

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

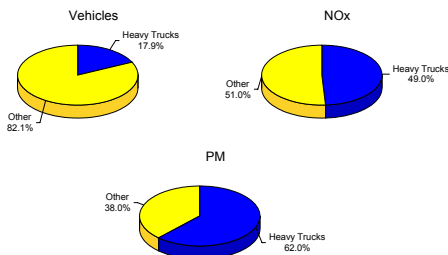


**Windsor Workshop**  
June 14, 2004  
**Michael P. Walsh**  
International Consultant

## 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

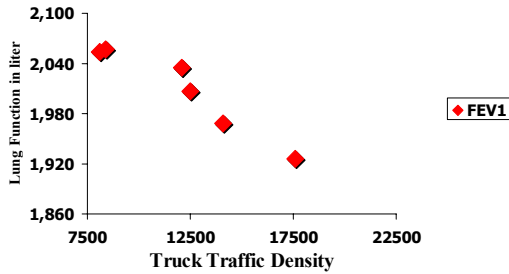


## PM<sub>10</sub> Study in Europe (Lancet Medical Journal – September 2, 2000)

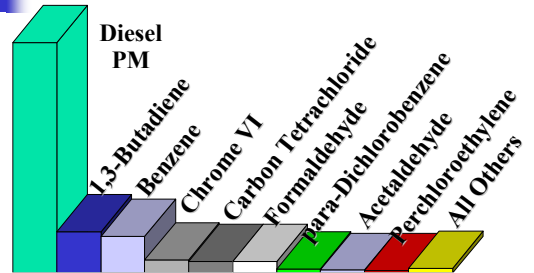
- ~6% of all deaths from PM<sub>10</sub>
- ~40,000 deaths per year in Austria, France, Switzerland; 2 times traffic fatalities
- Motor Vehicles Responsible For ~50%
- People in Cities Die ~18Months Earlier Than They Otherwise Would
- Over 300,000 cases of chronic bronchitis; 500,000 asthma attacks; 16 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

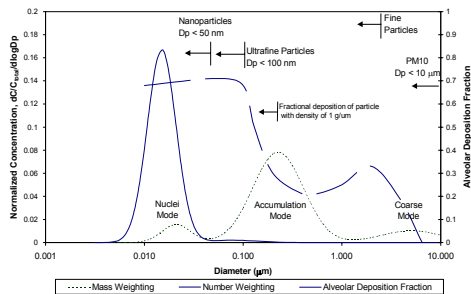


### Relative Cancer Risks From Air Pollutants in Los Angeles



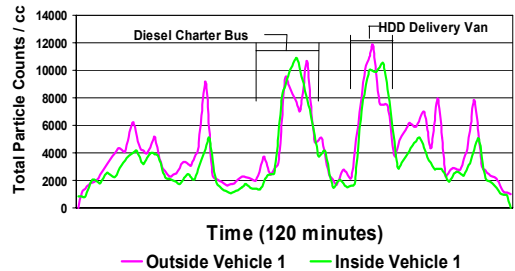
Based on ARB monitoring data 1995 - 1997

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

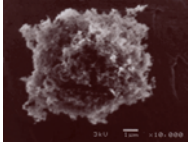


### ARB In-Vehicle Study Real-Time Fine Particle Counts

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



## Concerns Continue To Be Raised Regarding Impact of Soot On Climate



- Soot Deposited On Snow Reduces Its Ability To Reflect Sunlight

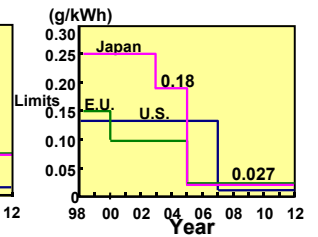
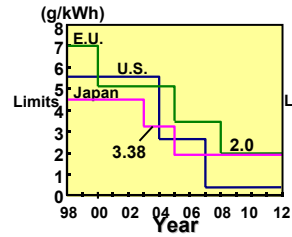
- Soot May be Twice as Effective as Carbon Dioxide in Forcing Global Warming



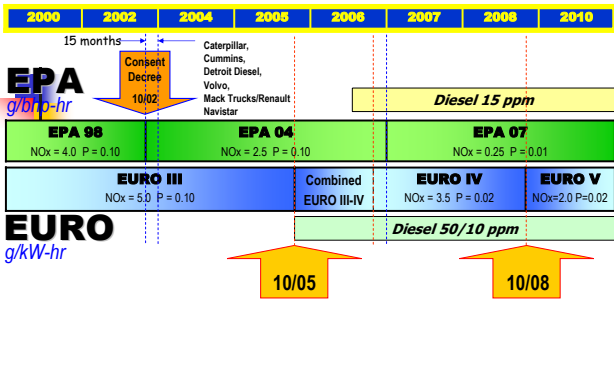
James Hansen and Larissa Nazarenko

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

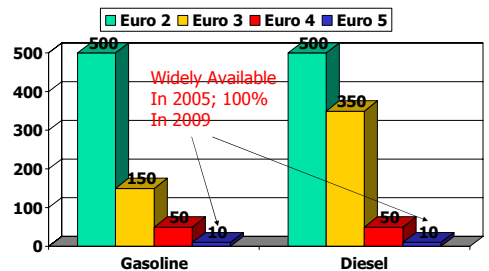
- Nitrogen oxides (NOx)
- Particulate matter (PM)

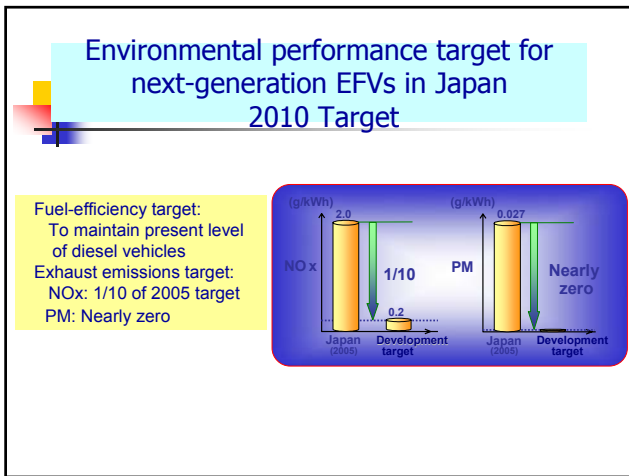
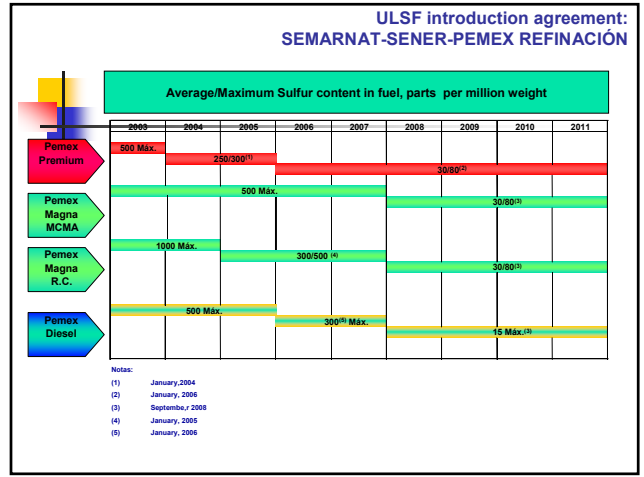
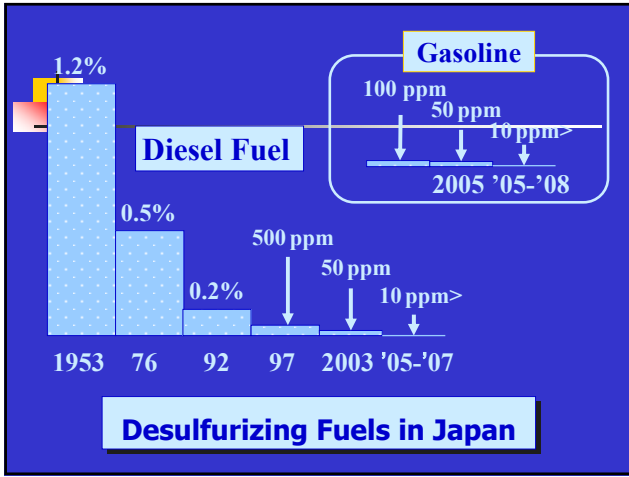


## Close Linkage Between Vehicle Emissions Standards and Fuel Sulfur Levels



## European Fuel Sulfur Levels (PPM)





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

**Heavy-Duty Vehicles**

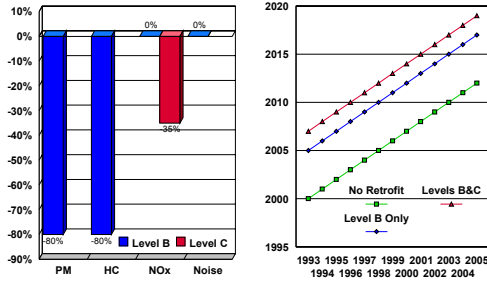
**Technical Targets**

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

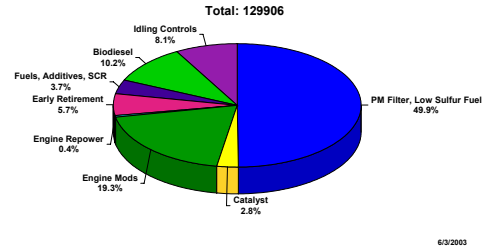
**Vehicle Types**

- \* Hybrid Vehicles
- \* CNG & DME Vehicles
- \* Super Clean Diesels
- \* FC Buses

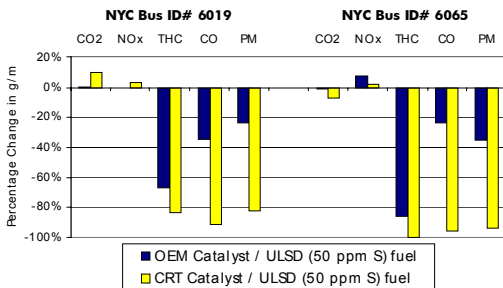
## Swedish Retrofit Program All Trucks Above 3.5 Tons



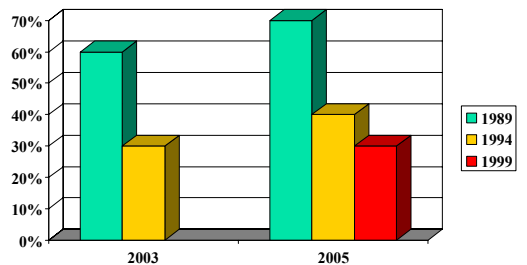
## Status of US EPA's Voluntary Diesel Retrofit Program



## New York City Retrofit Experience



## Retrofit PM Reduction Required For Device Consideration in Tokyo





### Final Engine Standards Program

hp	500 ppm NR fuel							15 ppm NR fuel							
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015			
<25	Tier 1	PM (reductions w/oxidation catalysts or engine-based control)													
25-75	existing Tier 2	PM (reduction w/oxidation catalysts or engine-based control)							PM: 100% NOx						
75-175	existing Tier 2	existing Tier 3							PM: 100%		NOx: 50%		50%		100%
175-750									PM: 100%		NOx: 50%		50%		100%

Percentages indicate portion of sales 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

- ## 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

## 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

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

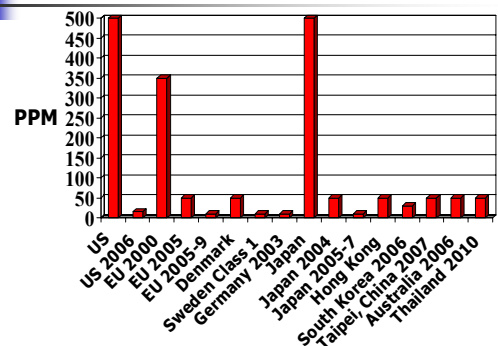
- Renovation of buses:
  - Reduction of 75%PM10 and 40% NOx with the Urban transport plan
  - Retirement of 2,700 pre-EPA buses
  - Incorporation of low emission's buses and **post treatment systems starting year 2004**
- Renovation of trucks:
  - EURO III and EPA98 Standards
  - **Incorporation of post 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:
  - CO emission 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 )

## 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

## Consensus: Ultra Low Sulfur Diesel Is A Necessity



## 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<sub>10</sub> & PM<sub>2.5</sub> & Ultrafines
  - Ozone
  - NO<sub>2</sub>
- 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

