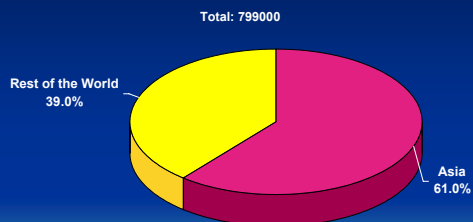


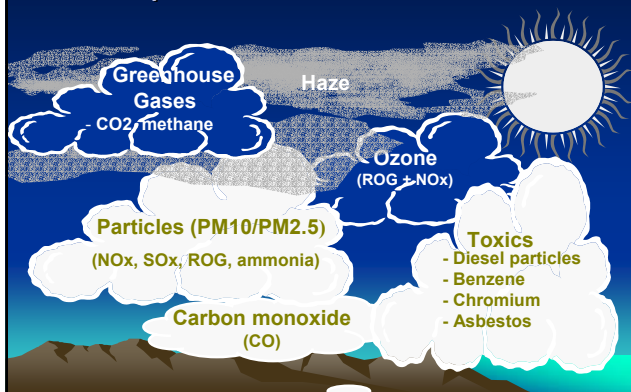
Health Effects and Regulatory Developments Around the World

Asian Vehicle Emission Control Conference 2004
Beijing
April 26-29, 2004

WHO Estimate of Premature Deaths Annually Due To Outdoor Air Pollution

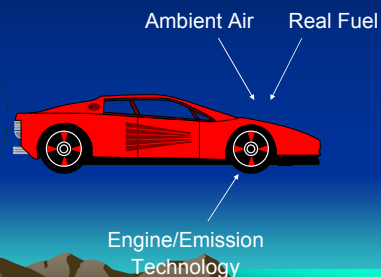


What pollutants are of concern?



Products of Combustion

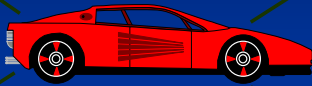
- Lead
- Hydrocarbons
- Carbon Monoxide
- Oxides of Nitrogen
- Carbon Dioxide
- Particulates
- Other pollutants
- Water Vapor



Other Emissions From Vehicles

Refueling Losses
displaced vapors

Evaporative Emissions
diurnal, running losses, hot soak



• Other Emissions

brake linings, tire wear, fluid leaks

Crankcase Losses
due to "blow-by"

Health Impacts of Air Pollution

Premature Deaths

Cancer

Developmental Effects

Hospitalization

Asthma Attacks and Bronchitis

PM Health Effects

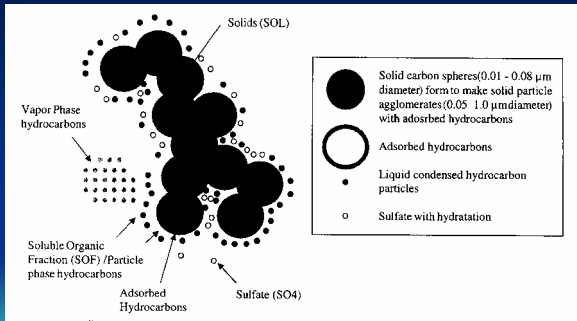
- High levels of PM (e.g. $500 \mu/m^3$) known to cause premature death
 - e.g. London 1952
- Recent studies in North and South America, Europe, Asia, have found association of PM with death at much lower levels
 - no evidence of a "threshold" (safe level)
- To date, a plausible biological mechanism for these effects has not been conclusively found

PM₁₀ Study in Europe

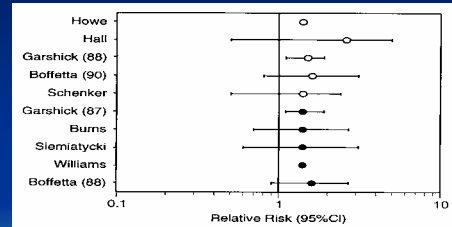
(Lancet Medical Journal – September 2, 2000)

- ~6% of all deaths from PM₁₀
- ~40,000 deaths per year in Austria, France, Switzerland; 2 times traffic fatalities
- Motor Vehicles Responsible For ~50%
- People in Cities Die ~18 Months Earlier Than They Otherwise Would
- Over 300,000 cases of chronic bronchitis; 500,000 asthma attacks; 16 million lost person days of activity
- Health Costs From Traffic Pollution ~1.7% of total GDP

Diesel Particulate Matter Raises Some Special Concerns



Lung Cancer Studies in Railroad Workers HEI, 1995



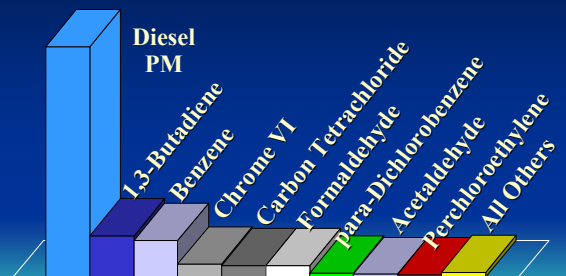
- All studies indicate an increase in lung cancer for exposed vs. unexposed workers

Assessing Diesel Cancer Risk

- Some 30 studies of lung cancer effects on workers
- Consistent small (20-40%) increase in lung cancer associated with exposure
- Some questions about each study
- WHO, IARC*, and U.S. agencies have concluded that diesel is a "probable human carcinogen"

* IARC = International Agency for Research on Cancer

Relative Cancer Risks From Air Pollutants in Los Angeles

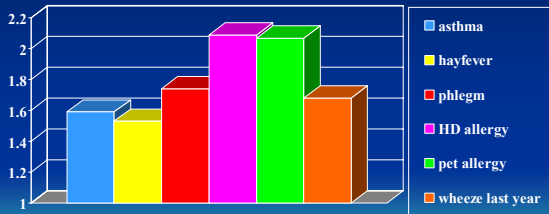


Based on ARB monitoring data 1995 - 1997

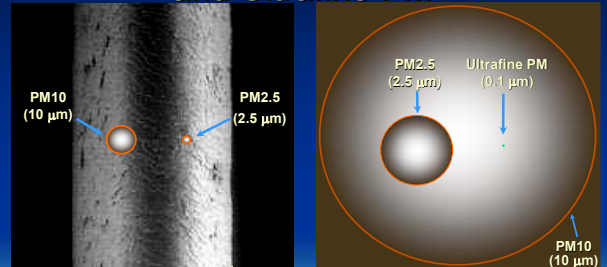
Diesel Effects on Childhood Illness Association between truck traffic and symptoms

(Brunekreef, et al Study in 24 Dutch schools)

Increased Symptoms comparing High Truck Traffic (>10,000) to Low Truck Traffic



Comparison of PM10, PM2.5, and Ultrafine PM



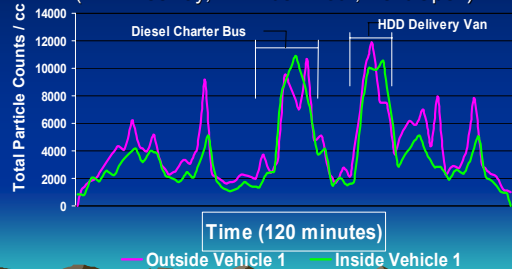
Concern Over Ultrafine PM Reinforced

- Daily Mortality in Erfurt Germany
 - Health Effects of Ultrafine & Fine PM Comparable
 - Effects of Ultrafines Depend on Number and Surface Area
 - Since 91/92 PM Mass Has Declined
 - Since 91/92 very small particles (.01-.03) increased

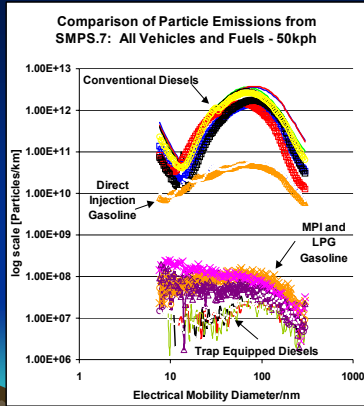
HEI Research Report 98, November 2000

ARB In-Vehicle Study Real-Time Fine Particle Counts

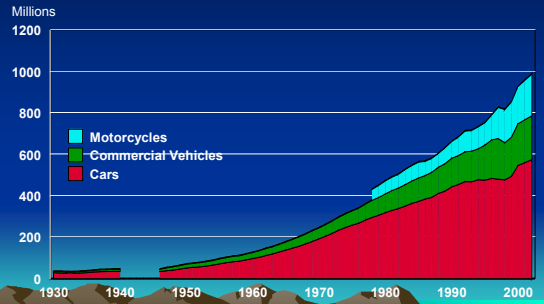
(L.A. Freeway, AM Rush Hour, Vent Open)



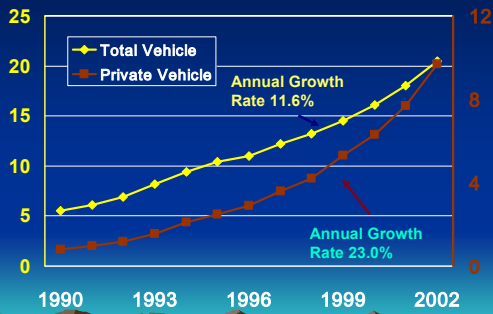
A PM Solution Exists But It Requires ULSD!



World Motor Vehicle Population

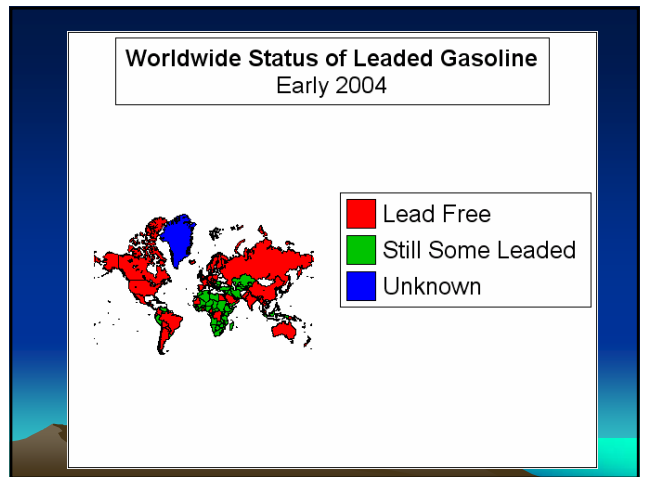
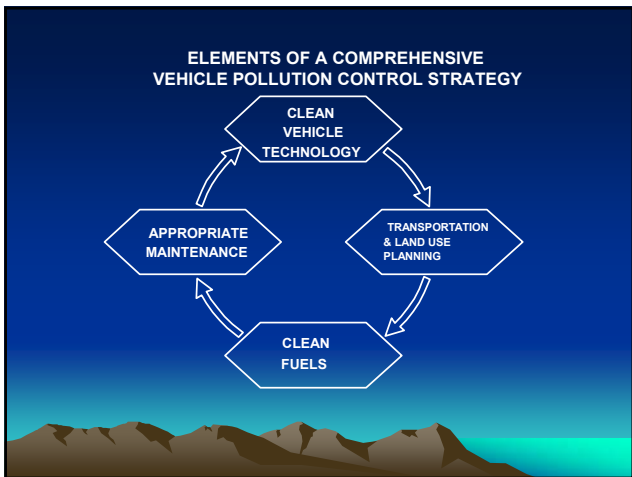
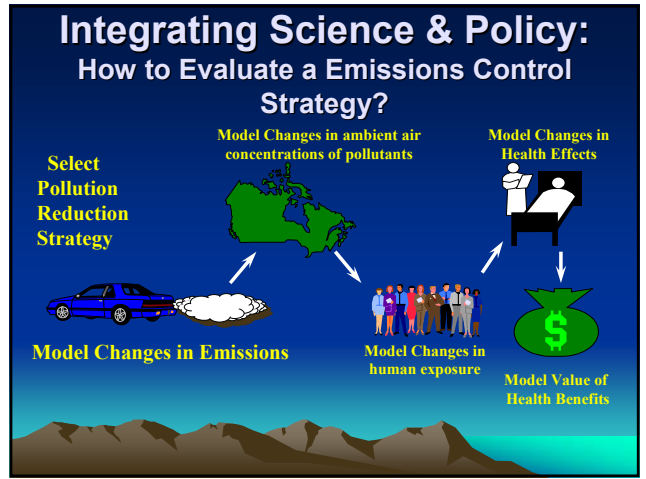


Chinese Vehicle Population Growth Has Been Exploding (million)

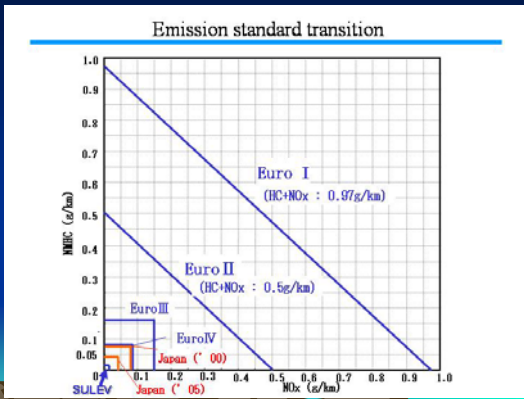


Growth in Annual Vehicle Production Has Been Even Faster (million)

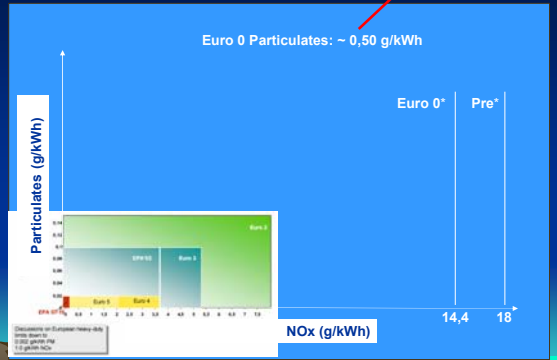




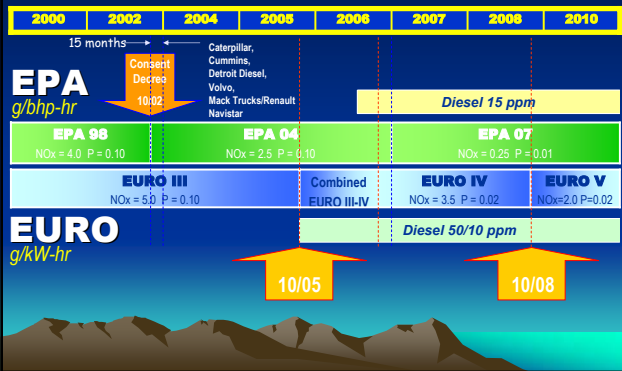
Light Duty Vehicle Emissions Standards



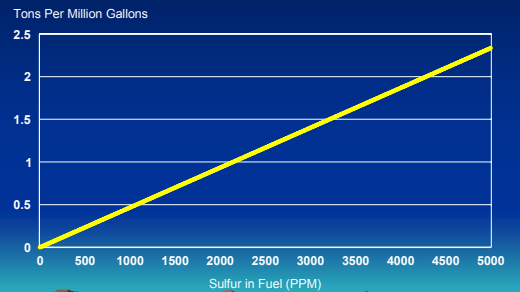
HD Emission Regulation



Close Linkage Between Vehicle Emissions Standards and Fuel Sulfur Levels



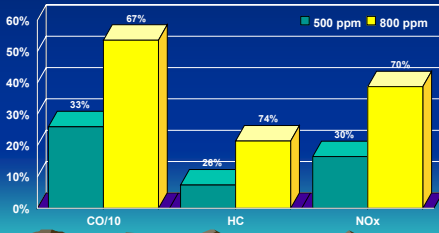
Tons of Directly Emitted PM From Diesel Fuels Sulfur



Derived From US EPA Data

Increase in In-Use Vehicle Emissions in Bangkok Due To Sulfur in Fuel (Gasoline)

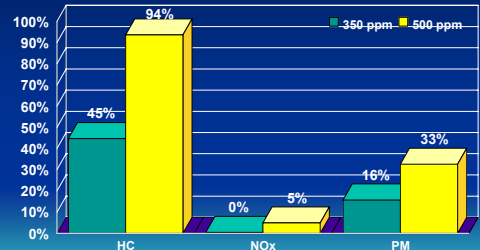
Percent Increase Compared to 150 PPM Sulfur



Impact on Vehicles Meeting EURO 3 Standards

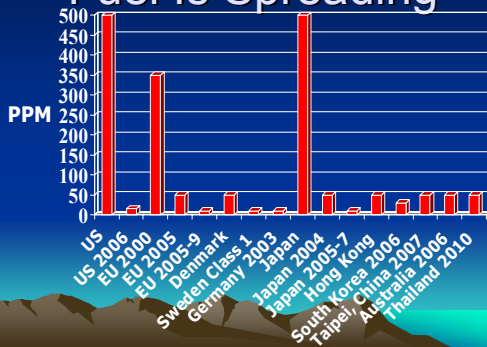
Increase in In-Use Vehicle Emissions in Bangkok Due To Sulfur in Fuel (Diesel)

Percent Increase Compared to 150 PPM Sulfur



Impact on Vehicles Meeting EURO 3 Standards

Ultra Low Sulfur Diesel Fuel Is Spreading

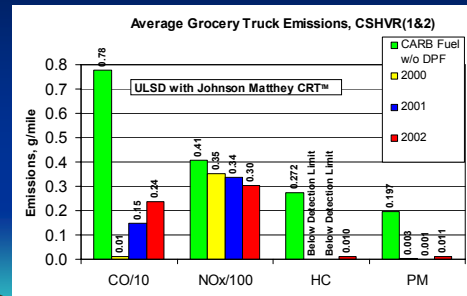


Dealing With Existing Vehicles

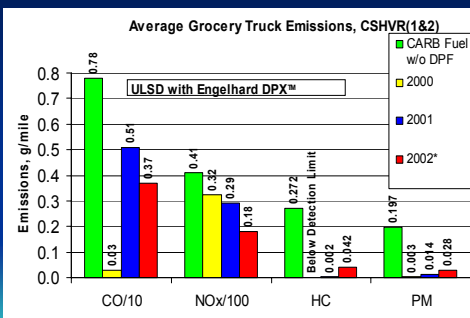
• Ultra low sulfur diesel with a catalyzed diesel particulate filter offers the following benefits:

- >90 - 98% PM reduction
- >70 - 90% CO reduction
- > 90% HC reduction
- >90% air toxics & ozone precursor reduction
- 0 - 5% NOx reduction

Durability & Reliability



Durability & Reliability



Conclusions: The Challenges For China



- Fuel Quality Must Be Improved
 - Sulfur
 - MMT
- Leapfrog To Euro 4/5
- Upgrade I/M Programs
- Constrain Discretionary Vehicle Use
- Expand Bus Rapid Transit