

U.S. EPA PEMS Measurement Allowance Program

Matt Spears, US EPA

Overview

- Background
- Measurement Allowance Test Plan Overview
- Error Model Overview
- Progress to Date
- Lessons Learned
- Next Steps



Background

- EMA/EPA/CARB settlement of NTE lawsuit led to U.S. EPA's HDIU rule.
- Industry agreed to a manufacturer run, in-use, on-road testing program.
- Builds on not-to-exceed (NTE) standard.
- Focus on compliance in the real world.
- Uses onboard emission measurement systems.



Background cont.

- HDIU rule proposed June 2004
- Finalized June 2005
 - Gaseous Emissions
 - Pilot 2005/06
 - Fully Enforceable 2007
 - PM Emissions
 - Pilot 2006/07, delayed one year
 - Fully Enforceable 2008, delayed one year



Background cont.

- Per the settlement, measurement allowances had to be determined for all regulated pollutants.
- A Memorandum of agreement (MOA) and test plan were put in place to jointly fund and direct testing to determine final values
 - EPA, ARB, and EMA
 - Cooperative funding and management of \$3M
 - 2-yr test plan at Southwest Research and Univ. of California @ Riverside, CA
 - Gaseous + PM
- The MOA addresses
 - Scope of program.
 - Schedule and location of testing.
 - Contributions by each party.
- The test plan addresses
 - Detailed experimental design.
 - Variability, environmental effects, chassis vs. on-engine comparison, etc.
 - Nominal NTE thresholds used in measurement allowance calculations
 - Exact algorithm for calculating measurement allowances
 - Monte Carlo simulation model
 - Steps required to validate model



NTE Thresholds Used in Program

Pollutant	g/hp-hr	g/kw-hr
NMHC	0.21	0.28
NO _x	2.0	2.68
CO	19.4	26.0

Based on 2007 Heavy-Duty Standards and NTE multipliers
(NO_x based on 1.3 g/hp-hr family emissions limit - FEL)



Emission Calculation Methods

- Method 1 ("Torque")

$$Method\ 1 = \frac{\sum g}{\sum Work} = \frac{\sum (concentration \times exhaustflow)}{\sum (speed \times torque)}$$

ECM Signals = Speed, Torque

Depends on accurate exhaust flow

- Method 2 ("BSFC")

$$Method2 = \frac{\sum g}{\sum \left[\frac{CB\ fuel}{BSFC} \right]} = \frac{\sum (concentration \times exhaustflow)}{\sum \left(\frac{exhaustflow \times concentration_{carbon} (HC + CO + CO_2)}{BSFC} \right)}$$

ECM Signals = Speed, Fuel (for BSFC)

Depends in linear exhaust flow

- Method 3 ("ECM Fuel Specific")

$$Method\ 3 = \frac{\sum \left[g \times \frac{ECM\ fuel}{CB\ fuel} \right]}{\sum Work} = \frac{\sum \left(\frac{concentration \times fuelflow}{concentration_{carbon} (HC + CO + CO_2)} \right)}{\sum (speed \times torque)}$$

ECM Signals = Speed, Torque, Fuel

No exhaust flow, ECM signals only

Measurement Allowance Test Plan Overview

- Key elements of the test plan are:
 - Comparison of 1065 compliant test cell measurement to PEMS via testing of three different engines (HHD, MHD, & LHD) over steady-state and transient NTE events.
 - Determination of PEMS susceptibility to environmental factors
 - Temperature, Pressure, Vibration, Wind (flow meter), EMI/RFI.
 - On-road validation of PEMS using CE-CERT Mobile Emissions Laboratory (MEL).
 - Replay of on-road validation tests at SwRI.
 - Development of error model based on results of test cell and environmental tests.
 - Evaluation of 3 BS emissions calculation methods.
 - This evaluation will result in brake-specific measurement allowances.



Error Model Overview

- Use Monte Carlo simulation in conjunction with three different BS calculation methods to determine measurement allowance.
- Measurement allowance will use the outcomes from the 3 calculation methods to select the “best” measurement allowances.
- Validation of model will occur via over the road & replay testing.

Progress to Date

- Testing is complete
- Measurement Allowances are determined
- Final Report nearly complete

Lessons Learned

- 1065 audits can be performed quickly (within a day) once audit rig is setup (time consuming part).
- High NO₂ concentrations are difficult to sample.
 - Water condensation in sample handling system can cause noticeable reduction in NO_x concentration
 - During audit, 1065.376 Chiller NO₂ Penetration Check
 - During engine tests
- Transient NTE cycles can be run in a laboratory setting.
- Multiple PEMS appear to perform similarly in test cell evaluation at SwRI.



Next Steps

- Develop and execute PM Measurement Allowance test plan according to MOA and new timeline
- EPA is committed to resolving the failure to validate Methods 2 and 3
 - Review error model inputs
 - Perhaps repeat validation testing
- EPA has authority to update measurement allowances in the future, as new information becomes available
 - Settlement document indicates that EPA may optionally revisit measurement allowances in 2010 timeframe; in anticipation of 2010 NOx standards
 - Settlement document indicates that measurement allowances are to encourage the procurement of the best available PEMS
 - Under the Clean Air Act, EPA generally has the authority to propose any changes to its own regulations



Questions?

- Thank you.

