

Global Trends in Diesel Emission Control A 2000 Update

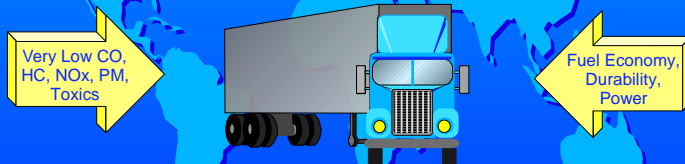
Reducing The Environmental Impact
of Heavy Duty Vehicles



Topic Today is Goods Movement



Ongoing Challenges For Heavy Duty Diesel Vehicles



Overview

- HDDV Diesels Major Source of PM & NOx
- Nitrogen Oxides Cause Many Problems
 - Ozone
 - PM
 - Acidification
- PM Serious Concern
 - PM10, PM2.5
 - Toxicity
- Major Regulatory Efforts Underway To Reduce PM & NOx
- Fuel Sulfur Playing A Major Role

Serious Air Pollution Problems Remain in the US

- ~62 (1-hr) to 125 (8-hr) Million People Lived in Non-Attainment Areas in 1999
- EPA's Forecast For 2007
 - 28 Ozone Non-Attainment Areas
 - 80 Marginal Areas
 - 129 Million People Living in These Areas
- Other Serious Problems
 - Crop Losses
 - Impaired Visibility
 - Eutrophication

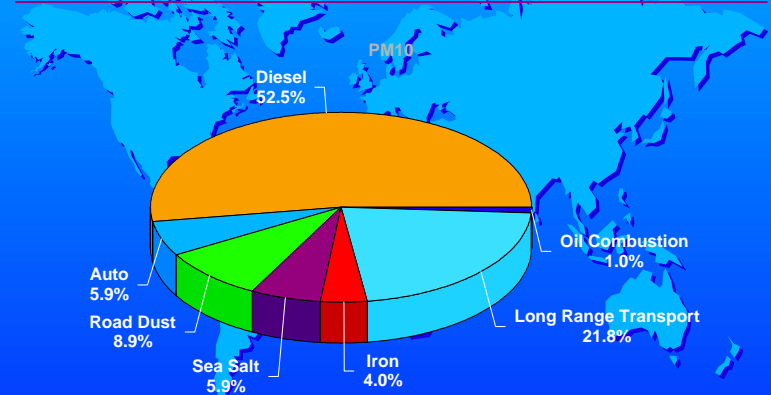
Ozone Problems in Europe in 1998 Number of Days over the Limits

	Indicative Ceiling (110 ug/m3)	Danger Limit 360 ug/m3
# of Days	10-60	8

PM10 Study Just Released in Europe (Lancet Medical Journal)

- ~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 about 18 months earlier than they would otherwise
- over 300,000 cases of chronic bronchitis; 500,000 asthma attacks; 16 million lost person days of activity
- Health costs from pollution from traffic ~1.7% of total GDP

Average Source Contribution To Midtown Manhattan Site



Chemical Mass Balance
AWMA 94-WP91.01

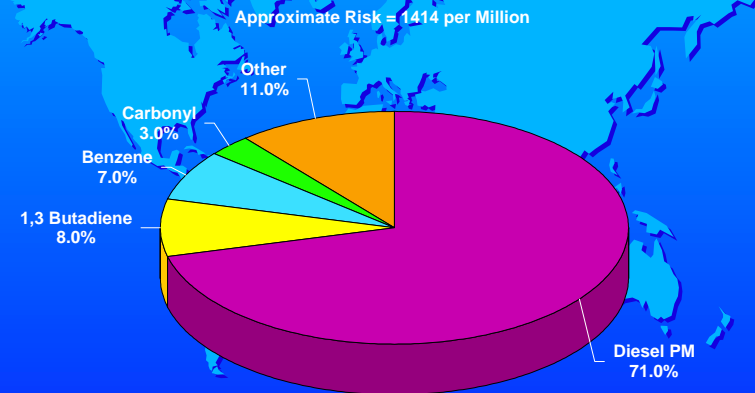
1998 CARB Assessment of Diesel PM Toxicity

- 30 Human Epidemiological Studies Found Link Between Diesel PM & Lung Cancer
- Diesel PM Declared "Toxic"
- STAPPA/ALAPCO Report - 125,000 Excess Cancers in US From Diesels

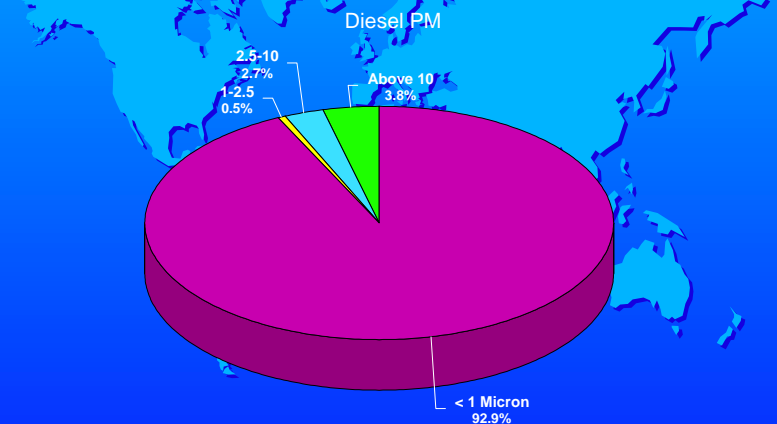
EPA Diesel Health Assessment Document - August 2000

- Highly respirable with large surface area
- Excellent carrier for organic and inorganic compounds
- Toxicologically relevant organic compounds include PAHs, nitro PAHs and oxidized PAH derivatives
- Chemical composition & size vary with engine type, operating conditions & fuel
- Likely carcinogenic to humans by inhalation at any exposure condition

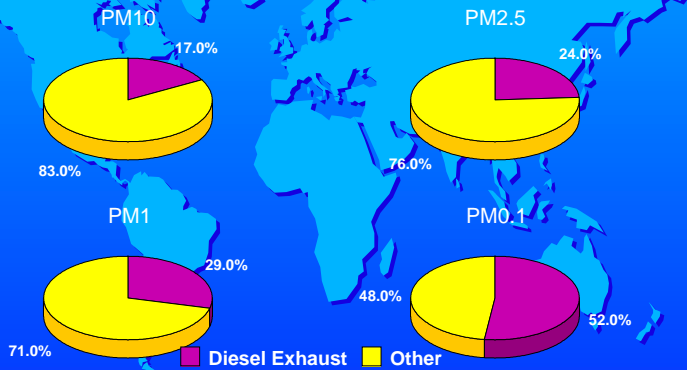
Average Los Angeles Basin Cancer Risk Apportionment



Size Distribution of Diesel Particles



PM Emissions in the UK - 1996

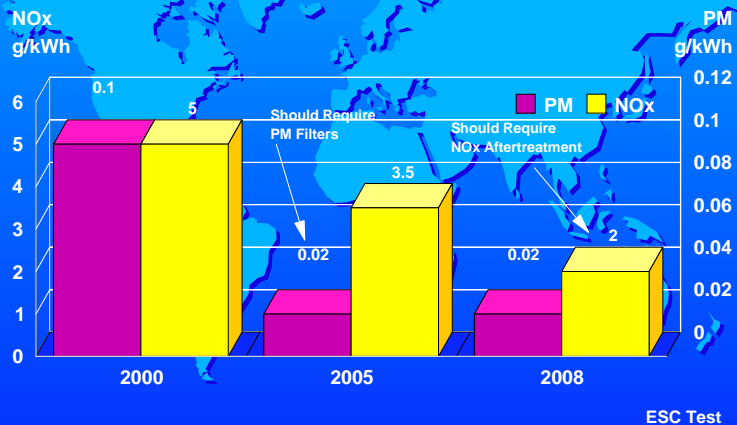


"Source Apportionment of Airborne Particulate Matter in the United Kingdom"

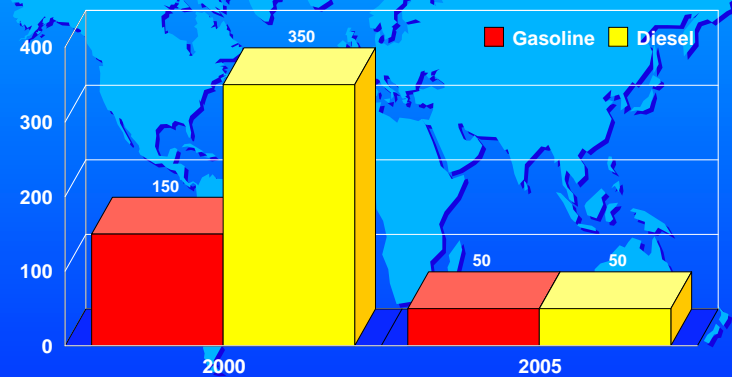
European Overview

- Low Sulfur Fuels Directive Adopted
- Tight Heavy Duty Standards Adopted; PM Filters, NOx Aftertreatment Likely But Mid Course Review Allowed
- Germany Pushing For Lower Sulfur in Diesel To Assure Feasibility of Tight Standards

European Heavy Duty Standards



Maximum Fuel Sulfur Limits Adopted For Europe (PPM)

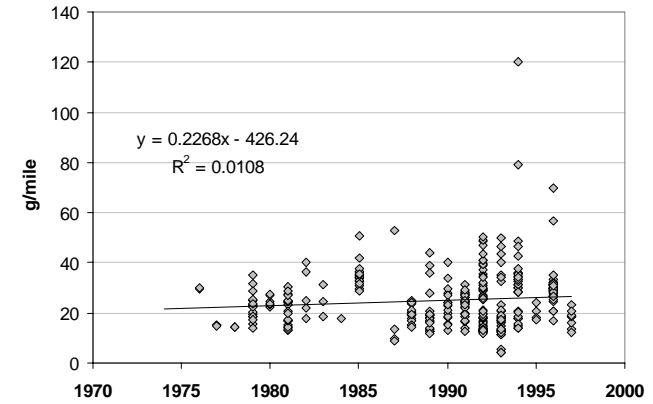


2005 Limits Can Be Encouraged From 2000 With With Fiscal Incentives

European "Call For Evidence" On Very Low Sulfur Fuel

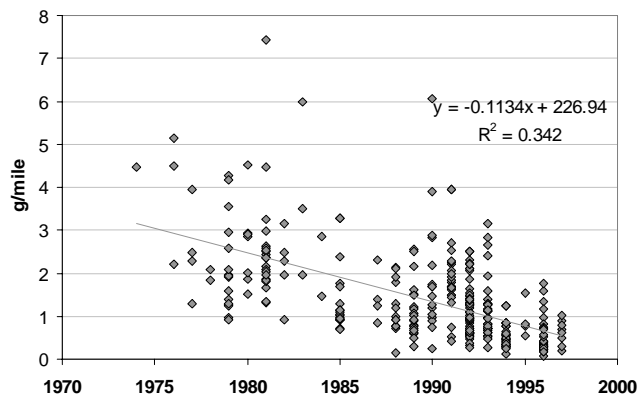
- Incremental Benefits
- Incremental Refining Costs
- Potential Linkage To Advanced Technologies
- Impact on Other Fuel Parameters
- Logistical & Investment Implications
- Overall Impact on Greenhouse Emissions (Well to Wheel)

Heavy-Duty Diesel NOx Emission Rates Measured on Chassis Dynamometer from Mid-1970s to Mid-1990s for 4-Stroke Engines



Source: Zielinska, 1999 Health Assessment Document for Diesel Emissions: Chapter 2 - Diesel Emissions, atmospheric concentrations, transport and transformation. U.S. EPA Office of Health and Environmental Assessment.

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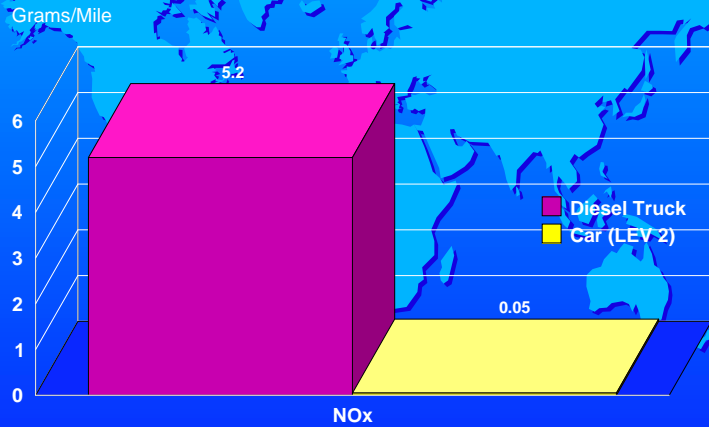


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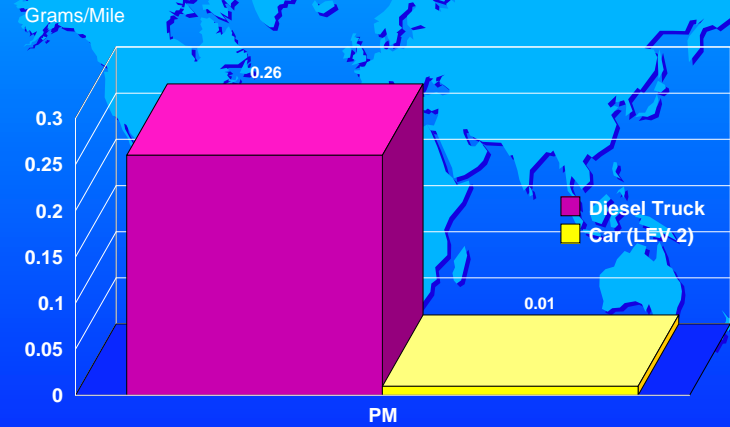
Problems With US Program

- | | |
|---|--|
| <ul style="list-style-type: none"> ■ Problems - NOx, PM, Fuel Economy Trade-Offs - High Sulfur Fuel - In Use Performance Versus Lab Performance | <ul style="list-style-type: none"> ■ Proposed Solutions - Tight Standards To Force Aftertreatment - Low Sulfur (<15 PPM) Fuel - SS Test, NTE Provisions, OBD, ROVER |
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Comparison Between Diesel Truck and Car - 2004 Model Year

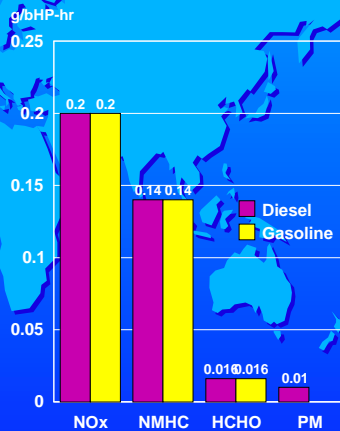


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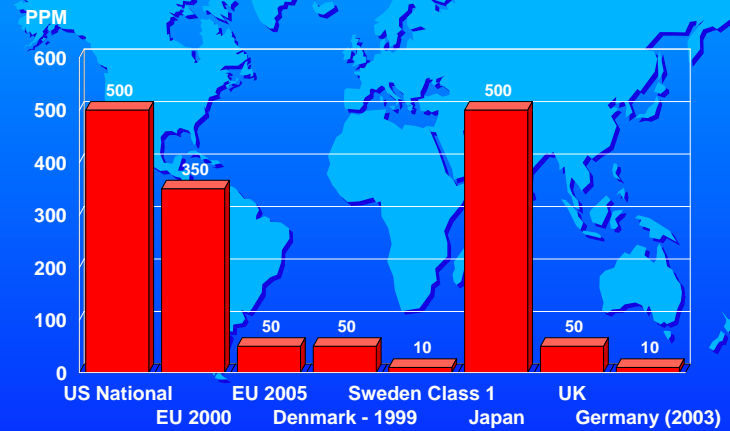


EPA Proposed 2007 Requirements

- NOx - 4 year Phase-in
- 0.15 PPM S - 2006
- No Crankcase Emissions
- 50+% Reduction in Evap HC
- Add Euro Test, OBD, NTE



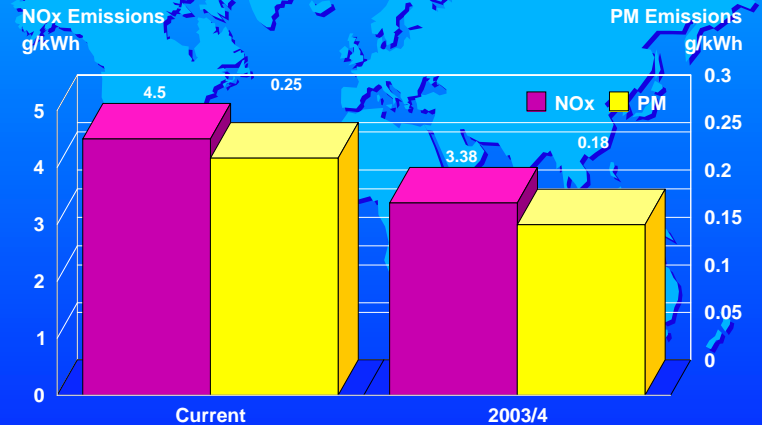
Diesel Fuel Sulfur Specifications



Japan Overview

- Diesel Truck Standards Tightened in 1998 but Still Relatively weak
- Another Step & Lower Sulfur (<50 PPM) Diesel Fuel Planned For 2007
- Tokyo Government & Courts Pushing For Faster Action; Likely in 2005
- Government Considering Carcinogenicity

Japanese Heavy Duty Diesel Standards

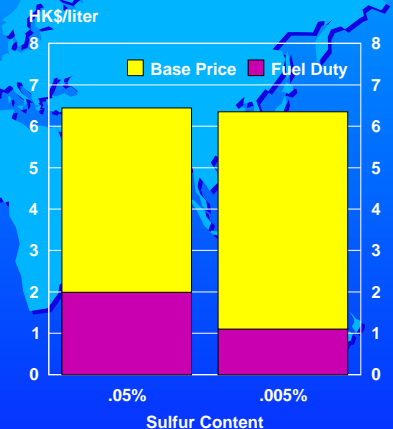


Major Retrofit Effort Emerging

- Europe
 - Major Cities in Sweden
 - Germany
 - UK
- US
 - California
 - NESCAUM
- Japan
 - Tokyo
- Other

Recent Developments in Hong Kong

- Tax Incentive Offered For 50 PPM Fuel
- Likely Strong Retrofit Effort to Follow
- Taxi Fleet Shifting From Diesel to LPG



Other Developments in Asia

- South Korea Shifting to CNG Buses
- Beijing Purchased 800 CNG Buses
- Indian Supreme Court Trying to Ban Diesel Buses
- Taiwan Forced To Allow Diesel Cars; Looking at Stringent PM Standards

Concluding On A High Note!



- Progress is Occurring
- Strong Push Over Next 5 - 8 Years