The Need For and Benefits of Eliminating Lead From Gasoline

Pretoria, South Africa
January 27, 2002

Outline
- The Problem of Motor Vehicle Pollution
- Lead in Gasoline
  - Why Lead Was Added
  - Why A Consensus To Eliminate It
- International Experience
- Beyond Lead

Combustion Emissions
- Lead
- Hydrocarbons
- Carbon Monoxide
- Oxides of Nitrogen
- Carbon Dioxide
- Particulates
- Other toxic pollutants
- Water Vapor

Engine/Emission Technology

Other Emissions
- Refueling Losses
  - displaced vapors
- Evaporative Emissions
  - diurnal, running losses, hot soak
- Crankcase Losses
  - due to "blow-by"
- Other Emissions
  - brake linings, tire wear, fluid leaks
Ozone Isopleth Plot (EKMA Diagram)

- Area of effective HC control
- 10:1 "Ridge"
- Area of effective NOx control
- Constant Ozone Concentration

Health Impacts of Air Pollution

- Premature Deaths
  - Cancer
  - Developmental Effects
  - Hospitalization
  - Asthma Attacks and Bronchitis

Health Effects

- Different Pollutants have Different Effects
  - Carbon Monoxide - circulatory system, heart
  - Ozone - respiratory system, lung
  - PM - lung, potential effects on heart
  - Diesel, Air Toxics - cancer, respiratory effects
- There are potential effects of the Mixture
- Some Populations more sensitive than others
  - elderly
  - people with heart and lung disease

Special Population Exposures

- Average Annual Levels Can Be Misleading
- In Urban Areas, there are Hot Spots:
  - Street canyons, roadsides, urban centers
  - Exposure levels for PM, diesel, CO, air toxics can be 2 to 10 times higher than average
  - Exposure levels for Ozone will be somewhat lower (NOx "scavenges" the ozone)
- In these settings, vehicle contribution will be higher
Observed Global Surface Air Temperatures

- 1990s warmest decade
- +1 °F last century
- Melting of glaciers
- Sea level rose 4-10" 
- +2 to 6 °F by 2100

Indicator of Climate Change

- Temperature tracks carbon dioxide
Potential Climate Change Impacts

Climate Changes
- Temperature
- Precipitation
- Sea Level Rise

Health

Agriculture

Water Resources and Aquatic Life

Coastal Areas

Forests

Species and Natural Areas

Source: Anne Grambsch (1998)

With All Of These Problems, Why Are We Worried About Lead in Gasoline?

Different Automotive Fuels = Different Exhaust Emissions

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Why Are Fuels Important?
- Fuel Constituents Directly Affect Emissions/Air Quality/Health
- Fuel Changes Can Immediately Impact on Emissions From All Existing Vehicles
- Fuel Composition Can Enable/Disable Pollution Control Technology
Why Was Lead Added To Gasoline

- Low Cost Octane Enhancer
- Higher Octane Allowed Better Engines
  - More Efficient
  - Higher Power Output

We Have Learned However
Lead In Gasoline Has Negative Side Effects

- High Ambient Lead Levels
- Serious Health Risks
- Precludes The Use of Catalytic Converters To Reduce Other Hazardous Vehicle Pollutants (CO, HC, NOx & Toxics)
- Higher Vehicle Maintenance Costs

Why Do We Care About Leaded Gasoline?

- Concerns About Lead
  - Impairs development of brain function in children & lowers IQ
  - Causes cardiovascular diseases in adults
  - No safe level of exposure
- Concerns About Leaded Gasoline
  - Largest source of exposure in most urban areas
  - Effective dispersion to all environmental media
  - Long-term exposure by accumulation
  - Increasing problem due to high traffic growth

Blood Lead Levels Considered Elevated

Is Any Lead Acceptable From A Health Standpoint?
Children Are Especially Susceptible To Adverse Health Effects

- increased likelihood of exposure,
- increased absorption, and
- increased susceptibility of the brain.

The Experience Of Egypt - Health Effects Study

- Heart Attacks - 6,500 to 11,600
- Strokes - 800 to 1,400
- Premature Deaths (Adults) - 6,300 to 11,100
- Infant Deaths - ~820
- Average IQ Loss in Children - 4.25 Points

The Experience of Egypt The Role of Gasoline

- Peak Ambient Levels ~ 10 micrograms/m3
- ~ 2/3rds from Gasoline; 1/3 Smelters

Trend in Lead Emissions and Air Quality in the US

- 87% Decrease in Average Ambient Lead Levels in 189 Urban Sites Over This Same Period
- Median Blood Lead Level Declined From 9.2 to 2.8 micrograms/dL

The Experience Of Egypt - Health Effects Study

- Peak Ambient Levels ~ 10 micrograms/m3
- ~ 2/3rds from Gasoline; 1/3 Smelters
The Experience of Egypt

Results of Action

- Refinery Modifications
  - Process Changes
  - 15% Oxygenates
- Within 6 Months
  - 85% Unleaded Nationally
  - 100% Unleaded in Cairo

Ambient Particulate Lead in Delhi
Pre and Post Unleaded Petrol

Lead Phase Out Started in September 1998

Ambient Pb Concentrations in Bangkok and Pb in Gasoline from 1988 - 1998

Premium ULG was introduced in 1991
Regular ULG was introduced in 1993
Complete phase out of regular leaded gasoline in 1993
Complete phase out of premium leaded gasoline in 1995

Comparison of Average Blood Pb Levels in Children at 6 Schools in Bangkok between 1993 and 2000

Source: CPCB

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<th>Year</th>
<th>School 1</th>
<th>School 2</th>
<th>School 3</th>
<th>School 4</th>
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The Magnitude of Health Impacts

- Losses of 4 or more IQ points in 30,000-70,000 Children in Bangkok
- More than 800 Infants and 10,000 Adult Deaths Annually in Cairo
- More than 150 Premature Deaths Annually in Jakarta

The Cost of Health Impacts

- Reduced Productivity and Lifetime earnings
- Increased Medical Costs
- Compensatory Education Costs
- Premature Deaths of Infants and Adults

*An Estimated $17 Billion for each 1 ug/m³ Increase in Ambient Airborne Lead in the US*
Impact of Lead on Catalyst Performance

The Three-way Catalytic Converter: A Familiar Technology Re-engineered for High Performance in Close-coupled and Underfloor Applications

- Layered washcoat architectures and support materials with high thermal stability
- Integrated HC adsorption functions
- Mounting materials with improved durability
- High cell density ceramic or metallic substrates
- Insulation schemes for heat management

Unleaded Gasoline: Gateway To The Future

- Direct Health Benefits
- Technology Enabling
- Modern Vehicle Technology
  - Low "Conventional" Emissions
  - Low Greenhouse Gas Emissions
  - Retrofit Technologies
- Modern Gasoline Technology
  - Low Benzene
  - Low Sulfur
  - Low Volatility

Lead Free Fuel Can Be Used in Older Vehicles

- Valve Recession Problem Has Not Materialized
- Need Sustained High Speed, High Load Operation
- Lead Substitutes Exist if Needed
- No Other Impediments Identified
Refinery Modifications Available
To Replace Lead In Gasoline

- Increase Refiner Severity to Raise Reformate Octane
- Increase Production/Use of High Octane Blend stocks
  - Reformate
  - FCC Gasoline
  - Alkylate
  - Isomerate
  - Oxygenates

Quality Tradeoffs For Key Gasoline Blendstocks

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Don't Replace One Harmful Substance With Another

California Civic 600 cpsi catalyst - 49,000 miles
- No MMT

Canadian Civic 600 cpsi catalyst - 49,000 miles
- With MMT

Sales of Lead Free Gasoline By End of 2002

- Lead Free
- Still Some Leaded
Issue: Fast Track or Slow Track

Cost Effectiveness and Policy Implications

- Phasing out Lead from Gasoline is Highly Cost-effective (In the US, the Benefits Outweighed Costs more than 10 Times)
- Benefits Justify Rapid Phase-out - Faster than Car Fleet Replacement

Problems With A Slow Transition

- Risks of Contamination
  - Deliberate
  - Accidental
- Expense of Dual Distribution System
  - Delivery
  - Pumps & Storage
  - Vehicles
  - Administrative

Issues to be Addressed in Phasing-Out Leaded Gasoline

Public Information
Refinery Modifications
Valve Recession in Older Vehicles
Fuel Pricing Policy
The Path to Unleaded Gasoline
Distribution Network
Octane Substitutes
New Vehicle Emission Standards
Policy Options For Lead Free
- Command and Control
- Vehicle Market Driven
- Fuel Pricing
- Combination

Eliminating Lead Is Only The Beginning Toward Clean Fuels
- Gasoline
  - Lead
  - Sulfur
  - RVP
  - Benzene
- Diesel
  - Sulfur
  - Sulfur
  - Sulfur
  - Other

Worldwide Consensus
Leaded Gasoline Should Be Eliminated
- Alternatives Are Widely Available
- Health Concerns No Longer Debatable
- Catalysts Are Best Solution To CO, HC, NOx Problems and Only Work With Lead Free Gasoline
- Modern Engines Designed For Lead Free Fuel

http://walshcarlines.com