Clean Diesel Progress

STAPPA – ALAPCO

Fall 2003 Membership Meeting

US EPA Office of Transportation and Air Quality

October 20, 2003
Presentation Overview

- Progress toward 2007 Highway
- Diesels in Tier 2
- Nonroad Diesel Proposal
- Locomotive and Marine ANPRM
Heavy-duty Highway Diesels
Nationwide Heavy-Duty NOx Emissions

![Graph showing NOx emissions from 2000 to 2030 with and without new standards.](graph_image)

- Without new standards, NOx emissions have decreased significantly from over 5 million tons in 2000 to around 2 million tons in 2020.
- With new standards, emissions have continued to decrease, reaching just over 1 million tons by 2020.

The graph indicates a steady decline in NOx emissions with new standards, suggesting effective implementation of emission regulations.
Nationwide Heavy-Duty PM Emissions

[Graph showing PM 10 emissions over calendar years with and without new standards]
2007 Highway Diesel Program

- 90% + Aftertreatment based standards
- Enabled through 90% + diesel fuel sulfur control
- Monetized benefits: $70 B/yr vs. Costs of $4.3B/yr
  - Over 8,300 premature deaths
  - Over 750,000 respiratory illnesses
  - 1.5 million lost work days
Heavy-duty 2007:
Tracking Progress

- EPA undertaking a number of steps to ensure program goals are met:
  - Technology progress reviews
  - Company visits
  - In-house engine and systems testing
  - Participation in external test programs
  - 2002 Clean Diesel Independent Review
  - Refinery pre-compliance reports
  - Implementation workshops
**Progress Toward 2007:**

*Engine Status*

- **2002 ➔ 2003**
  - Focus has shifted from R&D programs to product development

- **Engine companies have reached or are approaching technology down-select for 2007**
  - PM Traps for PM
  - Multiple paths for Nox
    - Engine-out
    - Nox adsorber
    - Urea-SCR for HHDV

- **Most companies will make decision in 4th quarter 2003 or 1st quarter 2004**
Progress Toward 2007: Fuel Status

- Refiner/Importer Pre-Compliance Reports
  - Annual pre-compliance reports due June 1, 2003-05

- Most refiners will make final decisions 4Q2003, 1Q2004
  - Results thus preliminary

- June 2003 reports indicate...
  - Industry is On Target to Comply with 15 ppm Fuel Requirements
  - 15 ppm Fuel Will be Widely Available; >95% 15 ppm
  - Highway Diesel Fuel Supply Will be Sufficient

- EPA will summarize the results and publish a report soon
Projected Highway Diesel Fuel Production vs. Consumption

![Projected Highway Diesel Fuel Production vs. Consumption](image)

- **500 ppm sulfur**
- **15 ppm sulfur**
- AEO 2000 estimated demand
- AEO 2003 estimated demand

**Volume of Highway Diesel Fuel Produced/Imported (bbls/day)**

Light-Duty Highway Diesels
Diesel Progress Toward Tier 2

- Investigation of advanced diesel technology
  - Testing of prototypes vehicles from a number of LD manuf.s.
  - Gauge progress towards compliance with Light-Duty Tier 2 Standards
  - Gauge progress on NOx control technology
  - Will continue to publish results in technical papers
# Light-duty Diesels: Vehicles Tested

<table>
<thead>
<tr>
<th>Vehicle Type:</th>
<th>Vehicle-A (Toyota Avensis <em>DPNR</em>)</th>
<th>Vehicle-B</th>
<th>Vehicle-C</th>
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<tbody>
<tr>
<td>Vehicle Type:</td>
<td>Small station wagon</td>
<td>Small station wagon</td>
<td>Mid-size car</td>
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<tr>
<td>Power Transmission:</td>
<td>Front-drive, 5-speed manual transmission</td>
<td>Front-drive, 5-speed manual transmission</td>
<td>Rear-drive, 5-speed automatic transmission</td>
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<tr>
<td>Engine:</td>
<td>2 L, 4-cyl. Turbocharged, charge-air-cooled DI Diesel w/DOHC, 4 valves/cyl.</td>
<td>~2 L, 4-cyl. Turbocharged, charge-air-cooled DI Diesel w/DOHC, 4 valves/cyl.</td>
<td>~3 L, 6-cyl. Turbocharged, charge-air-cooled DI Diesel w/DOHC, 4 valves/cyl.</td>
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<tr>
<td>Power/Torque Rating:</td>
<td>81 kW @ 4000 rpm, 250 Nm @ 2000 rpm</td>
<td>N/A</td>
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<td>Fuel System:</td>
<td>Denso HPCR</td>
<td>N/A</td>
<td>HPCR</td>
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<td>Emission Control Systems:</td>
<td>DPNR system, cooled EGR,</td>
<td>NOx adsorption catalyst, PM-trap, diesel oxidation catalyst</td>
<td>NOx adsorption catalyst, PM-trap, diesel oxidation catalyst</td>
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<td>Catalyst Volume:</td>
<td>DPNR: 2.8 L, DOC: 2.0 L</td>
<td>N/A</td>
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<td>Inertia Weight (as tested):</td>
<td>1590 kg</td>
<td>1530 kg</td>
<td>1930 kg</td>
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Testing of 2 more vehicles is currently in process.
FTP75 PM (mg/mi) vs. NOx emissions (g/mi) for current and advanced technology light-duty diesel vehicles.
Nonroad Diesels
Widespread Need for Air Pollution Reductions

- 127 million people live in 353 counties that exceed the air quality standard for ozone or fine PM, or both.
- Diesel exhaust is likely to be carcinogenic to humans.
- Fine particles from diesel exhaust can remain in the atmosphere for weeks, and carry over hundreds of miles.
- Ozone has been shown to reduce yields of vegetables and field crops.
- Clean Air Act requires EPA to take steps to remedy regional haze in 156 pristine “Class I” areas.
Nonroad Proposal Overview

- Same systems approach as taken for highway
  - High efficiency advanced emission control technology enabled by diesel fuel sulfur control
- 500 ppm maximum sulfur nonroad, locomotive and marine diesel fuel in 2007
- 15 ppm nonroad fuel in 2010
- Engine standards representing reductions of \( >95\% \) PM and \( \sim 90\% \) NOx - Starting in 2011, fully phased in by 2014
  - Also new PM stds for small engines beginning in 2008
- Enhanced testing requirements to ensure in-use emissions reductions
- Even greater benefits than highway at lower cost
  - Benefits of $80 billion/year vs costs less than $2 billion/year
  - Prevent: 9,600 premature deaths
  - 16,000 nonfatal heart attacks
  - 1 million lost work days
## Proposed Engine Standards Program

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

- Marine: 2.5%
- Locomotive: 3.5%
- Nonroad equipment: 10%
- Low sulfur fuel (highway): 67%
- Home heating, etc: 17% not covered

covered by the proposal
regulated since 1993
not covered
Nonroad Feedback

- Published May 23, 2003
- 3 Public Hearings (NY, Chi, LA)
- Comment Period Closed August 20
- ~150,000 Written Comments
- ~120 Substantive
  - States, Enviros, Labor, Farming, Fuel Industry, Engine/Equip Industry, Construction, Mining, Rail
Nonroad Feedback

- Overall Very Positive
- Widespread support for Standards and Timing
- Substantial issues raised over
  - Large engine standards
  - Fuel Program Design
  - 15 ppm std. For Loco and Marine
- Comments received on many other specific technical issues

Plan to issue FRM next ~April
Locomotives and Marine Diesel
Locomotives and Marine Diesel

- This sector includes freight, switch, and passenger locomotives as well as recreational and commercial marine engines.
- 26% of NOx, 12% of PM Mobile Source Inventories by 2020 if not controlled.
Considering systems approach for future marine diesel and locomotive standards modeled after land-based nonroad
- Potential for large reductions if aftertreatment based standards are implemented in these categories

Loco/marine diesel fuel sulfur control options discussed in the land-based nonroad proposal
- Recent nonroad proposal would extend 500 ppm fuel sulfur cap to locomotive and marine engines
- Considering extending 15 ppm cap as well

Next Steps:
- ANPRM planned for Spring 2004 within the same timeframe as the nonroad diesel FRM
Category 3 Marine Engines

- Comprised of engines >30 liters/cylinder; primary use is ocean going vessels
- These vessels use a class of diesel fuel known as residual or bunker fuel
- Air quality concern is emissions in port and transit to/from port
- Most vessels are foreign flagged; to be most effective rules require international harmonization through International Maritime Organization
International Maritime Organization

- MARPOL Annex VI was adopted by IMO in 1997; enough countries will likely ratify the treaty for it to go into force in 2005
  - Ships over 130 kW built on or after Jan. 1, 2000
  - NOx emissions only; about 15% reduction from uncontrolled

- Ocean-going vessels use residual fuel with high sulfur content
  - Annex VI sets global cap at 45,000 ppm (4.5%)
  - We will implement the 4.5% sulfur cap on residual fuel after Annex VI goes into force

- Interagency group will be working through IMO to designate coastal areas in the United States as SOx Emission Control Areas
  - All visiting ships must then use low-sulfur fuel (<15,000 ppm) or use SOx scrubbers
Future C3 Actions

- New CAA rule to be finalized by April 2007 (regulatory deadline)
- We will also work with IMO toward more stringent international limits for NOx, SOx, PM
For More Information...

- 2007 Highway Diesel Rule:
  - http://www.epa.gov/otaq/diesel.htm

- Light-duty Diesel Testing:
  - SAE Paper 2002-01-2877 (Toyota vehicle only)

- Nonroad Diesel Proposal:
  - Copy of proposal and supporting documents are available from:
    www.epa.gov/nonroad/
  - Submitted comments are available at:
    www.epa.gov/epahome/edocket/