

# Global Trends in Diesel Emission Control A 2000 Update

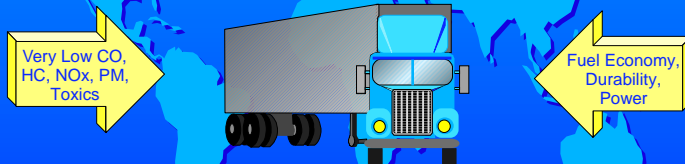
Reducing The Environmental Impact  
of Heavy Duty Vehicles



## 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

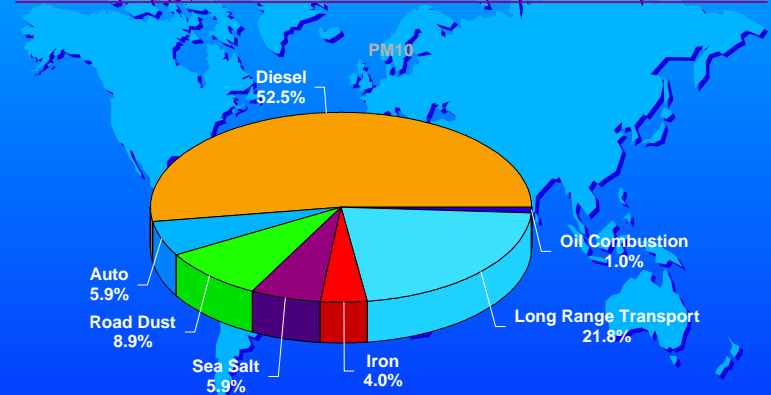
## Ozone Problems in Europe in 1998 Number of Days over the Limits

	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

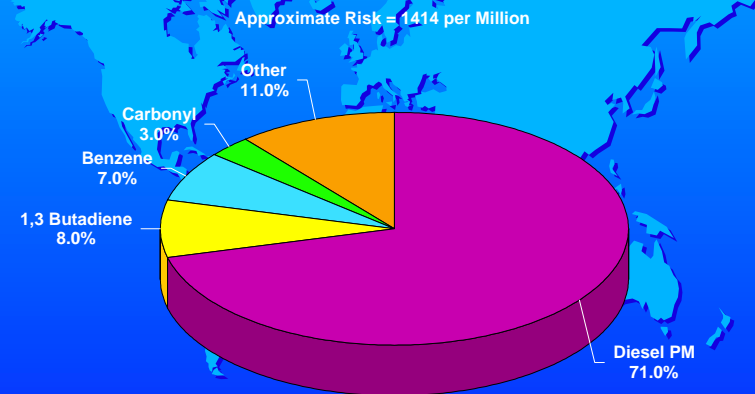
## 1998 CARB Assessment of Diesel PM Toxicity

- 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

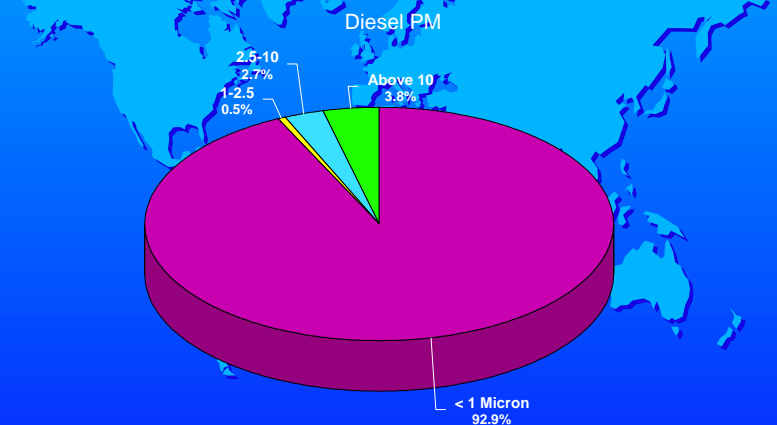
## EPA Diesel Health Assessment Document - August 2000

- 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

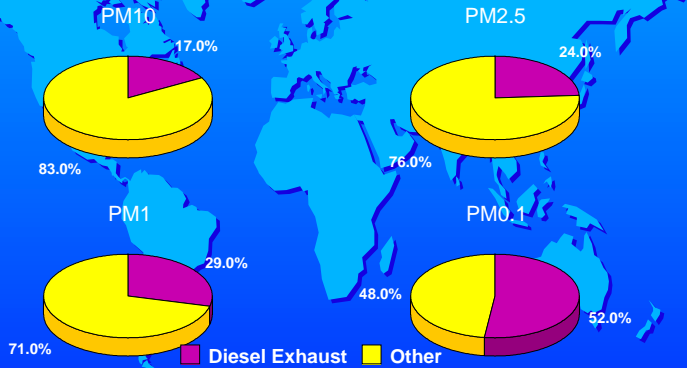
## Average Los Angeles Basin Cancer Risk Apportionment



## Size Distribution of Diesel Particles



## PM Emissions in the UK - 1996

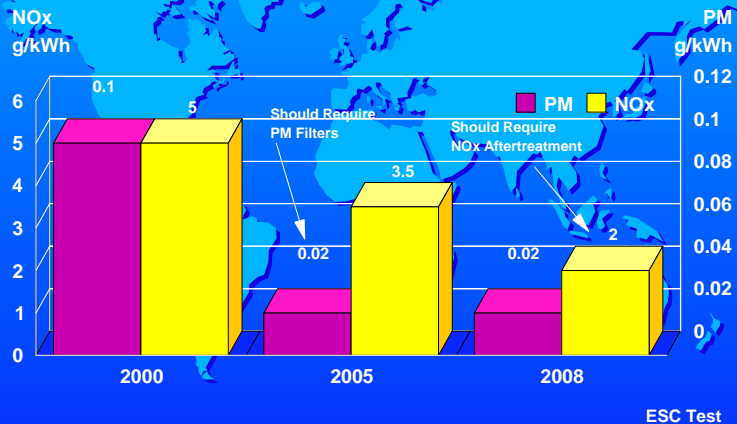


"Source Apportionment of Airborne Particulate Matter in the United Kingdom"

## European Overview

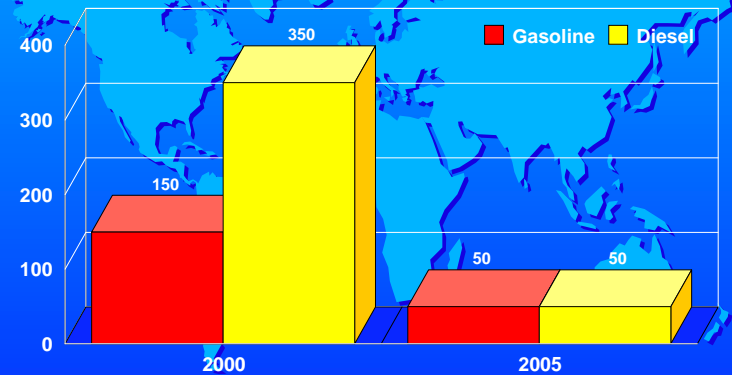
- Low Sulfur Fuels Directive Adopted
- Tight Heavy Duty Standards Adopted; PM Filters, NOx Aftertreatment Likely But Mid Course Review Allowed
- Germany Pushing For Lower Sulfur in Diesel To Assure Feasibility of Tight Standards

## European Heavy Duty Standards



ESC Test

## Maximum Fuel Sulfur Limits Adopted For Europe (PPM)

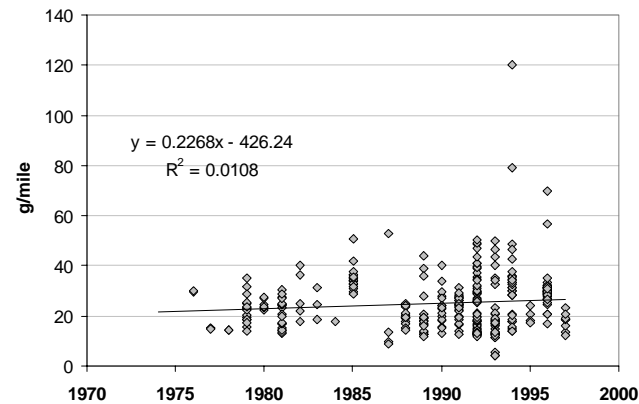


2005 Limits Can Be Encouraged From 2000 With With Fiscal Incentives

## European "Call For Evidence" On Very Low Sulfur Fuel

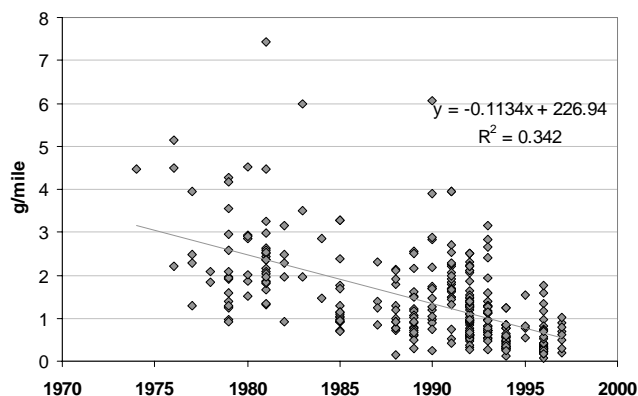
- Incremental Benefits
- Incremental Refining Costs
- Potential Linkage To Advanced Technologies
- Impact on Other Fuel Parameters
- Logistical & Investment Implications
- Overall Impact on Greenhouse Emissions (Well to Wheel)

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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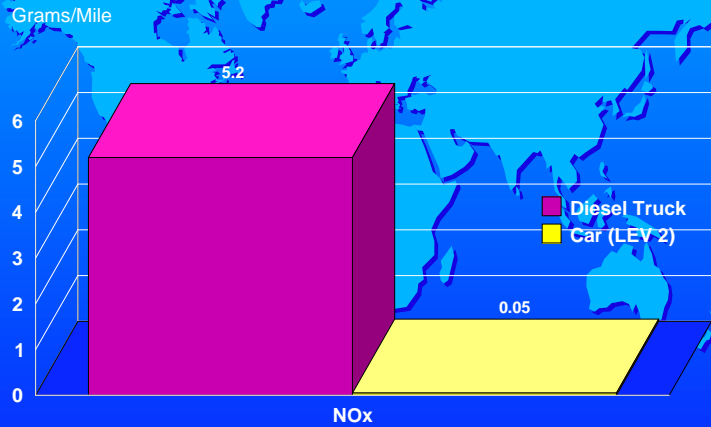


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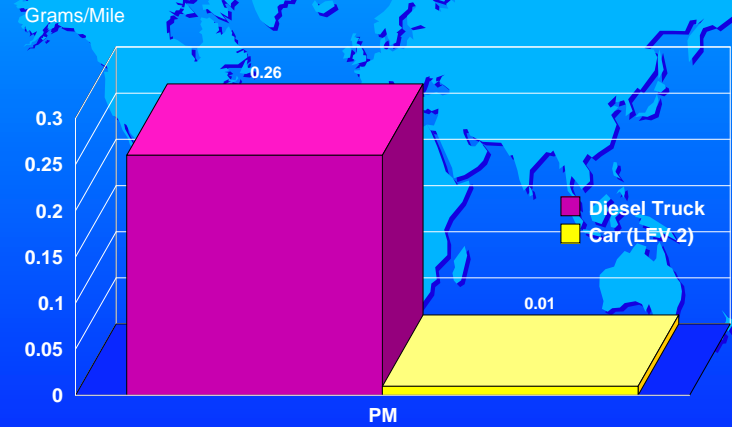
## Problems With US Program

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

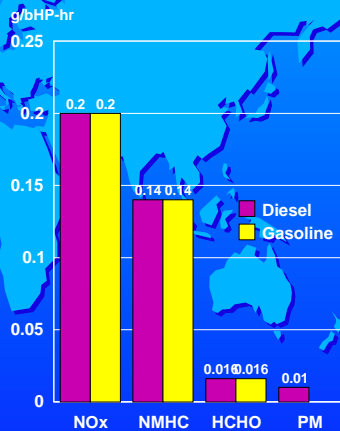


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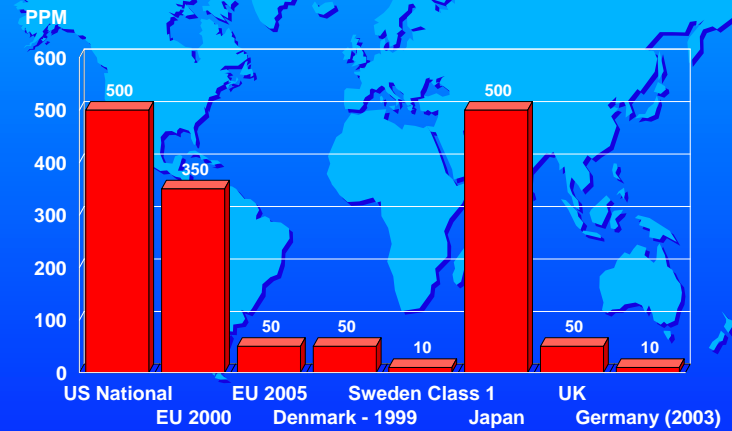


## EPA Proposed 2007 Requirements

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



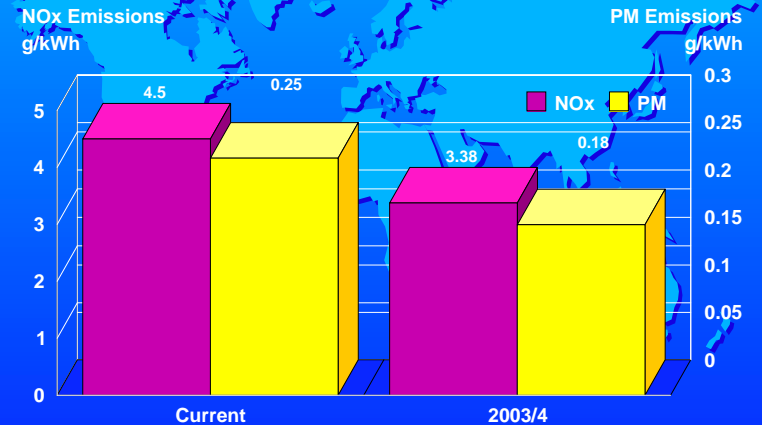
## Diesel Fuel Sulfur Specifications



## 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

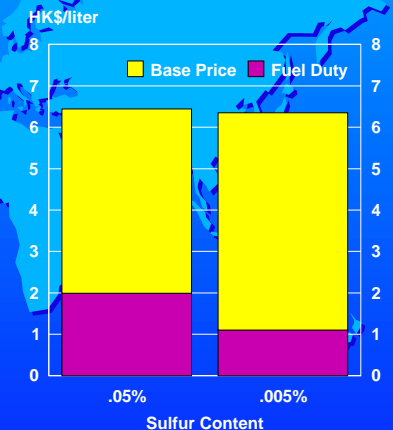


## Major Retrofit Effort Emerging

- 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