

Overview of Worldwide Regulation of Diesel Vehicle and Engine Emissions

Corning's Clean Diesel Workshop
Germany, September 26, 2000



Overview

- Diesels Major Source of PM & NOx
- Serious Concerns Remain
 - PM Health Effects
 - PM Toxicity
 - Ozone Health Effects (NOx)
 - Secondary PM2.5 Formation (NOx)
- Major Regulatory Efforts Underway
- Fuel Sulfur Increasing Focus
- Retrofit of Existing Vehicles Growing

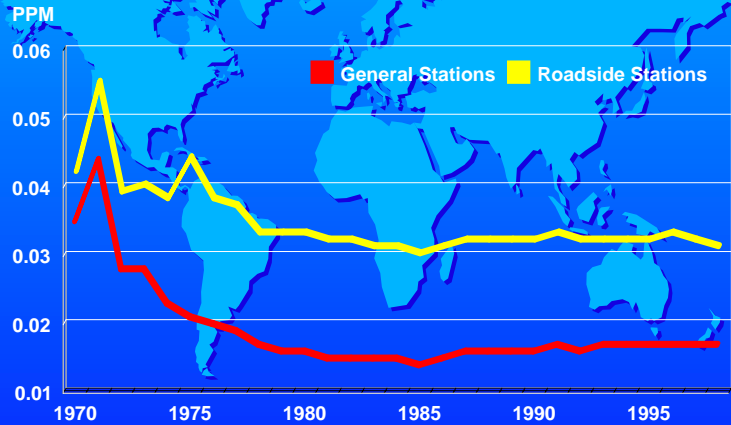
Serious Ozone Air Pollution Problems Remain in the US

- ~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

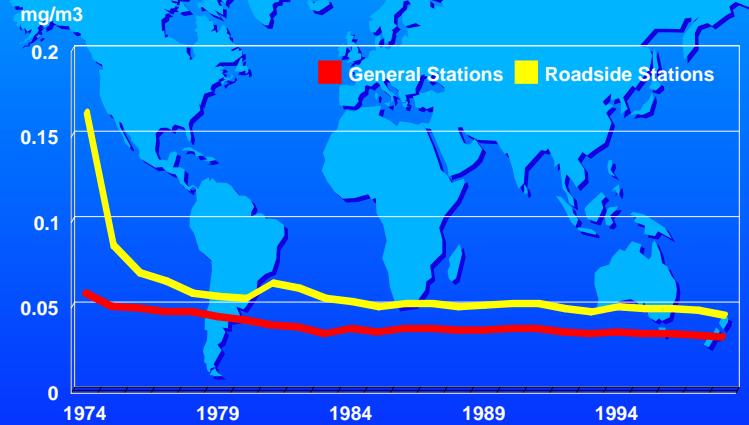
Ozone Problems in Europe in 1998 Number of Days over the Limits

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

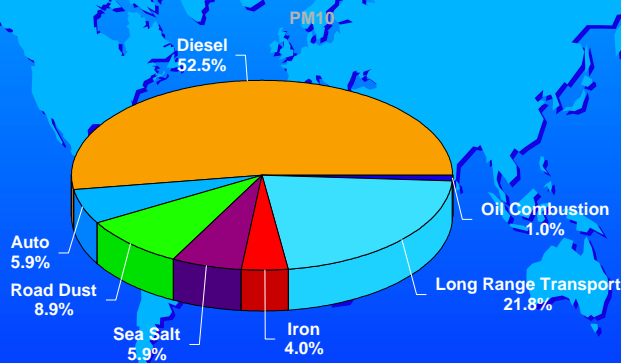
Nitrogen Dioxide Air Quality Trends In Japan



Suspended Particulate Matter Air Quality Trends In Japan

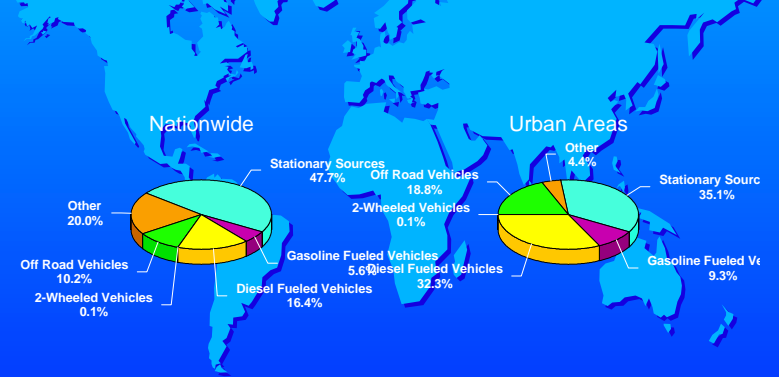


Average Source Contribution To Midtown Manhattan Site

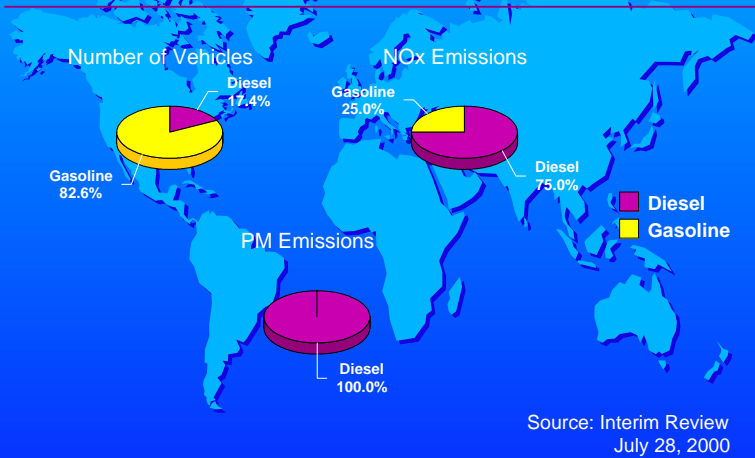


Chemical Mass Balance
AWMA 94-WP91.01

NOx Emissions From Various Sources in Japan (Tons/Year)



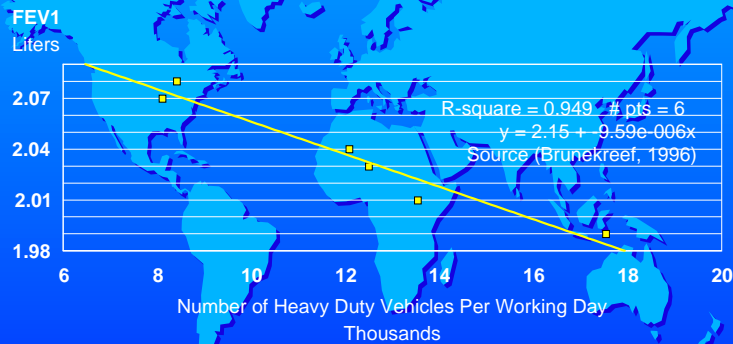
Emissions From Vehicles in Japan



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

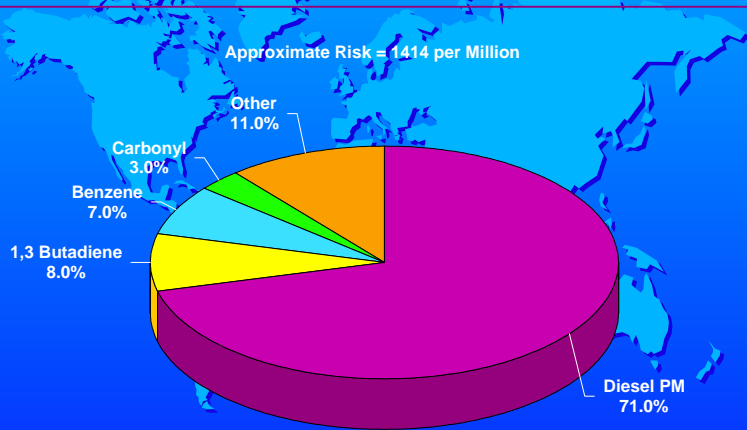
Association Between Lung Function of Children Living <300 Meters From Motorway and Intensity of Cargo Traffic



1998 CARB Assessment of Diesel PM Toxicity

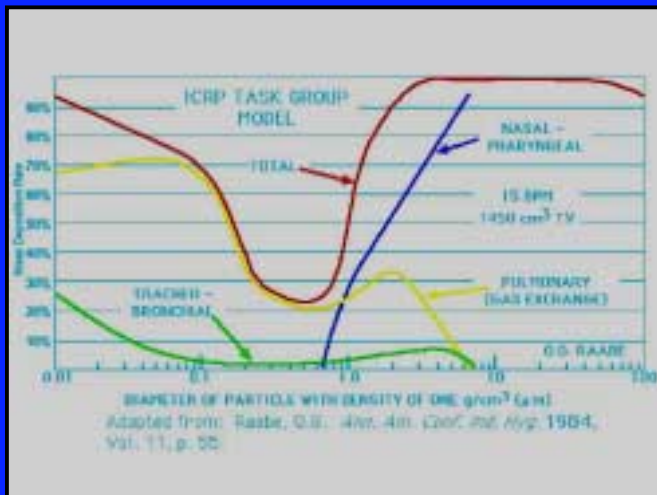
- 30 Human Epidemiological Studies Found Link Between Diesel PM & Lung Cancer
- Diesel PM Declared "Toxic"
- STAPPA/ALAPCO Report - ~125,000 Excess Cancers in US From Diesels

Average Los Angeles Basin Cancer Risk Apportionment

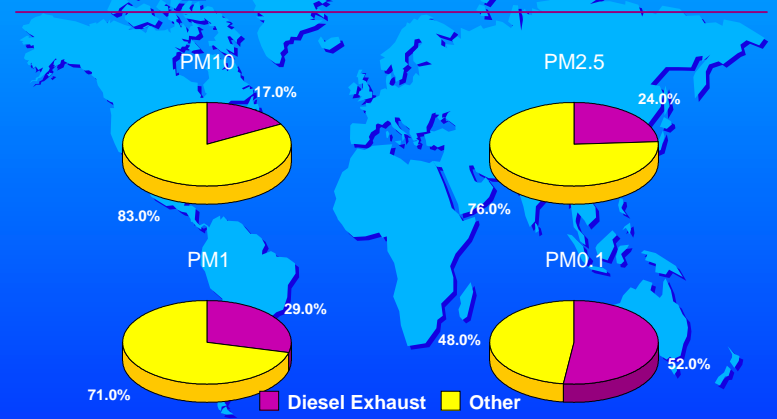


EPA Diesel Health Assessment Document - August 2000

- 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



PM Emissions in the UK - 1996

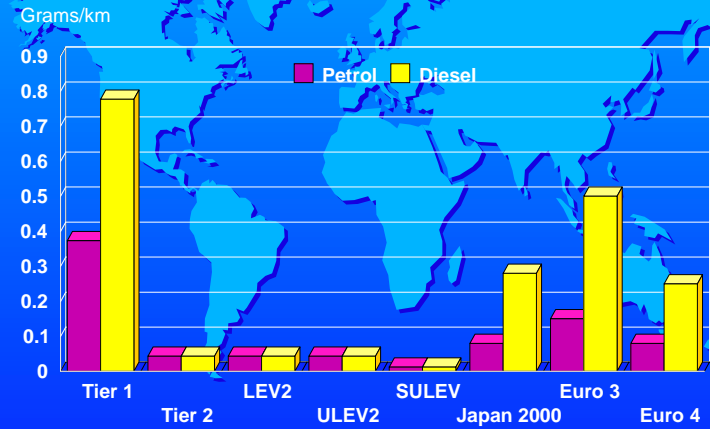


"Source Apportionment of Airborne Particulate Matter in the United Kingdom"

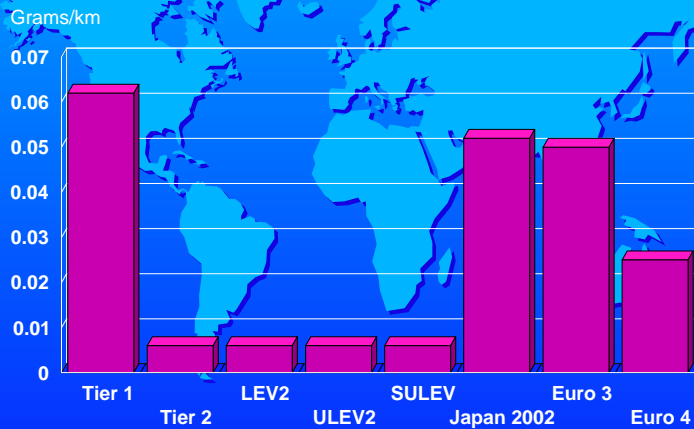
Diesel Challenges Around World

- Substantially Reduce PM
 - Mass
 - Number
 - Toxicity
- Substantially Reduce NOx
 - Ozone Control
 - Secondary PM
 - Acidification

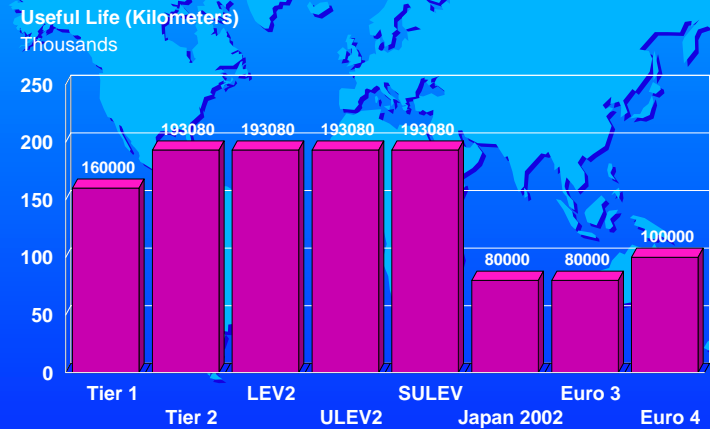
Global Trend in Light Duty NOx Control



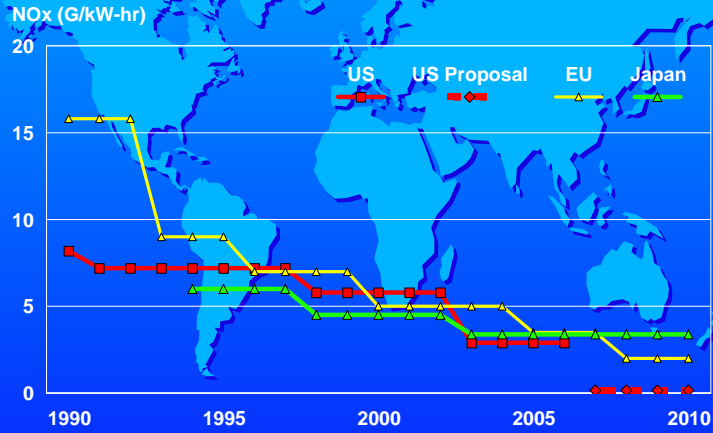
Global Trend in Light Duty Diesel PM Control



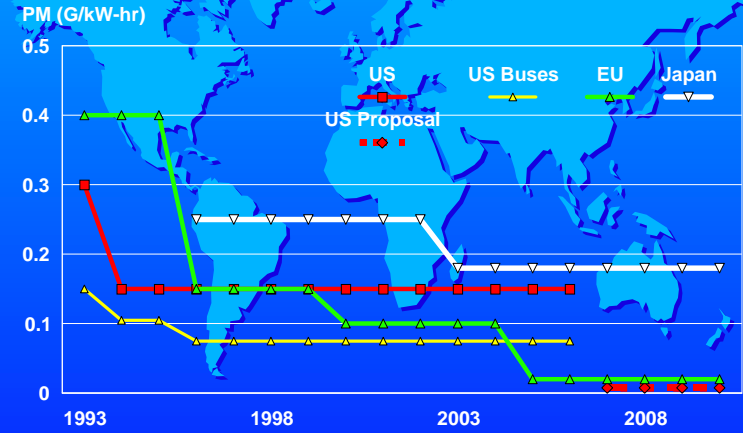
Global Trends in Car Durability Requirements



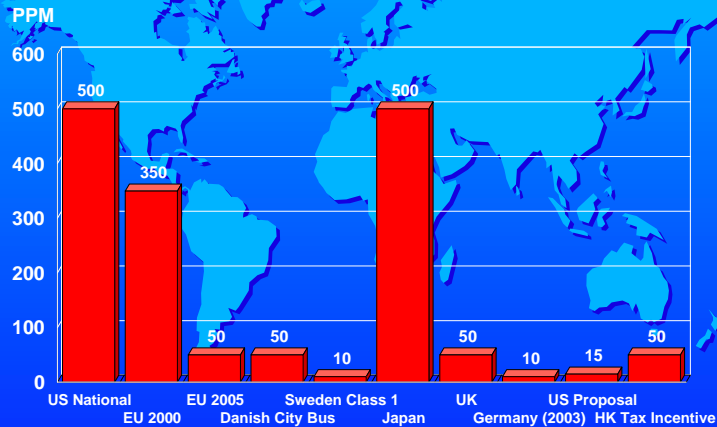
Global Trend in Heavy Duty Vehicle Emissions



Global Trend in Heavy Duty Vehicle Emissions



Diesel Fuel Sulfur Specifications



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 "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)

Open Issues in Europe

- Is 50 PPM Sulfur Low Enough?
- Will Filters or Traps Be Used Across the Board To Meet PM Standards?
- If Not, Implications
 - For Ultra Fine PM?
 - For Toxic Emissions?
- Should Light Trucks 2 & 3 Be Tightened to Car Standards?
- Should Light Duty Diesel NOx Be Tightened To Gasoline NOx Standards?

US Overview

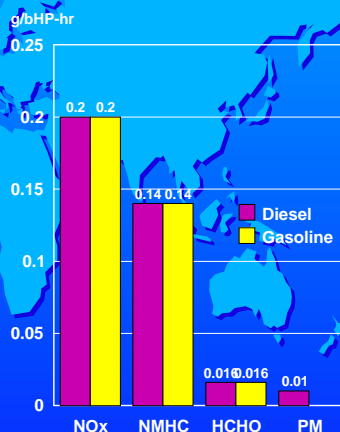
- CA Adopted LEV2-2004; Diesel=Gasoline; SUV = Car
- Federal "Tier 2" Standards Adopted; Diesel=Gasoline; SUV = Car
- Massive Heavy Duty Diesel Enforcement Action Stimulating Program
- Tighter HD PM & NOx Standards Proposed
- Lower Sulfur in Diesel Fuel Proposed

Problems With US Truck Program

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

EPA Proposed 2007 Requirements

- NOx - 4 year Phase-in
- 15 PPM Sulfur - July 2006
- No Crankcase Emissions
- Add Euro Test, OBD, Not To Exceed Provisions



Latest Developments in Japan

- Tokyo Government & Courts Pushing For Faster Action on PM
- Shift from NOx to PM Priority Control
- 2007 Diesel Standards Brought Forward; Likely New Heavy Duty Transient Test
- Low Sulfur Fuel (< 50 PPM) Before 2005
- Aggressive Retrofit Program Being Evaluated For Tokyo
 - Low Speed Driving Conditions
 - Low Sulfur Fuel
 - NO to NO2 Shift

Tokyo Five Step "Diesel NO" Proposal

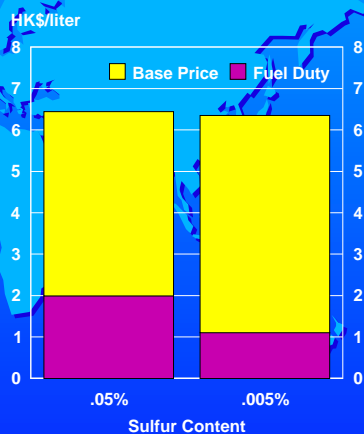
- Ban on Sale and Use of Diesel Cars
- Tighter New Vehicle Standards Brought Forward
- Shift Tax Benefit Away From Diesel Fuel
- Stimulate Advances in Technology To Control Existing Diesels and Require its Use
- Diesel Commercial Vehicles Replaced By Gasoline Where Possible

Major Retrofit Effort Emerging

- Europe
 - Major Cities in Sweden
 - Germany
 - UK
- US
 - California
 - Northeast States (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; Low Sulfur Fuel in Delhi
- Taiwan Forced To Allow Diesel Cars; Looking at Stringent PM Standards

Conclusions

- Progress on New Vehicle Controls Occurring Worldwide
- Low Sulfur Fuel Spreading Rapidly
- Aggressive Retrofit Efforts Underway
- Remaining Questions:
 - Is Europe Finished or Will Tighter Fuels/Vehicle Standards Be Needed?
 - Will US EPA Proposal Prevail?
 - How Successful Will Global Retrofit Efforts Be?