Utilizing Portable Emissions Measurement to Evaluate EPA Emerging Technologies

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The American Lung Association's State of the Air 2010 lists these 10 cities as the country's most polluted by ozone:

1. Los Angeles, Calif., metropolitan area (including Long Beach and Riverside)
2. Bakersfield, Calif.
3. Visalia and Porterville, Calif.
4. Fresno and Madera, Calif.
5. Sacramento, Calif., metropolitan area (including Arden-Arcade and Yuba City)
6. Hanford and Corcoran, Calif.
7. Houston, Texas, metropolitan area (including Baytown and Huntsville)
8. San Diego, Calif., metropolitan area (including Carlsbad and San Marcos)
10. Charlotte, N.C., metropolitan area (including Gastonia and Salisbury)

Emerging Technology Program

• **The Clean Diesel Emerging Technologies Program is an opportunity to advance new, cutting edge technologies that reduce diesel emissions from existing fleets.**

• Two components of the Emerging Technology Program:
  1. Technology manufacturer ➔ seek placement of their technology on the Emerging Technologies List.
  2. Grant competition ➔ eligible entity applies for funds to purchase an emerging technology.
## Emerging Technology List

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Technology</th>
<th>Application</th>
<th>Reductions (%)</th>
<th>Effective Date/Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caterpillar, Inc.</td>
<td>Urea-SCR and DOC</td>
<td>Locomotive</td>
<td>25 65 70 N/A</td>
<td>December 2, 2009</td>
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<tr>
<td>EcoPower Hybrid Systems Inc.</td>
<td>Hybrid System</td>
<td>Non-road Gantry Crane</td>
<td>25 30 0 0</td>
<td>December 8, 2009</td>
</tr>
<tr>
<td>Engine Control Systems</td>
<td>Urea-SCR</td>
<td>On-highway</td>
<td>25 65 85 85</td>
<td>March 27, 2009</td>
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<tr>
<td>Engine Control Systems</td>
<td>Active DPF</td>
<td>On-highway</td>
<td>90 N/A 80 80</td>
<td>July 9, 2010</td>
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<tr>
<td>Johnson Matthey</td>
<td>Urea-SCR and DPF</td>
<td>On-highway</td>
<td>90 65 95 85</td>
<td>April 9, 2009</td>
</tr>
<tr>
<td>Krystallon, Plc</td>
<td>PM Seawater Scrubber</td>
<td>Marine</td>
<td>50 0 50 0</td>
<td>December 8, 2009</td>
</tr>
<tr>
<td>Nett Technologies, Inc.</td>
<td>Urea-SCR</td>
<td>On-highway</td>
<td>25 65 60 60</td>
<td>March 26, 2009</td>
</tr>
<tr>
<td>Parker Hannifin Corporation</td>
<td>Hybrid Drive</td>
<td>On-highway - refuse</td>
<td>0 30 30 30</td>
<td>January 27, 2011</td>
</tr>
<tr>
<td>Delphi Corporation</td>
<td>Solid Oxide Fuel Cell (SOFC) Auxiliary Power Unit (APU)</td>
<td>On-highway - class-B tractors</td>
<td>N/A</td>
<td>January 27, 2011</td>
</tr>
<tr>
<td>Advanced Cleanup Technologies, Inc.</td>
<td>Advanced Maritime Emissions Control System (AMECS)</td>
<td>Marine</td>
<td>70 70 30</td>
<td>Pursuing Verification</td>
</tr>
<tr>
<td>Caterpillar, Inc.</td>
<td>Upgrade Kit 1</td>
<td>Marine</td>
<td>25 N/A N/A</td>
<td>Pursuing Verification</td>
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<tr>
<td></td>
<td>Upgrade Kit 2</td>
<td></td>
<td>25 21-29 N/A</td>
<td>Pursuing Verification</td>
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<tr>
<td></td>
<td>Upgrade Kit 3</td>
<td></td>
<td>25 41-49 N/A</td>
<td>Not Pursuing Verification</td>
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<tr>
<td>ESW Canada</td>
<td>DOC and CCV</td>
<td>Marine</td>
<td>25 0 25 70</td>
<td>Not Pursuing Verification</td>
</tr>
<tr>
<td>Johnson Matthey</td>
<td>Urea-SCR and DPF</td>
<td>On-highway</td>
<td>90 65 95 85</td>
<td>Verified</td>
</tr>
<tr>
<td>Miratech Corporation</td>
<td>DOC</td>
<td>Marine</td>
<td>25 0 50 70</td>
<td>Certified (EMD 710 engines)</td>
</tr>
<tr>
<td>Nett Technologies, Inc.</td>
<td>Urea-SCR</td>
<td>Non-road</td>
<td>20 65 60 60</td>
<td>Verified</td>
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<tr>
<td>Tinnerman/ Shadowood</td>
<td>LNT-SCR and DPF</td>
<td>On-highway</td>
<td>90 65 90 90</td>
<td>Pursuing Verification</td>
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<tr>
<td>Truck Emission Control Technologies Inc.</td>
<td>EGR and DOC/DPF</td>
<td>On-highway</td>
<td>50 40 60 70</td>
<td>Pursuing Verification</td>
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</tbody>
</table>
Project Information

Vehicle Selection → Data Logging → Retrofit Installation

Degreen Retrofit

Partially Age Retrofit

Degreened Test (#1): PEMS or Chassis

Partially Aged Test (#2): PEMS or Chassis

Continuous: Feedback and Reporting
## Vehicle Information

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Vehicle Type</th>
<th>Fleet Owner</th>
<th>Retrofit</th>
<th>Engine</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Asphalt Reclaimer</td>
<td>TxDOT</td>
<td>Urea-SCR</td>
<td>CAT</td>
<td>2004</td>
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<tr>
<td>2</td>
<td>Loader/Crawler</td>
<td>TxDOT</td>
<td>Urea-SCR</td>
<td>CAT</td>
<td>2000</td>
</tr>
<tr>
<td>1</td>
<td>Tractor/Crawler</td>
<td>TxDOT</td>
<td>Urea-SCR</td>
<td>CAT</td>
<td>2002</td>
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<tr>
<td>10</td>
<td>School Bus</td>
<td>HISD</td>
<td>Urea-SCR</td>
<td>CAT</td>
<td>2003</td>
</tr>
<tr>
<td>15</td>
<td>School Bus</td>
<td>HISD</td>
<td>LNT-SCR/DPF</td>
<td>International</td>
<td>2004</td>
</tr>
<tr>
<td>2</td>
<td>School Bus</td>
<td>HISD</td>
<td>EGR/DOC-DPF</td>
<td>CAT</td>
<td>2003</td>
</tr>
<tr>
<td>15</td>
<td>Dump Truck</td>
<td>TxDOT</td>
<td>EGR/DOC-DPF</td>
<td>CAT</td>
<td>2000</td>
</tr>
<tr>
<td>3</td>
<td>Aerial Utility Truck</td>
<td>TxDOT</td>
<td>EGR/DOC-DPF</td>
<td>CAT</td>
<td>2000</td>
</tr>
</tbody>
</table>

**Total Retrofits = 50**
Portable (PEMS) Testing Equipment

- (2) Semtech DS (pre and post).
  - NOx (NO+NO\(_2\)), CO, THC, CO\(_2\), O\(_2\)
- (2) Maha MPM4 (pre and post)
  - PM (mg/m\(^3\))
- NH\(_3\) sensor (post, NH\(_3\)-slip)
- Exhaust Flow Meter (post, SCFM)
PEMS Challenges – Non-Road

- No Shore Power
- Hours from Nearest Supply Shop
- Vehicle Differences/Dimensions
- Weather
  - Precipitation/Heat
- Light
  - Nighttime/Pre-dawn testing
- Other Ambient Conditions
  - Dust/Snakes
- Safety/Security
  - Personnel
  - Equipment
Preparation – Trailer
Preparation - Inventory

- Halogen flood lamps
- 4” flex subventing
- 3” and 4” exhaust clamps
- 3” and 4” elbows and reducers

TOTES
- 3” and 4” exhaust clamps
- 3” and 4” elbows and reducers
- Filters, including NHS DS
- Safety, hard hats, highway
- Clamps, ratchet
- Uni-start including hardware
- Electric
- Drags
- Metal brackets, shelving
- DS, with all peripheral devices
- Diagnostic bus rods and space harnesses
- 4900W Generator
- Nitrogen 2000 peq bottles
- FID Fuel 2000 peq bottles
- (2) Heads 2000 W Generators
- NHS test, vent, and sensor
- Fiberglass insulating wrap

NOTES:
- 3/4” metal tubing, 1/4” flexible tubing
- Creepers
- BS to Pin
- (2) Multi-position haldens
- Umbrellas
- Drinking water
- Aluminum foil
- Black divided paper tray
- Rainwater for van
- (2) Sure flashe disposal
- Gloves
- Spare fan outlets
- Emergency electrical paper
- Tape, duct, electrical, plastic
- Zip ties, small, medium, large, extra large
- Screw and bolt and nut screws
- Cementor1, 10V-30
- Thermo couple, connection wires
- Spare used 3/8” tubing in orange box
- DS cover, DS, shingle
- DS power supply and sample line
- Computer bag, computer, power cords, Diagnostic tablet, Diagnostic key, USB and SD card hankers

- Drawers
- Extension cords, 25’ (9.14 m)
- Fire extinguisher
- Sneeze small red toolbox

- 5:16 “ rubber hose
- Black rubber eggs
- Fuel filters and funnel
- WD-40
- 1 gal fuel can
- (2) 5 gal fuel cans

NOTES:
Preparation – Pallet Setup

- Maha 1
- Maha 2
- Semtech 1
- Semtech 2
- Generator 1
- Generator 2
- Power Supply
- Flow Meter
- Exhaust Flow w/Sample Lines
Asphalt Reclaimer – Duty Cycle

4 Different Modes

- Wait/Idle – low load
- Drive – mid load
- Mix – mid load
- Cut – high load
Data from PEMS Testing
Data from PEMS Testing

NETT off road - Corpus Christie Asphalt Reclaimer 1584G - NOx
Test Date 1/25/11

Red-Drive
Blue-Wait
Green-Mix
Purple-Cut
Data from PEMS Testing

<table>
<thead>
<tr>
<th>Component</th>
<th>Reduction (%) Unit # 1600</th>
<th>Reduction (%) Unit # 1584</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx</td>
<td>52</td>
<td>43</td>
</tr>
</tbody>
</table>

Data is weighted using Exhaust Flow rate
Summary

• Keys for successful testing
  • Preparation
  • Large amounts of data will help eliminate one-off errors
• Know the variables
  • Duty cycle
  • Vehicle differences
Future Work

• Complete further testing (100+ tests at the end of 4 projects)
• Further improvements in PEMS methodology

• Acknowledgement: EPA Emerging Technology Program