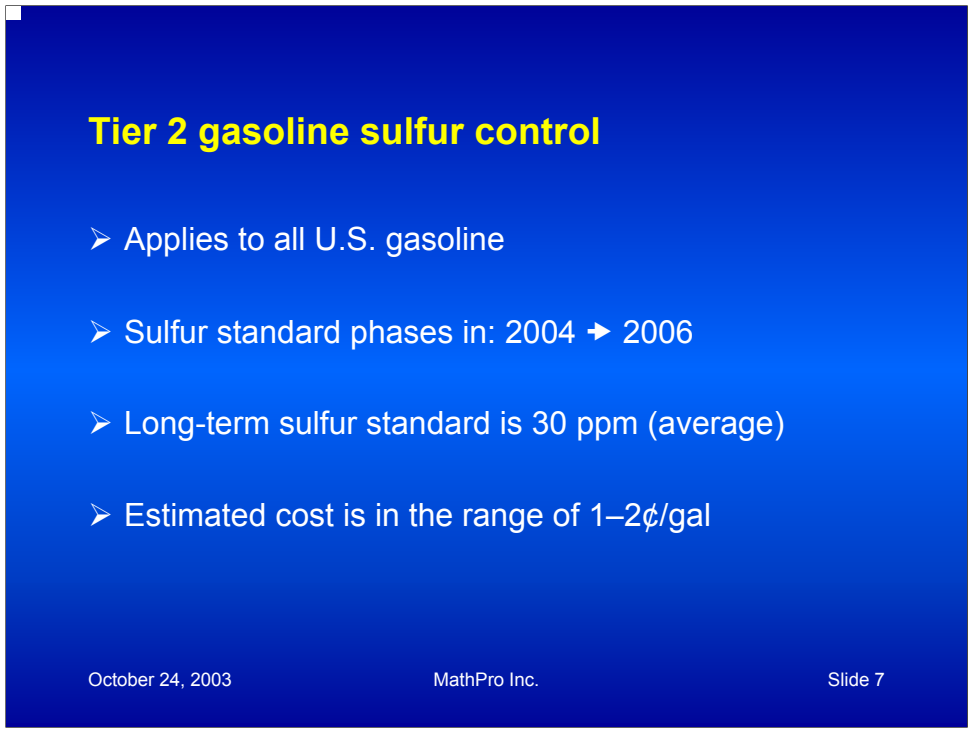


➢Tier 2 gasoline sulfur control program is likely to be a success story, with rapid adoption of new process technology, smooth roll-out, and low costs,

➢The California and NY/CT MTBE bans are likely to have significant consequences, in terms of increased reliance on non-domestic sources of supply, increased refining costs, increased average prices at the pump, and increased price volatility.

➢The RFS, if passed by Congress (as many consider likely), would force significant additional volumes of ethanol into the gasoline pool, repeal the federal oxygen requirement for RFG, and (maybe) ban MTBE use nationwide. All of these measures would have significant national and regional effects on gasoline production capacity and costs.

➢The implementation of the 8-hour ozone standard is not defined yet. Areas designations will be established next year. SIPs are due in 2007. Hence, forecasting effects on the refining industry of the 8-hour standard is not useful at present . However, it could result in a significant increase in the volume shares of RFG and boutique fuels, at the expense of conventional gasoline.



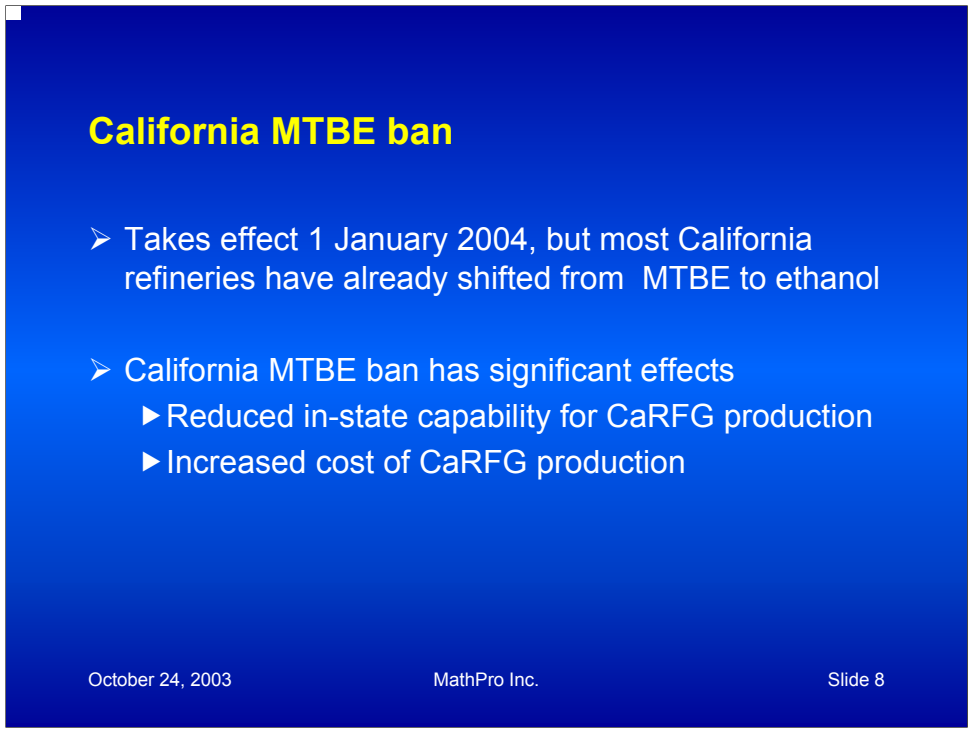
- Sulfur standard goes from 120 ppm avg. in 2004 to 30 ppm avg. in 2006.

- Geographic Preference Area (GPA) provision allows later compliance times for refineries in Mountain States, Alaska, and Hawaii.

- Virtually all refineries are using advanced desulfurization processes developed in direct response to Tier 2 program.

- New processes achieve up 99% sulfur removal, with low hydrogen consumption, limited octane loss, and low investment..

- Some refineries are already meeting the Tier 2 sulfur standard.

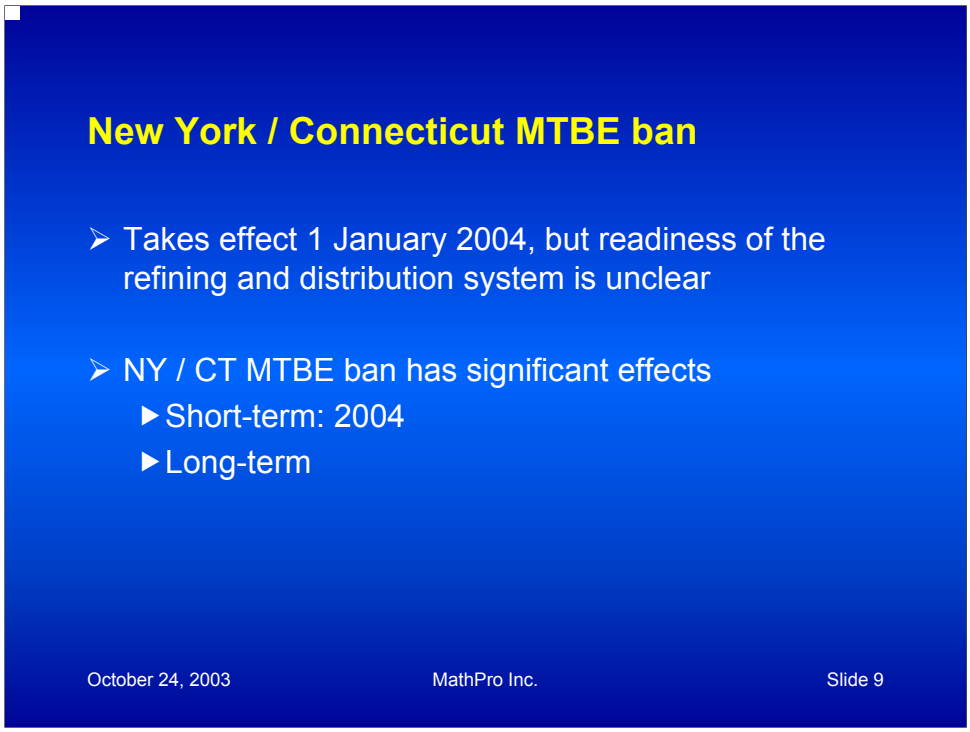


➢California modified its Predictive Model for certifying compliance with CARB standard to make it "ethanol-friendly".

➢Nonetheless, replacing MTBE with ethanol reduces gasoline production capacity in California by 60-100 K Bbl / day (about 6–10% of total production). This shortfall has to be made up by imports of CARBOB or premium blendstocks such as alkylate.

➢CARBOB, blendstock, and ethanol imports strain existing port, terminal, and other infrastructure facilities.

➢The estimated total cost of the California MTBE ban is ≈ 6–8¢/gal. The retail price effect may be larger. The magnitude of these economic effects is a function of the delivered price of ethanol.

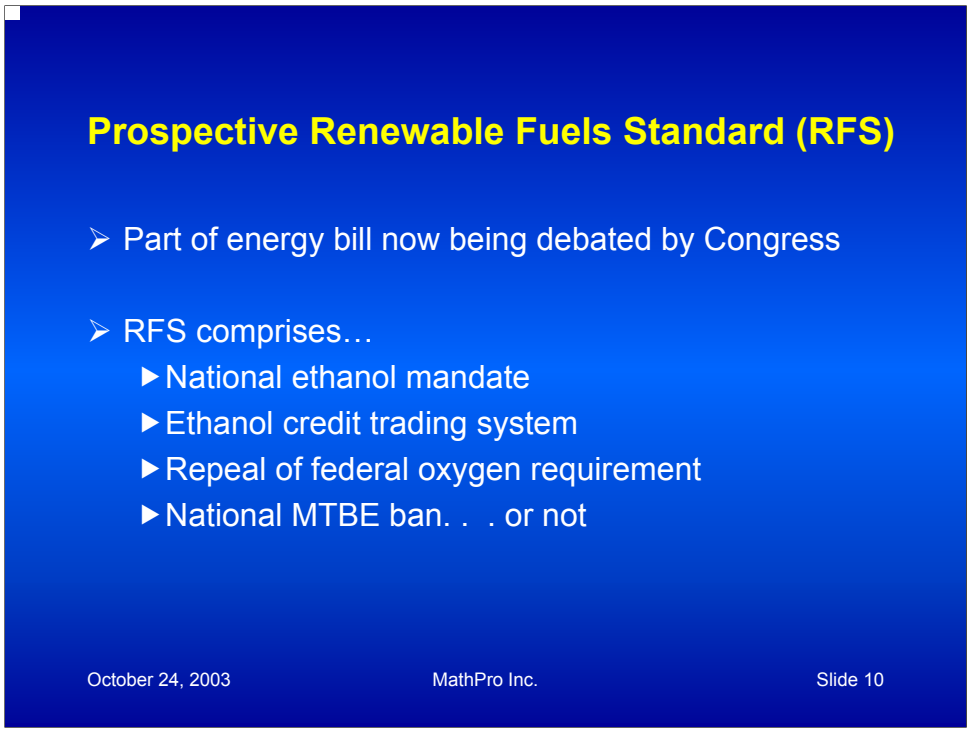


- In a recent report (*Preparations for Meeting New York and Connecticut MTBE Bans;* October 2003; SR/O&G/2003-02), EIA states that it can identify sources for about 70-80% of the required NY/CT RFG volume, but cannot verify that the remainder will be immediately available in the two transition periods: after 1 Jan. 2004 and after the shift from winter to summer gasoline in late spring.

- Hence, EIA foresees likelihood of supply shortfall and price spike in the transition periods.

- In the long term, EIA foresees
  - Significant changes in the sourcing pattern for NY/CT RFG
  - Greater reliance on imported supplies
  - Increased price volatility
  - Higher average price

- EIA estimates that, in the long term, the NY/CT ban could raise the average retail price of RFG in NY and CT by about 5¢/gal.



- The ethanol mandate sets increasing annual requirements for fuel ethanol usage
  - 3.0 bgy (195 K Bbl / day) in 2005
  - 5.0 bgy (326 K Bbl / day) in 2012
  - Thereafter, increasing in step with gasoline production

- Repeal of the oxygen requirement would be effective immediately.

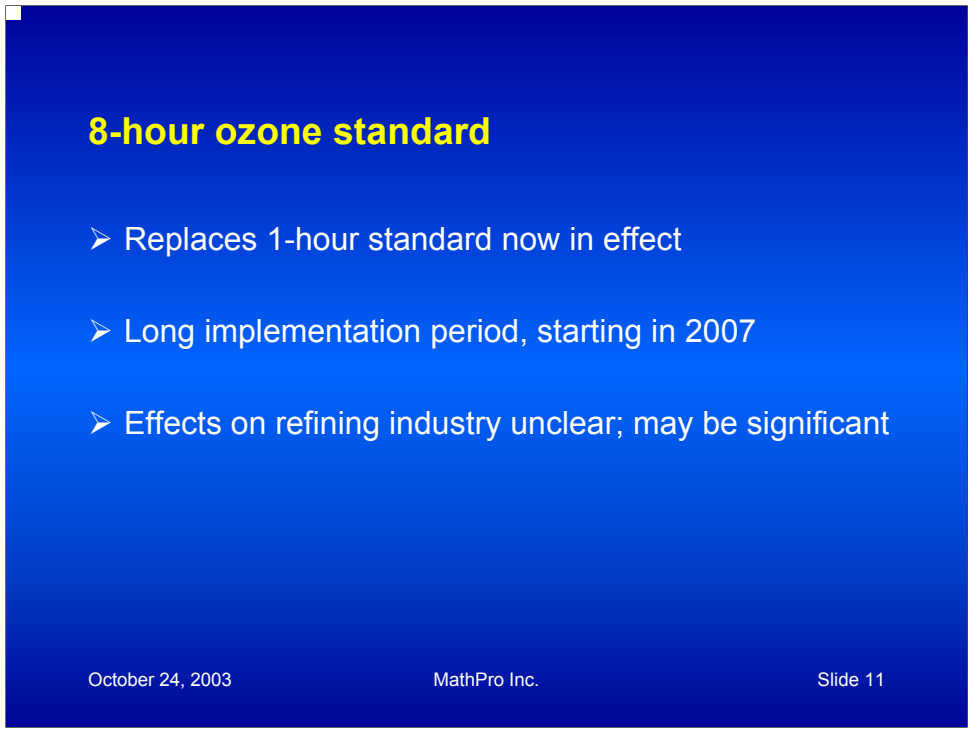
- Credit trading is intended to minimize cost of ethanol mandate by allowing ethanol use to remain concentrated in Midwest, where delivered cost is lowest.

- Ethanol supply is no longer an issue because the ethanol industry has invested aggressively in new capacity, in anticipation of the RFS.

- If enacted, the national MTBE ban would take effect in 2007. However, final legislation could leave MTBE use to the individual states.

- A national MTBE ban would reduce the gasoline production capability of U.S. refining sector by almost 200 K Bbl / day, after allowing for ethanol blending to satisfy the oxygen requirement, and increase cost of RFG production by more than 6¢/gal.

- The RFS program may provide subsidies for retro-fitting merchant MTBE plants to alkylate or iso-octane/iso-octene production. Without subsidies, most merchant plants would shut down. The RFS program also may include provision limiting liability of MTBE producers with respect to “defective product” claims.



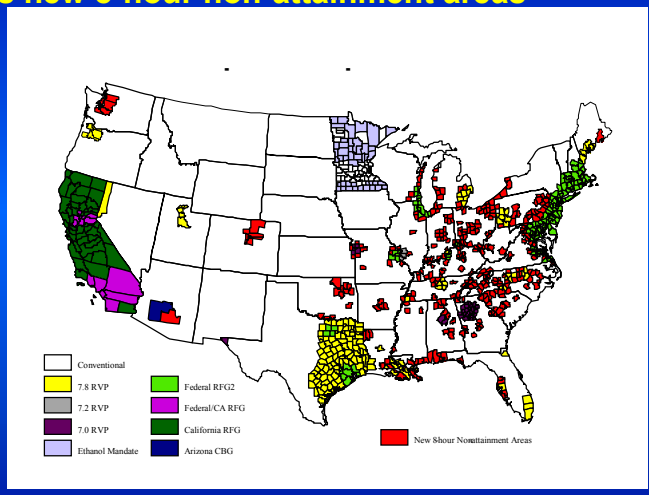
➢The 8-hour standard is more stringent than the current 1-hour standard. Consequently, it will increase the number of counties that are in ozone non-attainment.

➢This is in turn is likely to increase the number and extent of areas whose SIPS include some form of cleaner-burning gasoline: RFG or low-RVP CG.

➢Thus, from a refining standpoint, the main effect of the 8-hour ozone standard will be to increase the volume shares of RFG, low-RVP CG, and other boutique fuels, and decrease the volume share of CG.

➢The 8-hour ozone standard is flying below the refining industry's regulatory radar, due to its protracted implementation schedule and the press of other, more immediate programs.

Areas covered by current U.S. gasoline programs *plus* new 8-hour non-attainment areas

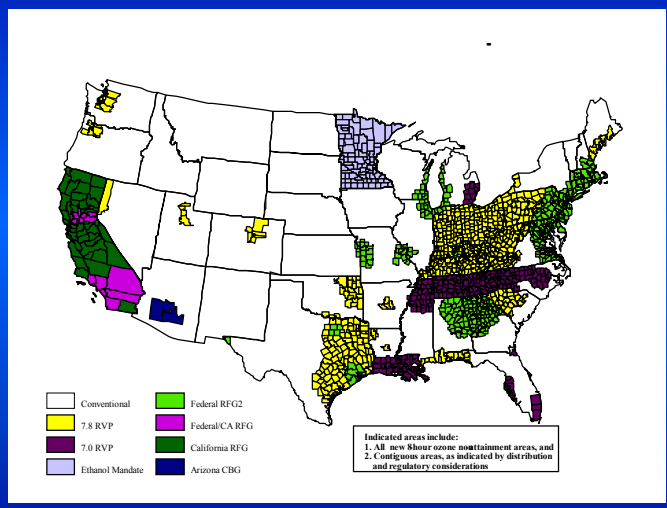


October 24, 2003 MathPro Inc. Slide 12

➢This map shows the areas likely to be in non-attainment of the 8-hour ozone standard, if it were implemented now: the existing 1-hour non-attainment areas now covered by federal and state gasoline programs *and* the new 8-hour non-attainment areas.

➢The new 8-hour non-attainment areas account for about 22% of U.S. gasoline consumption.

Projected long-term pattern of gasoline use under 8-hour standard



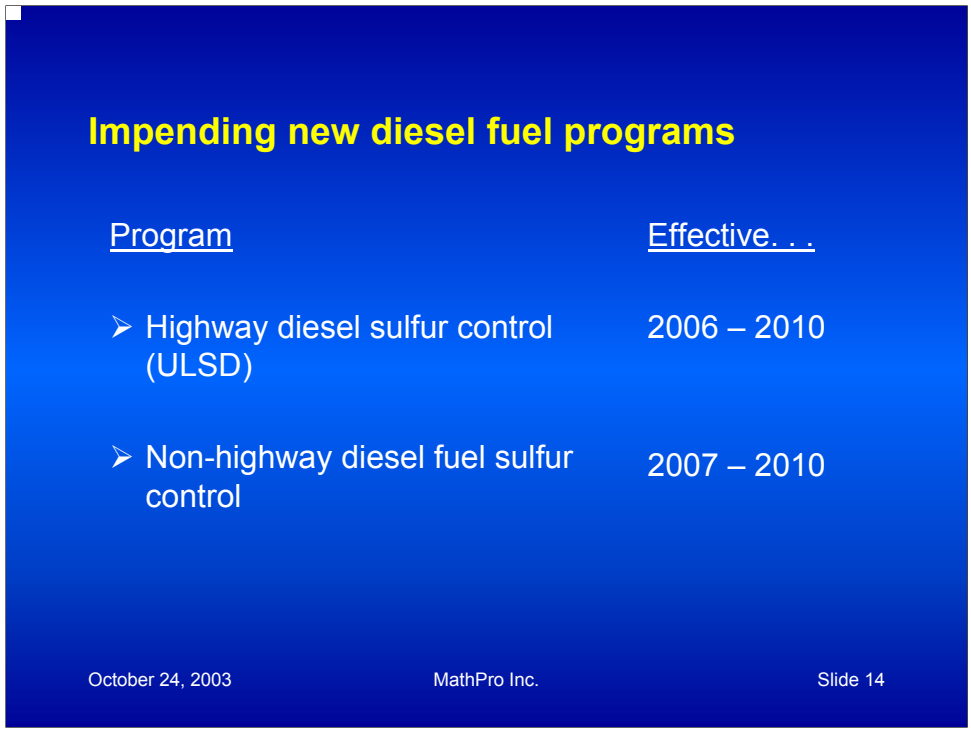
October 24, 2003 MathPro Inc. Slide 13

➢This map depicts a “worst-case” (or “best-case”, depending on your point of view) projection of the pattern of gasoline use that could be induced by the 8-hour ozone standard when attainment programs are fully implemented.

➢Under this scenario, every 8-hour non-attainment area adopts some type of cleaner burning gasoline – RFG or low-RVP CG – as as part of its SIP.

➢As a result, the volume share of RFG would increase to about 40%. The volume share of CG would drop from about 47% at present to about 25%. CG would account for less than 20% of gasoline consumption east of the Mississippi.

➢This is an extreme, and probably unlikely, scenario. But it serves to indicate that the 8-hour standard is looming over the regulatory horizon and is likely to have an important influence on gasoline markets in the next decade.



- The two programs have the same sulfur standard: 15 ppm cap – meaning that refineries will strive to produce ULSD containing < 10 ppm sulfur at the refinery gate.

- The refining industry is likely to implement the two programs together because of
  - Overlapping implementation schedules
  - Co-production of highway and non-highway diesel by most refineries
  - Logistics system considerations downstream of the refinery

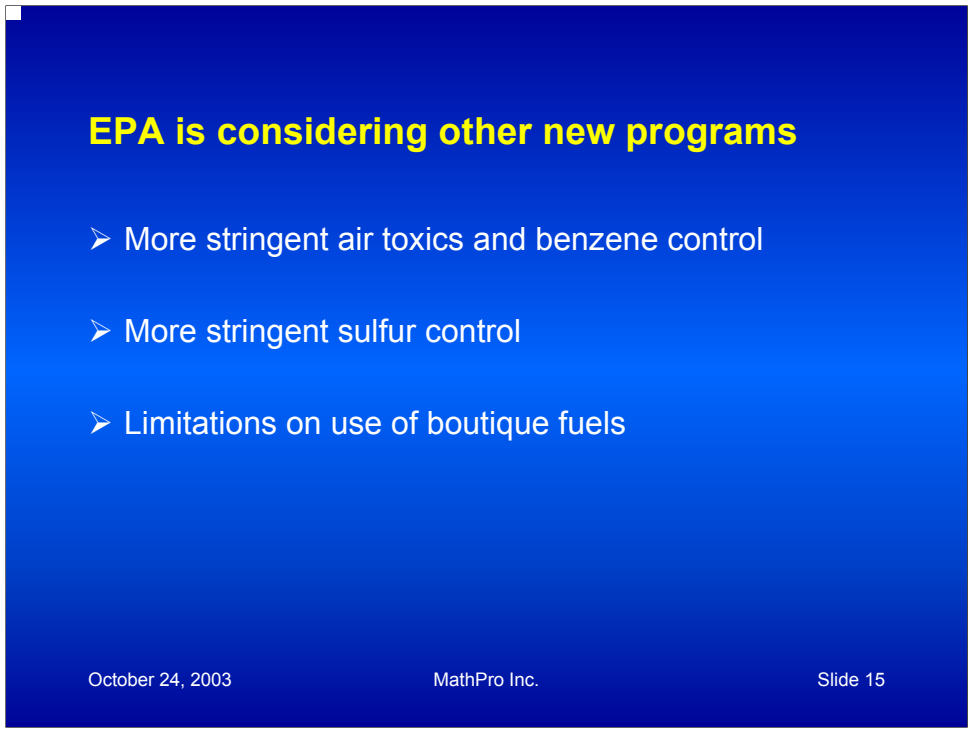
- The refining cost of ULSD production is a refinery-specific function of production volume, technology of existing units for producing EPA diesel (500 ppm sulfur), sulfur content of the distillate pool, and proportion of cracked (hard-to-desulfurize) stocks in the distillate pool.

- The average cost of ULSD production is likely to be in the range of 5–8 ¢/gal, with significant refinery-to-refinery variation.

- Most refiners now producing EPA diesel or CARB diesel are likely to be able to retrofit their existing units, rather than build grass-roots units.

- Technology for diesel fuel sulfur control is advancing rapidly in response to ULSD, as has been the case with gasoline sulfur control.

- Early concerns regarding supply shortfall – because high-cost refiners presumably would choose not to produce ULSD – appear to have waned, and properly so.



➢EPA shows continuing interest in achieving further reduction of
- ▶vehicle emissions of air toxics, and
- ▶the benzene content of gasoline

either individually or together.

➢Gasoline sulfur control down to 10 ppm (cap) or less is technically feasible, may not be costly, and continues to be advocated by the automobile industry.

➢EPA continues to consider mandating a national slate of fuels – comprising no more than four different fuel types (e.g., CaRFG3, federal RFG, 7.0 RVP CG, and CG) – from which state and local air quality regulators would have to choose, as a means of restricting or eliminating the use of boutique fuels.

➢Any new national fuel program that EPA might adopt would likely be implemented after 2010.

Meanwhile, the automobile industry continues to advocate new fuels programs

- Zero-sulfur gasoline (< 5 ppm)
- Distillation index (DI) control (DI 1200)
- The "Alliance Proposal" gasoline
- Enhanced deposit control
- Ban on metallic additives (e.g., MMT)
- Zero-sulfur diesel (< 5 ppm)
- Premium diesel for light-duty vehicles (cetane > 50)

October 24, 2003 MathPro Inc. Slide 16

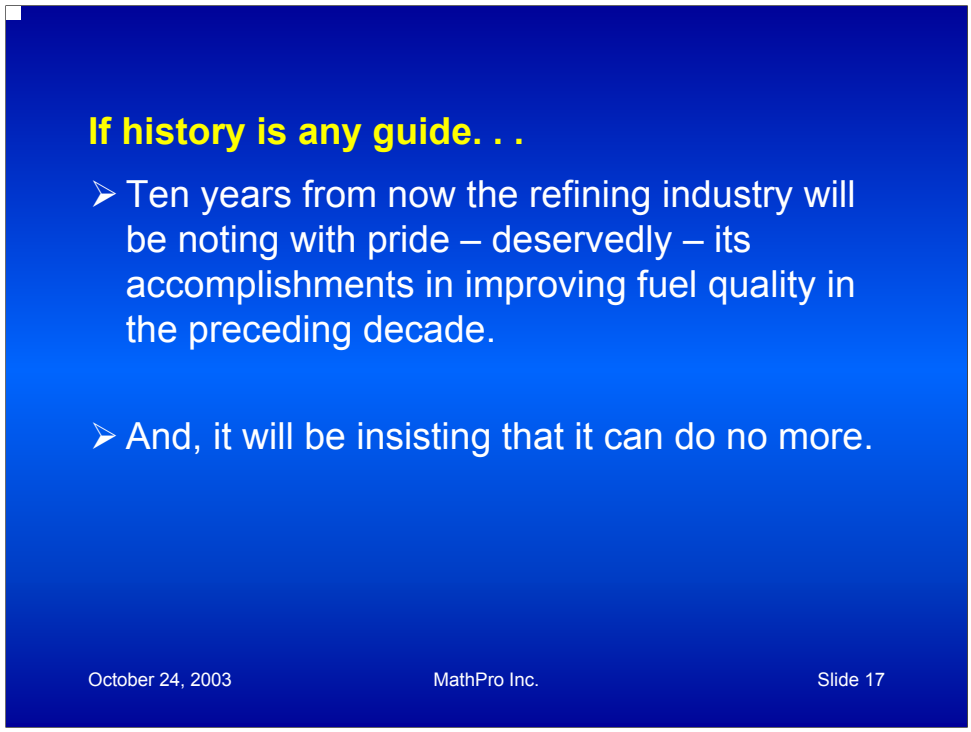
➢The automobile industry's clean fuels agenda warrants close attention, because the industry has been more successful in achieving the clean fuels standards it seeks than the refining industry has been in forestalling them.

➢Zero-sulfur fuels are deemed to be "enablers" of advanced emission control systems needed to meet tough new emissions standards for vehicles and engines.

➢Premium diesel standard (cetane > 50, aromatics < 15 vol%, improved lubricity, zero sulfur) is aimed at facilitating development of a future market for diesel-powered light duty vehicles, as in Europe.

➢The "Allliance Proposal" gasoline standard (shown below next to the CaRFG3 standard) is the most stringent clean fuel proposal to date.

		Flat Limits on Properties	
Gasoline Properties		Alliance Proposal	CARB Phase 3 Program
RVP	(psi)	7.00	7.00
Sulfur	(ppm)	*5*	20
T_{50}	(° F)	*200*	213
T_{90}	(° F)	*300*	305
Aromatics	(vol%)	25.0	25.0
Olefins	(vol%)	*5.0*	6.0
Benzene	(vol%)	0.8	0.8
Oxygen	(wt%)	1.8 – 2.2	1.8 – 2.2



- Remember, ten years ago:
  - Gasoline sulfur control wasn't even on the regulatory agenda.
  - MTBE in ground water was not an issue.
  - The federal RFG1 program had not started.
  - The California RFG2 program was not defined.