Worldwide Evolution of Diesel Emissions Standards

3rd Aqius & Aaiqus Paris Forum
September 28, 2004
Michael P. Walsh
International Consultant

Environmental Drivers

- No serious debate regarding diesel PM control
  - Only question is when PM number will be controlled
- No serious debate regarding NOx control
  - Ozone
  - Secondary PM
  - Acidification/Eutrophication
- Some debate regarding greenhouse impacts
  - CO2 very good
  - Black carbon negative

Status of New Vehicle Controls

- US largely finished for a while at least
  - Cars, Trucks, most off road done
  - Locomotive & Marine Still To come
- EU major push next 2-3 years
  - Car, truck proposals due 2005
  - Tax incentives
  - Non road likely tightened
- Japan will also go to next steps
- Developing countries following EU/US with significant lag

Light Duty Vehicle NOx Standards (g/km)
Light Duty Vehicle PM Standards (g/km)

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

Climate Forcings

Watts Per Square Meter

Aerosol Effects Are Not Known Accurately

Euro 5 Scenarios Proposed By Commission For Diesel Cars

% Reduction From Euro 4
International Emission Regulations:
- Heavy-duty vehicles (GVW>3.5t) -

Nitrogen oxides (NOx) Particulate matter (PM)

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

Ultra Low Sulfur Diesel Fuel Is Spreading

ULSF introduction agreement:
SEMARNAT-SENER-PMEPEX REFINACIÓN

Average/Maximum Sulfur content in fuel, parts per million weight
Lubricating Oil Specifications Change For Aftertreatment Compatibility

- Reduce ash to enable extended maintenance intervals on the diesel particulate filter
- Maintain other properties at current levels for backward compatibility
- Cost impact expected to be negligible

US Final Engine Standards Program

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Percentages indicate portion of sales required to meet advanced emission control technology standards.

Existing Vehicles Receiving Great Attention Worldwide

- Major retrofit programs underway in US including California, Europe, Japan
- Retrofit demonstrations in Mexico City and Bangkok
- Increasing attention to diesel I/M with loaded tests
- Some developing countries limiting vehicle lifetimes
New York City Retrofit Experience

Technologies Are Advancing Rapidly

- PM Filters Are A Reality For Both Light and Heavy Duty Vehicles
- Major Efforts on NOx Controls Underway
  - Combustion Improvements
  - EGR
  - SCR
  - DeNox Catalysts
  - NOx Adsorbers
  - Different Solutions May Apply to Different Markets/Vehicles

NOx Reduction Options

- Engine-Out NOx Measures Reduce Size / Cost of Aftertreatment
- Aftertreatment Options need to be Evaluated for Maturity and Cost
- Combination of Engine Out and Aftertreatment may Provide Best NOx Reduction Value Path

The Path Toward 2007

- Development engines begin running
- Initial Summer testing of 2007 engines
- Winter Testing of 2007 engines / vehicles
- Emission certification and Deterioration demonstration
- 80% Production of 15 ppm fuel
The Challenge for On-Highway Trucks

- Ultra Low Sulfur Diesel Fuel
- Particulate Reduction with the use of Particulate Filters
- On-Board Diagnostics
- New Lubricating Oils Compatible with Aftertreatment
- Manufacturer Run In-Use Emission Testing
- Closed Crankcase
- NOx Reduction with Increased EGR rates
- Additional Maintenance Requirements
- Anti – Idling Requirements

The Testing Program

- Assess in-use exhaust emissions using portable emission measurement systems for NTE compliance.
- Applicable to 2007 and late model-year engines.
- Testing to be conducted on: -on in-use vehicles. -under real-world driving conditions, -within useful life of engine
- Emissions to be measured are: NOx, HC, CO, and PM
- Testing to be conducted and paid for by manufacturers
- Pilot testing for 2005-2006 model years
- Nonroad program modeled after on-highway

One Manufacturers (DDC) Global Technology Perspective

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Conclusions

- Diesel PM & NOx Remain Major Concerns
  - PM10, PM2.5, & Ultrafines
  - Ozone
  - NOx
  - Special Concerns With Diesel PM
    - Small Size
    - Toxicity
- Stringent New Diesel Standards and Low Sulfur Fuel Requirements Spreading
- DPF Filters Seen As Key To Control: Different NOx Controls
- Europe and Japan Considering Additional NOx Controls
- Europe and Japan Considering Additional New Vehicle and Engine Standards
- Non Road & Retrofits – Unfinished Agenda