Port Equipment Yard Truck
Emission Reduction Demonstration

May 18, 2005
Sacramento, California
California Environmental Protection Agency

Air Resources Board

Demo Program Overview

♦ Combined POLA, POLB & ARB Project

♦ Program Components
  – Offroad certification type emission testing
  – Data logging for duty cycle data
  – In-Use emissions data (field testing)
Demo Program Components

♦ Certification Type Emission Testing
  – Yard truck chassis offroad certification type testing (Modified C1, 8 mode steady-state)

♦ Data Logging
  – Review existing duty cycle information
  – Perform additional data logging
    • 3 terminals, 12 trucks total
    • Yard duty and ship load/unload duty

♦ In-use Emission Testing
  – In-Use driving (simulated yard and loading duty)
  – Ride-along or pull-along emission measurement system

Certification Style Emission Testing

♦ Offroad Certification Type Emission Testing for Direct Comparison
  – 2004 onroad vs. 2004 offroad engines
  – Additional baseline emissions data
  – Alternative fueled yard trucks
    LNG and Propane
  – Emulsified diesel
## Emission Test Matrix

<table>
<thead>
<tr>
<th>Engine Type</th>
<th>Engine Size (Cummins)</th>
<th>Model Year</th>
<th>CARB Diesel</th>
<th>ULSD</th>
<th>Emuls. Diesel</th>
<th>Alt. Fuel</th>
<th>In-Use Testing (Ride-along)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (Typical In-use Equipment)</td>
<td>5.9L</td>
<td>2000</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>5.9L</td>
<td>1997</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Off-Road Engine</td>
<td>8.3L</td>
<td>2001 or 2002</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>New On-Road Engine</td>
<td>QSB 5.9L</td>
<td>2004</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Propane Fueled Engine</td>
<td>ISB 5.9L</td>
<td>2004</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
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<tr>
<td>LNG Fueled Engine</td>
<td>8.3 L</td>
<td>2005</td>
<td>1</td>
<td>1</td>
<td>1</td>
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</tr>
</tbody>
</table>

### Offroad Test Cycle- 8 Mode C1

**Table of test modes and weighting factors**

<table>
<thead>
<tr>
<th>Torque</th>
<th>100</th>
<th>75</th>
<th>50</th>
<th>25</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Speed</td>
<td>100</td>
<td>75</td>
<td>50</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>Intermediate Speed</td>
<td>100</td>
<td>75</td>
<td>50</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>Low Idle</td>
<td>15%</td>
<td>15%</td>
<td>15%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>C1</td>
<td>15%</td>
<td>15%</td>
<td>15%</td>
<td>10%</td>
<td>10%</td>
</tr>
</tbody>
</table>
Modified Test Cycle - 8 mode

Modifications to the C1 test cycle
- Increased the engine speed for the intermediate speed modes
  - Necessary to increase wheel speed during testing to achieve power levels in dynamometer
- Used wheel horsepower instead of engine horsepower in emission factor calculations
  - Wheel power is lower than engine power due to losses in transmission, etc.
  - May result in higher measured emission factors compared to certification data
  - Plan to use ECM data to estimate engine horsepower and recalculate emission factors

Offroad Certification Type Testing
Offroad Certification Type Testing

- Testing Performed By UC Riverside CE-CERT
- Using Mobile Emission Laboratory (MEL)
- Chassis Dynamometer at Johnson Machinery
- Trucks supplied by POLA terminals

Preliminary NOx data

‘04 ISB Onroad vs. ‘04 QSB Offroad

![Chart showing NOx emissions for ISB Onroad vs. QSB Offroad in different modes.](chart.png)
Preliminary THC data
‘04 ISB Onroad vs. ‘04 QSB Offroad

ISB Onroad vs. QSB Offroad THC

Preliminary PM data
‘04 ISB Onroad vs. ‘04 QSB Offroad

ISB Onroad vs. QSB Offroad PM
Certification Information

‘04 ISB Onroad vs. ‘04 QSB Offroad

Tier 2 Nonroad Emission Standards

<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>g/bhp-hr</td>
<td>g/bhp-hr</td>
<td>g/bhp-hr</td>
<td>g/bhp-hr</td>
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<tr>
<td>NOx +NMHC</td>
<td>4.8</td>
<td>4.25</td>
<td>2.4</td>
<td>2.3</td>
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<tr>
<td>PM</td>
<td>0.15</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
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</tbody>
</table>

Preliminary Results

‘04 ISB Onroad vs. ‘04 QSB Offroad

Weighted Emission Factors
(modified C1 8 mode)

<table>
<thead>
<tr>
<th></th>
<th>2004 QSB Offroad</th>
<th>2004 ISB Onroad</th>
<th>% Difference</th>
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</thead>
<tbody>
<tr>
<td>THC</td>
<td>0.16</td>
<td>0.05</td>
<td>69.4</td>
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<tr>
<td>NOx</td>
<td>5.54</td>
<td>2.45</td>
<td>55.8</td>
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<tr>
<td>PM</td>
<td>0.14</td>
<td>0.10</td>
<td>30.0</td>
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</tbody>
</table>
Next Steps

♦ Complete remaining certification type testing (May-June)
♦ Finalize data logging protocol and complete data logging
♦ Finalize In-use emission testing protocol and perform in-use testing

Contacts

♦ Bonnie Soriano (ARB)
e-mail: bsoriano@arb.ca.gov
phone: 916.327.6888
♦ John Lee (ARB)
e-mail: jlee@arb.ca.gov
phone: 916.327.5975
♦ Shokoufe Marashi (POLA)
e-mail: SMarashi@portla.org
♦ Thomas Jelenic (POLB)
e-mail: jelenic@polb.com

Web Site: http://www.arb.ca.gov/cargo