US Engine Manufacturer Views on In-Use Testing

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Outline:

- In-Use emissions testing background
- EMA response to the US in-use test Final Rule
- The challenge of in-use testing
- NTE Threshold
- Pilot and enforceable program timelines
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- Sample equipment installation
- Issues/problems/concerns
- PM In-Use Pilot Program Concerns
- Conclusions

In-Use Emissions Testing Background

- Heavy-Duty In-use testing came into the regulatory area in the US as a result of the 1998 EPA Consent Decrees which stipulated Supplementary Emissions Tests (ESC) and Not to Exceed standards in addition to the traditional US HDOH FTP Transient Test for engine certification.

- The manufacturer run in-use testing program was a result of a cooperative settlement agreement in 2003 between EPA, CARB and EMA on certain provisions of the Not to Exceed Standards (NTE).

- The Final Rule on In-Use Testing Program for Heavy-Duty Diesel Engines and Vehicles program was announced in June 2005

In-Use Emissions Testing Background

- In-use emissions of diesel vehicles will be monitored using Portable Emissions Measurement Systems (PEMS) with NOx, HC, CO and PM being the pollutants to be measured.
- Measurement Accuracy Margins will be established to account for the emissions measurement variability associated with the PEMS in-use.
- A pilot program for both gaseous and PM was established for EPA and engine manufacturers to gain the necessary experience with in-use testing protocols and generation of in-use test data using PEMS.
- EPA will select engine families for the in-use test
- Engine Manufacturers will select vehicles based upon 7 EPA stipulated criteria and screening process – EPA has to approve selection
- Testing has to be completed within 18 months of engine family selection
- Vehicle and family pass/fail criteria need to be met

Engine Manufacturers Association's response to EPA's Final Rule on In-Use Emissions Testing

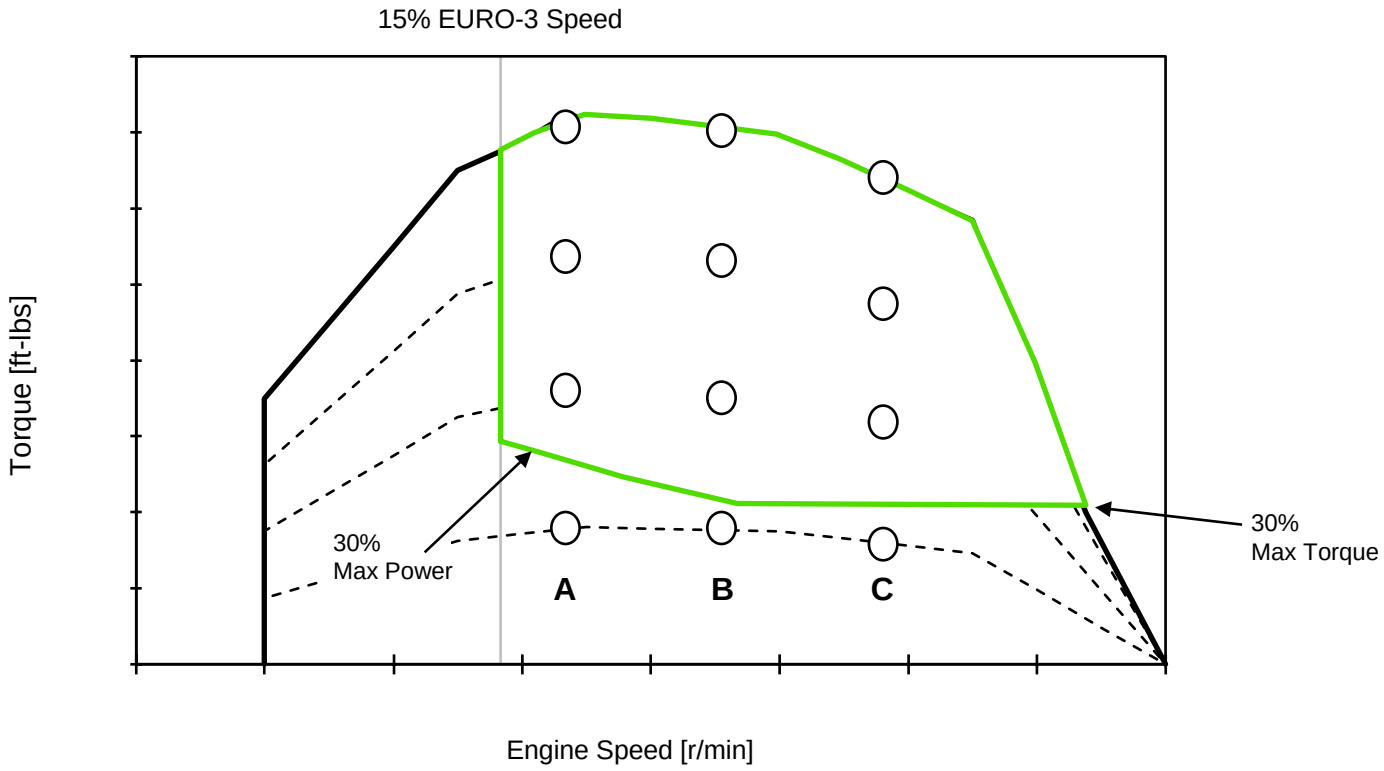
EMA's President stated:

- **The voluntary agreement to develop, conduct and fund a new in-use testing program demonstrates the continued strong commitment of diesel engine manufacturers to produce heavy-duty engine systems that reduce emissions and improve air quality in our cities and states.**
- **The agreement on an in-use testing program with EPA and CARB is truly a milestone for heavy-duty diesel engine manufacturers and cleaner air because it moves emissions testing from the laboratory into real-world operating conditions.**
- **The program not only will verify that near zero emissions levels measured under laboratory certification conditions are achieved on our streets and highways, but will also provide valuable feedback to engine manufacturers on any need to further improve and enhance emissions control systems.**

The Challenge Of In-Use Testing

- Engine manufacturers are up to the challenge of in-use testing.
- Some manufacturers may even look at in-use testing as a process where they could show comparative advantage compared to their competition.
- Engine design, mapping engine operating surfaces etc. could be challenging in order to satisfy NTE for in-use testing in the NTE zone for events as short as 30 second under a variety of engine driving operations and ambient conditions.
- What is additionally challenging is actually preparing for and conducting in-use test protocol with customer engines/vehicles and the PEMS

“Not to exceed” Zone



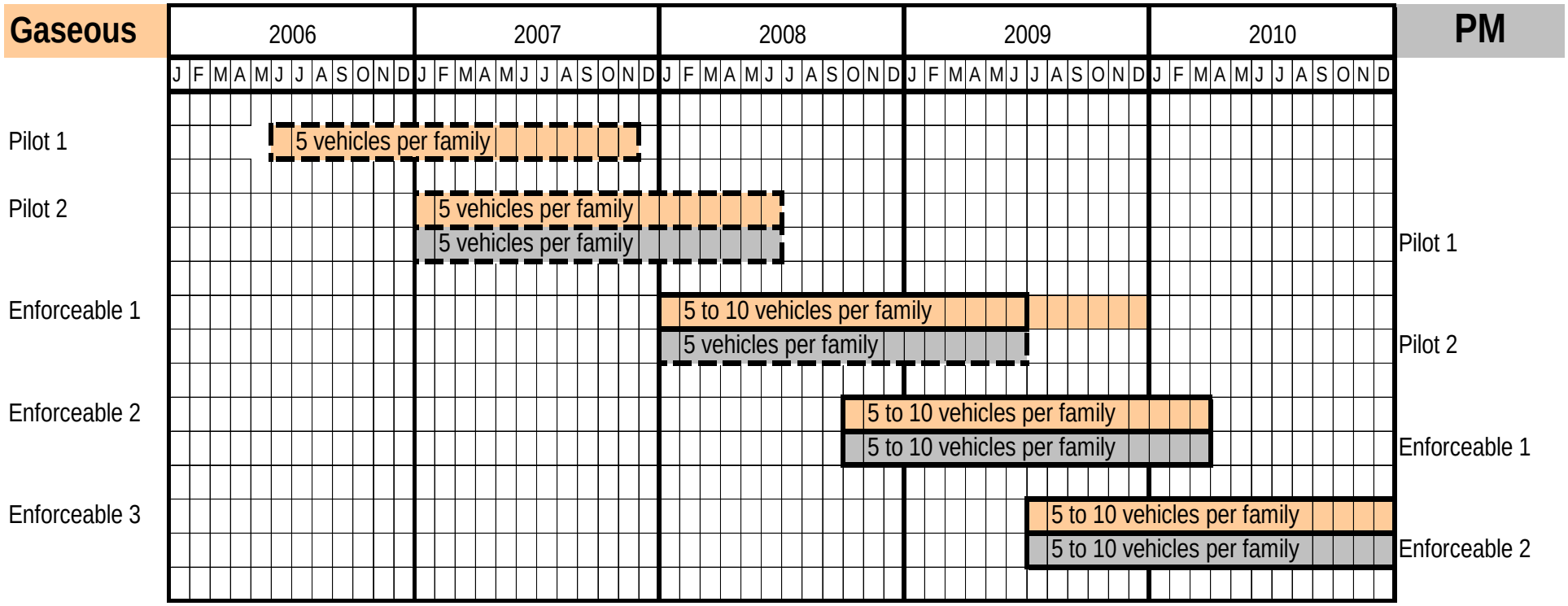
In-Use NTE Threshold Calculation

(FEL x NTE multiplier[1]) + (NOx meas. allowance[2]) + (NMHC meas. allowance[2]) = In-Use NTE Threshold[3]

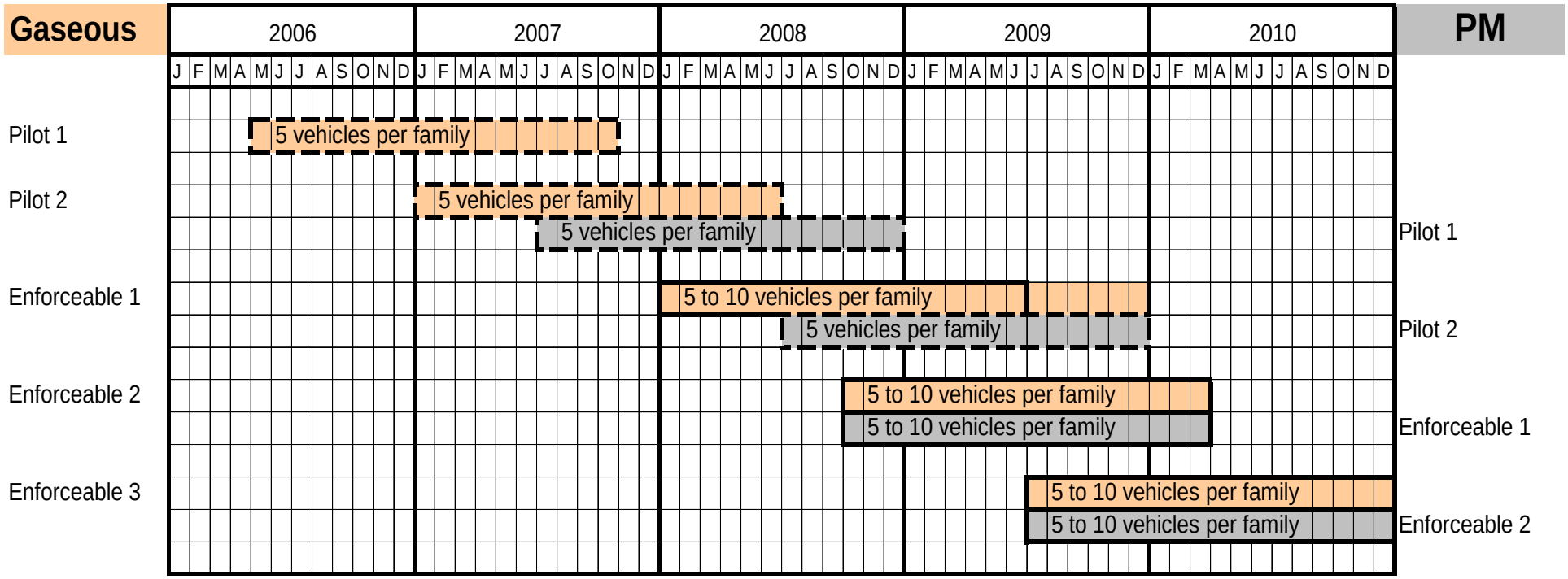
(2.5 g X 1.25) + 0.5 g + 0.17 g = **3.8 g/bhp-hr NOx + NMHC**

1. NTE Multiplier = 1.5 for FEL's < 1.5 OR 1.25 for FEL's > 1.5 86.007-11 (a)(4)
2. Measurement allowance values (0. 5 NOx, 0.17 NMHC) are temporary. Actual measurement allowance will be determined by conducting an MSA. EPA/EMA contracted Southwest Research Institute to conduct the MSA. Results have just become available (0.45 NOx, 0.02 NMHC, 0.5 CO) and will be implemented by a DFR. 86.1912 (a)
3. In-Use NTE Threshold is rounded to same significant digits as FEL. 86.007-11 (a)(4)(v)
4. There are other NTE provisions provided by EPA that need to be considered such as:
   - NTE Carve outs where NTE is excluded in the NTE zone
   - Special regeneration provisions
   - NOx and NMHC After treatment Warm up Provisions
   - NTE deficiency provisions
   - Cold Temperature Exclusion

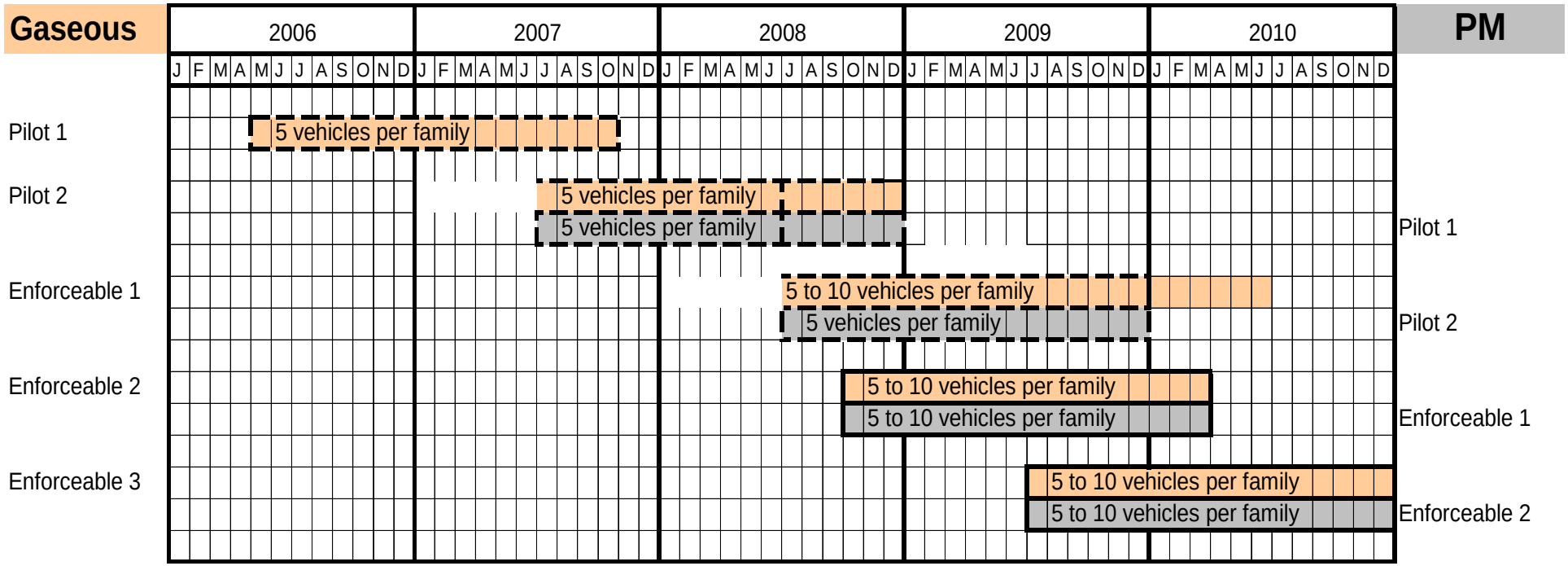
Manufacturer-Run In-Use Testing Program Schedule



Proposed Revision – Delay PM Pilot by six months



Align Gaseous with PM
EPA Re-Issues Engine Selection



In-Use Support Vehicle and Trailer

Test Equipment

Emission Analyzer
- 78 lbs
- 22” X 17” X 17”
- 12 ft sample line
- 360 – 720W Power Consumption

Portable Generator
- 50 lbs
- 20” X 11” X 17”
- 59dB

Installation Summary

- Emission analyzer is mounted in/on vehicle
- Data-link connection is made via in-cab data-link connector and/or engine harness
- Exhaust flow meter is installed in exhaust system in order to measure exhaust flow
- Heated sample line connected between flow meter and analyzer
- Analyzer is powered by either
  - Portable generator mounted on vehicle
  - Connecting to vehicle batteries

Sample Installation Pictures

Day Cab Class 8 Truck

Sample Installation Pictures

Analyzer in Cab – Passenger seat area

Front Discharge Cement Mixer

SEMTECH in vented enclosure

Bolted to rear fender

Powered with vehicle batteries

Urban Transit Bus

SEMTECH in vented enclosure

Reese hitch mounted to bus

Enclosure and generator mounted to hitch platform

Day Cab Class VIII Truck

Passenger seat removed – SEMTECH in cab

Heated line, GPS, weather probe, power cords passed through door window

Customer Vehicle Testing Issues

- Required to work around normal vehicle schedule
  - Results in long, irregular work hours
- Difficulty in locating customers
  - Some are eager to participate, others don't see it as beneficial to them
  - Once engaged in testing, they are usually cooperative and supportive
- Fleet schedule variability
  - Vague departure and/or arrival times
  - Miscommunication common at larger fleets
- First test at a given customer site is always the most difficult
- Test equipment takes up a lot of room. Semtech with environmental case, power supply, generator, EFM control box.
- Adding PM PEMS could make room availability and installation an important issue.
- Large quantity of equipment required for testing is problematic, forgotten equipment, bulk, spares.
- Long haul trucking requires following to remove equipment at next available stop.
- Must depend on driver to record some info, such as trailer VIN, weights. They just don't always do it.
- Limited or no troubleshooting time
  - Could result in a lost day of testing or questionable data

Some Gaseous PEMS Issues

- Field maintenance and calibration of the analyzers.
- THC measurement is cumbersome and expensive. Not sure of the benefit or use.
- Exhaust systems are difficult to un-assemble. We end up cutting them apart and replacing them.
- Leak checking heated emission line on vertical stack exhaust is problematic.
- Semtech can't be lifted by one person easily.
- Heated FID line is fragile and expensive.
- CFR linearization requirement is probably too stringent for In-Use equipment

Lessons Learned

- Start customer I.D. process as early as possible
- Communicate regularly with field network to speed up customer location
- Solicit multiple customers concurrently to minimize testing down time
- Verify ESN's, vehicle numbers, and truck mileage early in I.D. process
- Improved procedures / tools for exhaust stack removal
- Carry spare parts and consumables to prevent down time
  - Heated line
  - FID fuel
  - Weather probe
  - GPS receiver
  - Filters
  - Power supply
- Visit customer before test date to develop installation plan
  - Take pictures / measurements of vehicles
  - Specific fabrication or unique hardware requirements can be addressed ahead of time

PM Pilot Program Concerns

- EPA has already selected engines for the PM in-use Pilot program and the 18 month clock for obtaining and reporting in-use emissions data from customer engines has started.
- There is a potential of a six month delay of Pilot Program startup.
- EMA feels that there are too many questions that have yet to be answered before the pilot program can proceed.
- The most critical question is the readiness of a PM PEMS.
- EMA members have very little experience or familiarity with any PM PEMS nor do they have any information about its capability, commercial availability and delivery.
- The Memorandum of Agreement between EPA, CARB and EMA to develop emission measurement accuracy margins has a clause in it which states that “if fundamental, irresolvable technical problems are identified relative to PM portable emissions measurement systems, the PM portion of the RDD (research, development and demonstration) program, will go into abeyance until such time as suitable emissions measurement devices are identified and available or the problems otherwise resolved.”
- EPA, CARB and EMA need to work together to assess PM PEMS capability and suitability for in-use testing prior to the start of a PM Pilot program.
- Substantial PM and Gaseous PEMS initial cost >$350K.

Conclusions

- Heavy-Duty In-Use Emissions Testing is here to stay for the foreseeable future.
- It will be a challenge for Engine Manufacturers but they will be up to the challenge.
- There are a number of issues and concerns which need to be overcome especially for PM in-use measurement.

Thank You!