Global Trends in Heavy Duty Diesel Emission Regulation: A 2004 Update

Windsor Workshop
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Health Effects From Diesel Emissions Beyond Dispute

- WHO Concludes ~ 800,000 Premature Deaths Each Year From Urban PM; Diesels One Major Source
- Numerous Studies in Europe & US Consistently Link PM With Premature Deaths, Hospital Admissions, Asthma Attacks, Etc.
- No Evidence of a Threshold
- Ozone Also A Serious Health Concern To Which HDE NOx Contributes

The Role of Trucks in Japan

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 ~18Months 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
Dutch Study Links Proximity To Truck Traffic With Lung Function
Brunekreef, Epidemiology 1997; 8: 298-303

Relative Cancer Risks From Air Pollutants in Los Angeles

Based on ARB monitoring data 1995 - 1997

Typical engine exhaust mass and number weighted size distributions shown with alveolar deposition

ARB In-Vehicle Study Real-Time Fine Particle Counts
(L.A. Freeway, AM Rush Hour, Vent Open)

Time (120 minutes)

Outside Vehicle 1
Inside Vehicle 1
Concerns Continue To Be Raised Regarding Impact of Soot On Climate

- Soot Deposited On Snow Reduces Its Ability To Reflect Sunlight
- Soot May be Twice as Effective as Carbon Dioxide in Forcing Global Warming

James Hansen and Larissa Nazarenko

International Emission Regulations: - Heavy-duty vehicles (GVW>3.5t) -

- Nitrogen oxides (NOx)
- Particulate matter (PM)

Close Linkage Between Vehicle Emissions Standards and Fuel Sulfur Levels

European Fuel Sulfur Levels (PPM)
Desulfurizing Fuels in Japan

- **1953**: 1.2%
- **1976**: 0.5%
- **1992**: 0.2%
- **1997**: 0.2%
- **2003 '05-'07**: 0.2%
- **2005 '05-'08**: 0.2%
- **2007**: 0.2%

**Gasoline**
- 100 ppm
- 50 ppm
- 20 ppm
- 5 ppm

**Diesel Fuel**
- 500 ppm
- 50 ppm
- 10 ppm

**Desulfurizing Fuels in Japan**

Environmental performance target for next-generation EFVs in Japan

- **2010 Target**
  - **Fuel-efficiency target**: To maintain present level of diesel vehicles
  - **Exhaust emissions target**: NOx: 1/10 of 2005 target
  - **PM**: Nearly zero

**Next Generation EFVs to be Developed by 2010 and to be Disseminated by 2020**

**Technical Targets**
- 1/10 of 2005 Diesel NOx
- Std. (0.02 g/kWh)
- Nearly Zero PM
- Diesel-Like Efficiency

**Vehicle Types**
- *Hybrid Vehicles*
- *CNG & DME Vehicles*
- *Super Clean Diesels*
- *FC Buses*
South Korea

- Vehicle Standards
  - Diesel Vehicles – Euro 4 by 2006
  - 50% Tighter by 2010
- Fuels
  - Diesel S from 430 to 30 by 2006
- “Clean” Vehicle Incentives – (50-75% Lower)
  - Mandatory For Public Agencies
  - Economic Incentives For Others

Taiwan

- From July 1999, US 94 Heavy Truck & Diesel Light Truck Standards Were in Effect
- On 1 January 2007:
  - US 2004 HD Standards Apply; EU Heavy Duty Standards Deemed Equivalent
  - Diesel S from 350 to 50

Final Engine Standards Program

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<td>500 ppm NR fuel</td>
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<td>25-75 PM</td>
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<td>75-175 PM</td>
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<td>PM: Tier 4</td>
<td>175-750 PM</td>
<td>100% NOx, 90%</td>
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Percentage of sales portion of each required to meet advanced emission control technology standards.

For Engines>750 HP, EPA Will Require PM Filters But NOx Controls
For Some Categories Still Under Review
Brazil

- Heavy Duty Trucks & Buses
  - Euro 3 Phased in 2004-2006
  - Euro 4 in 2009
- Fuels
  - Diesel Fuel S in City from 2000 to 500 in 2005 & to 50 in 2009; on rural areas from 3500 to 2000 in 2005 & to 500 in 2009

Mobile Sources Program In Mexico

- Tighten emission limits for new gasoline and diesel vehicles.
  - Gasoline:
    - Tier I first introduced in 1999 (US-EPA-94).
    - Tier II to be introduced in 2006, under discussion.
  - Diesel:
    - EPA-98 currently in place.
    - Standards for new diesel vehicles under discussion.
- Key Issue Is Fuel Quality

18 measures of High Impact (2001-2005) in Chile

- Renovation of buses:
  - Reduction of 75% PM10 and 40% NOx with the Urban transport plan
  - Retirement of 2,700 pre-EPA buses
  - Incorporation of low emission’s buses and post treatment systems starting year 2004
- Renovation of trucks:
  - EURO III and EPA98 Standards
  - Incorporation of post combustion treatment systems.
- New standards for light vehicles:
  - Tier I and EURO III Standards
- Dust Control:
  - Street dust control
  - Street pavement programs

- Fuel Improvement:
  - Diesel Quality from 300 to 50 ppm by 2004
  - Gasoline Quality improvement by 2003
  - Gasoline Quality improvement by 2005
  - Progressive regulations on firewood burning
- New industry standards:
  - SOx emission standards
  - Reduction program of SOx in major industrial processes
- Integrated System of Compensations and Tradable Emission Permits:
  - Emission shares of NOx in the industry
  - Emission shares of PM10 in industrial processes
  - A 150% emissions compensation for all new activities (industry and transport)

Consensus: Ultra Low Sulfur Diesel Is A Necessity

- PPM

- Key Issues: CO, SOx, PM10, Emissions in major industrial processes
  - Emission shares of NOx in the industry
  - Emission shares of PM10 in industrial processes
  - A 150% emissions compensation for all new activities (industry and transport)
Consensus: Diesel PM Filters
Technology of Choice
- Over 500,000 New Cars in Europe
- Retrofitted on Thousands of Vehicles Worldwide (e.g., Sweden since ‘96)
- Will Be On Most New Diesel Vehicles in Japan by 2005
- In US, International Already Certified & Cummins & Caterpillar On Track For 2007

Europe & US Diverging On NOx Control
- DeNox Catalysts
  - Seems To Be EPA’s First Choice in US
  - Are Where They Need To Be At This Point According To Independent Diesel Review Panel – No Show Stoppers!
  - Will Likely Not Be Needed in the US Before 2010
- SCR
  - Is First Choice in Europe
  - Fuel Economy Benefits Attractive
  - Infrastructure Remains A Concern To US EPA But Significant Efforts Are Underway
  - Also Concern Over Placing Refueling Responsibility on Truckers

Conclusions
- Diesel PM & NOx Remain Major Concerns
  - PM 0.1 & PM 0.1 & Ultrafines
  - Ozone
  - NOx
- Special Concerns With Diesel PM
  - Small Size
  - Toxicity
- Stringent New Diesel Standards and Low Sulfur Fuel Requirements Spreading
- PM Filters Seen As Key To Control; Different NOx Controls
- Europe and Japan Considering Additional Heavy Duty Truck Standards
- Non Road & Retrofit – Unfinished Agenda