Workshop for 2009 Biennial Heavy-Duty OBD Changes

Advanced Engineering Section
Mobile Source Control Division
California Air Resources Board

CARB Workshop
October 15, 2008
El Monte, CA

Discussion Points

- Background
- Infrequent Regeneration Adjustment Factors
- In-Use Monitor Performance Ratios
- Diesel Monitors
- Other Monitors
- Standardization Changes
- Certification Demonstration Testing
- Enforcement Regulation

Discussion Points

- Background
- Infrequent Regeneration Adjustment Factors
- In-Use Monitor Performance Ratios
- Diesel Monitors
- Other Monitors
- Standardization Changes
- Certification Demonstration Testing
- Enforcement Regulation

Background

- Since its adoption in 2005, HD OBD regulation subject to biennial reviews
  - Report back to the Board on manufacturers' progress in meeting the requirements and propose changes, as needed
- Discuss main issues and proposed changes today
  - Board Hearing scheduled for early 2009
  - Feedback from today will be used to develop final staff proposal for Board Hearing

Background (cont)

- Discussion today will also include proposed HD OBD enforcement regulations
  - Proposed regulation language currently not available
  - Industry input needed to complete regulation
- Format for today's discussion
  - Staff presentation on issues and proposed changes within each discussion point followed by discussion of those items

Discussion Points

- Background
- Infrequent Regeneration Adjustment Factors
- In-Use Monitor Performance Ratios
- Diesel Monitors
- Other Monitors
- Standardization Requirements
- Certification Demonstration Testing
- Enforcement Regulation

Infrequent Regeneration Adjustment Factors (IRAFs)

- Currently: calculate and use appropriate adjustment factors in determining OBD thresholds
  - to account for changes in emissions from regeneration events due to malfunctioning component
- Industry request: Eliminate IRAF requirement
  - Additional testing/resources to determine IRAFs for each monitor significant and costly
  - Either ignore or apply adjustment factors determined during baseline tailpipe emission certification

IRAFs (cont.)

- Costs and resources should be limited
  - Does not require repeating the entire process to determine the modified IRAFs
    - Focus on relative comparisons to already known baseline IRAFs
  - Engineering judgment to determine if:
    - Likely is an impact on frequency or regen emissions;
    - Analysis of existing data can be used to determine relative impact;

Example

Monitor	Affects Frequency?	Affects Regen Emissions?	Rationale
EGR Low Flow	No	No	Low EGR flow = lower engine out PM so no frequency increase, EGR closed during regen so no impact on emissions
EGR High Flow	Yes	No	Excessive EGR = higher engine out PM so might increase frequency, some EGR flow during regen likely only reduces NOx during regen emissions

Example (cont).

- Suspected frequency impact:
  - Monitor PM filter regeneration trigger (e.g., soot loading model)
    - Calculate loading rate over an FTP with fault implanted
    - Compare relative loading rate to baseline loading rate
    - Apply relative factor to baseline frequency factor
  - Similar approach by measuring engine out PM?
- Suspected regen emission impact:
  - Measure emissions during a regen with malfunction implanted
    - E.g., manually trigger regen, insert loaded PM filter, or encounter naturally while doing calibration testing
    - Compare emission level with known baseline regen emission level
    - Apply relative factor to baseline IRAF.

IRAFs (cont.)

- Emission impact from infrequent regenerations while a malfunction is present is NOT accounted for in baseline tailpipe emission certification
  - OBD malfunctions may affect engine-out emission levels or aftertreatment performance
  - Emissions can increase dramatically during a regeneration event with a fault present
  - If not re-determined with a fault present, cannot verify total emissions will be at or below the required OBD threshold levels when a fault is detected

Discussion Points

- Background
- Infrequent Regeneration Adjustment Factors
- In-Use Monitor Performance Ratios
- Diesel Monitors
- Other Monitors
- Standardization Changes
- Certification Demonstration Testing
- Enforcement Regulation

In-Use Monitoring Frequency
- Background -

- Track number of times monitors run in-use (numerator)
- Track a counter that represents vehicle activity (denominator)
- Ratio of these two (numerator/denominator) provides an indicator of in-use monitoring frequency
- Design monitors to meet a minimum ratio of 0.100 on 2013+ MY
  - 0.100 is interim ratio until enough experience exists to better define

In-Use Monitoring Frequency
- Background (cont.) -

- Some continue to try to design all monitors to execute on the denominator drive cycle
  - Or ask for special denominators to include their monitor enable conditions
- Actual purpose of denominator is to measure vehicle activity
  - Not a drive cycle that must run all monitors
- Robust monitors might never run on the denominator drive cycle and still have adequate monitoring frequency

In-Use Monitoring Frequency
- Industry Concerns -

- General denominator increments when (among other conditions):
  - 5 cumulative minutes $\geq$ 25mph for gasoline engines; or
  - 5 cumulative minutes $\geq$ 15% load for diesel engines
- '15% load' suggested by industry because vehicle speed signal not always available
- Recent request by manufacturers to use 50% load (in lieu of 15%) to address inconsistencies
  - Some engines may be above 15% load at idle, some not until significantly off-idle.
- Additional request to optionally use the 25 mph (in lieu of 15% load) for diesel engines

In-Use Monitoring Frequency
- Staff Proposal for Denominator Criterion -

- Must have a consistent measure of in-use monitoring frequency to ensure equitable compliance to minimum ratio
- Proposal would require all diesel engines to use engine speed (in lieu of 15% load)
  - 5 cumulative minutes $\geq$ 1150 rpm
- Ensures engine is being used to do work and thus, a trip reliant on proper emission control operation
- Proposal does not allow 'option' for diesels to use any other metric (e.g., vehicle speed)
  - But does not require use of engine speed criteria until 2013 MY

In-Use Monitoring Frequency
- Staff Proposal for PM Filter Denominator -

- Currently, manufacturer must submit a proposal for consideration
  - Neither staff nor industry had good feel for regen intervals in 2005
  - But, need consistent definition used by all
- Trying to compromise between in-use frequency and natural occurrence of events needed for some monitors
  - But, cannot accept very infrequent monitoring events for an item that is needed virtually all the time for proper emission control
- Proposal: General denominator satisfied and cumulative engine run time $\geq$ 750 minutes since the last time the PM filter denominator was incremented
  - "Typical" distances between PM filter regenerations reported as 300 to 500 miles
  - Calculated using 500-mile regeneration interval and average speed of 40 mph
  - Also applies to diesel NMHC converting catalyst monitoring

Discussion Points

- Background
- Infrequent Regeneration Adjustment Factors
- In-Use Monitor Performance Ratios
- Diesel Monitors
- Other Monitors
- Standardization Changes
- Certification Demonstration Testing
- Enforcement Regulation

Diesel Fuel System Monitor

- Currently: continuous monitoring of fuel system pressure
  - Proper fuel pressure is important to maintain low emission
  - Continuous monitoring ensures fault detection even if fault affects only a portion of engine operating conditions
- Manufacturers request: once-per-trip monitoring for non-common rail systems (e.g., unit injector)
  - Claim no viable solutions for continuous fuel pressure monitoring
  - Design of unit injector makes it impractical to add pressure sensor into each injector

Diesel Fuel System Monitor Proposed Amendments

- ARB concerned that proper pressure is just as important on non-common rail systems
- Proposal to allow once-per-trip monitor for fuel systems that achieve injection pressure within the injector if manufacturer:
  - Submits a failure mode and effects analysis showing all failures that affect pressure
  - Designs monitor(s) to detect all fuel pressure failure modes
    - May have to cover different regions of engine operation with separate monitors if some pressure faults only impact a particular region

Diesel Fuel System Monitor Proposed Amendments (cont.)

- Common question from manufacturers regarding calibration of fuel system monitors
- Clarify for fuel pressure:
  - Common-rail systems expected to calibrate for a fault equally affecting all cylinders
  - Systems that build injection pressure in the injector expected to calibrate for both an individual injector fault and a fault equally affecting all cylinders (e.g., equal deterioration across all injectors)
- Clarify for quantity and timing:
  - All systems expected to be calibrated for both a single injector fault and a fault equally affected all cylinders

PM Filter Monitor
Filter Performance

- Current Thresholds for 2010 – 2012 MY
  - PM emissions $\geq$ 0.05 g/bhp-hr or applicable standard + 0.04 g/bhp-hr
- Manufacturer's Proposal for 2010 – 2012 MY
  - PM emissions > 0.10 g/bhp-hr or applicable standard + 0.09 g/bhp-hr
  - Indicated that PM sensors needed to meet current threshold and not available for 2010

PM Filter Monitor
Filter Performance

- ARB's Proposal for 2010 – 2012 MY
  - PM emissions > 0.07 g/bhp-hr or applicable standard + 0.06 g/bhp-hr
- Rationale for Modification
  - Addresses industry's concerns by providing near-term compliance relief
  - New proposal is feasible

PM Filter Monitor
Filter Performance

- Technical Feasibility of Proposal
  - MDVs are capable of detecting PM filter performance deterioration at the proposed levels right now without PM sensors
  - Preliminary data from two HD manufacturers show the proposal is feasible
  - Improvements to soot models, pressure sensor accuracy, PM filter/engine part-to-part variability
  - Reduction of engine-out PM

PM Filter Monitor
Frequent Regeneration

- Current Threshold for NMHC unchanged
  - 2010 MY+ : NMHC emissions > 2.5x std
  - 2013 MY+ : NMHC emissions > 2.0x std
- ARB's Proposal for NOx Threshold
  - ≥ NOx std + 0.2 g/bhp-hr

PM Filter Monitor
Filter Regeneration

- Rationale for Modification
  - Alignment with OBD II requirements for MDVs
  - Review of manufacturer data has shown NOx emissions can be very high during regen events

NOx Converting Catalyst Monitor

- Current 2010-2012MY requirement for NOx conversion efficiency and SCR reductant delivery monitoring:
  - Threshold: NOx standard + 0.3 g/bhp-hr

NOx Converting Catalyst Monitor Manufacturer Concern

- Current NOx sensor accuracy not sufficient for threshold
  - +/-12 ppm after aging
  - E.g., cannot robustly discern a properly operating system at 20 ppm (that could read as high as 32 ppm) from a malfunctioning system at 50 ppm (that could read as low as 38 ppm)
- Request to increase threshold to NOx std + 0.6 g/bhp-hr

NOx Converting Catalyst Monitor Proposed Amendment

- Some interim relief is warranted
  - But not as high as manufacturers' request
- Proposed threshold: NOx std + 0.4 g/bhp-hr for 2010-2012MY

NOx Converting Catalyst Monitor Possible Monitoring Strategies

- Some manufacturers on track to meet current thresholds:
  - Focus on monitoring during naturally occurring higher NOx concentrations (e.g. higher engine load)
- Alternative possibilities include:
  - Intrusively increasing engine out NOx to raise tailpipe outlet concentrations with failed part
    - Partially mitigate emission impact by injecting more reductant
  - Investigate correlation of ammonia storage ability to conversion efficiency
    - Temporarily interrupt dosing and evaluate reaction of system
    - Data shows possible relationship but more research needed to see if correlation is strong enough/sensitive enough

NMHC Converting Catalyst Monitor

- Current Requirements
  - Threshold: 2.5x NMHC standard for 2010-2012
  - Applies to DOCs and catalyzed DPFs

NMHC Converting Catalyst Monitor (cont.)

- Manufacturers' Requests
  - Threshold: 4.0x the NMHC standard
  - Eliminate use of adjusted IRAF
- Rationale:
  - Only feasible to detect completely-failed catalyst
  - Modified threshold would ensure functional monitoring for most engines

NMHC Converting Catalyst Monitor (cont.)

- Proposal regarding DOCs:
  - Threshold remains at 2.5x NMHC
  - Monitoring at that level is feasible for several manufacturers
- Suggestions for monitoring strategies
  - Look more closely at time to temp and/or fuel required to begin/maintain exotherm
  - Monitor during accelerated warm-up strategies
  - Reduce engine-out NMHC emissions

NMHC Converting Catalyst Monitor (cont.)

- Addition of NOx threshold for 2013+MY for DOC
  - Detect fault before emissions exceed either 2.0x NMHC std or NOx std +0.2 g/bhp-hr
- Rationale:
  - With some strategies (e.g., disabling NOx controls during regen), NOx emissions greatly impacted by reduced NMHC catalyst performance

NMHC Converting Catalyst Monitor (cont.)

- Proposal for catalyzed DPFs:
  - Delay requirement until 2013MY
  - Provides more time to refine systems, optimize regeneration strategies, and better investigate the impacts of a catalyzed DPF
- Suggestions for monitoring strategy
  - Regeneration frequency if coating helps achieve passive regeneration

Catalysts used for proper feedgas

- Current Requirement:
  - Detect catalyst that is unable to generate the proper feedgas for SCR system
  - Applies to 2010+ HD OBD engines

Catalysts used for proper feedgas (cont.)

- Manufacturers' Requests
  - Remove the requirement from the NMHC converting catalyst section
    - Indicated no feasible method to monitor this function
  - Rely on the SCR catalyst conversion monitor to detect this failure
    - When it is bad enough (if ever) to cause the SCR catalyst monitor to reach its threshold emission level

Catalysts used for proper feedgas (cont.)

- ARB intends to keep the requirement
  - $NO \rightarrow NO_2$ function is well understood and relied upon
  - This property will likely be lost before NMHC conversion efficiency decreases significantly
- Relying on existing SCR monitor is insufficient
  - This emission function not likely, by itself, to cause SCR monitor threshold to be exceeded so complete failure would go undetected
- Possible monitoring techniques:
  - Evaluate SCR NOx conversion efficiency during specific operating conditions where high NO_2 generation expected
  - Evaluate urea consumption rates
  - Evaluate DPF active regeneration frequency increases if NO_2 production is heavily used for passive regeneration

Catalysts used for proper feedgas (cont.)

- Proposal:
  - Delay monitoring requirement until 2013MY
  - Additional leadtime for manufacturers to:
    - better understand the catalyst properties used to generate the feedgas
    - optimize and refine catalyst configurations and DPF regeneration strategies
    - gain experience with NOx sensors and SCR systems to investigate areas where feedgas generation is expected to be high or have a substantial impact on conversion efficiency and focus on those regions for possible monitoring approaches

‘Clean-up’ NMHC Catalysts

- Current requirements for NMHC catalysts require all catalysts to be monitored
  - Must submit proposal to ARB for review and approval
- Now proposing specific requirements for catalysts used downstream of SCR
  - Eliminates need for manufacturer plan to ARB
- Functional monitor proposal:
  - Detect a malfunction when catalyst has no detectable amount of NMHC, CO, NOx, or PM conversion capability
  - Monitoring not required if no measurable emission impact on criteria pollutants during any reasonable driving condition

Engine Cooling System Monitor

- Currently required to monitor cooling system (e.g., thermostat, ECT sensor) for proper performance:
  - must reach minimum temperature necessary to enable other OBD monitors within a reasonable time
  - must reach near thermostat-regulating temperature within a reasonable time
- Manufacturers expressed difficulties due to the variety of vehicles that an engine is installed in
  - Wide variety of engine warm-up characteristics
  - Difficult to distinguish fault from normal warm-up

Engine Cooling System Monitor (cont.)

- Manufacturers requested allowance to make pass or fail decisions after more trips than the currently-allowed two trips (e.g., six trips)
- Doesn't address root problem
  - Primarily allows less robust monitors more time in hopes that false fails will not occur often enough, or the driver will not frequently engage in 'abnormal driving patterns'
  - Better to define more limited enable conditions or improve modeled ECT to either account for or disable the monitor during 'abnormal' driving conditions where an accurate pass/fail decision cannot be made

Engine Cooling System Monitor (cont.)

- Manufacturers requested that monitoring be disabled/desensitized on engine starts with ambient or starting temperature below 60 degF
- ARB agrees with desensitizing monitor at lower engine start temperatures
  - But 60 deg F is too common in-use
- Propose to allow on engine starts <50 degF
  - Limited vehicle operation in CA at <50 degF

Engine Cooling System Monitor (cont.)

- Manufacturers requested that monitoring be limited to detection of fully stuck open thermostats
  - Irrespective of what temperature is or is not achieved
- Doesn't achieve near the same benefit
  - Failures that prevent proper warm-up for emissions and monitors need to be detected regardless of the failure mode (e.g., fully stuck open, partially stuck open, leaking, opening too early)

Engine Cooling System Monitor (cont.)

- Additional requirement to monitor for failures which cause the ECT to cool back down below monitor enablement temperatures after they have been reached
  - Discussions with manufacturers indicated such a condition was not only possible but quite likely with some applications
  - E.g., an idling vehicle may initially pass thermostat monitoring but at higher speeds where flow is introduced across the radiator and engine block, ECT can go back down below the enable temperature
- Intended to have draft language in regulation but omitted by mistake
  - Concern that particular failure modes or applications would effectively disable monitors without robust detection of a fault

Engine Cooling System Monitor (cont.)

- Engine manufacturers want to allow vehicle manufacturers some authority to calibrate their own cooling system criteria to properly account for appropriate heat/work losses
- ARB generally agrees with this allowance:
  - Recognizes the difficulty of engine manufacturers to calibrate for every vehicle application the engine will be used in
  - Would allow the OBD system to be better optimized for the specific truck configuration while still allowing vehicle manufacturers control over what they add to the system and how it impacts vehicle warm-up
- Engine manufacturers will need to ensure vehicle manufacturers are given proper instruction on how to determine the appropriate calibration
  - Engine manufacturers ultimately held responsible for OBD compliance in-use

Discussion Points

- Background
- Infrequent Regeneration Adjustment Factors
- In-Use Monitor Performance Ratios
- Diesel Monitors
- Other Monitors
- Standardization Changes
- Certification Demonstration Testing
- Enforcement Regulation

Emission-related Failure Modes

- Currently required to detect all failure modes of emission-related components/systems
  - "Emission-related" - affects emissions or other OBD monitors
- Industry proposed to only detect specific failures modes that are emission-related
- Staff disagrees and will keep current requirement
  - Industry's proposal will result in more work and testing to determine which specific failure modes are emission-related or not
  - Areas of contention include differing emission impact of failure mode based on driving conditions and vehicle application, possible indirect impact on other monitors, thoroughness of evaluation of all failure modes and interactions, etc.

“Continuous” Monitoring

- “Continuously” currently not defined for non-circuit /out-of-range monitors
  - E.g., diesel fuel system pressure control monitor, EGR system feedback control monitor
- Intend these “continuous” monitors to run virtually all the time except during conditions where cannot distinguish good from bad
  - Language for these monitors modified to reflect this

Diesel “Idle” Definition

- Currently define “idle” for diesels as conditions where vehicle speed is less than or equal to one mph
- Manufacturers have indicated some engines do not have access to vehicle speed
- Propose redefining “idle” based on either vehicle speed or engine speed
  - Vehicle speed <= 1mph or engine speed <= (normal warmed-up idle speed + 200rpm)
  - Language modified accordingly in applicable sections: permanent fault code erasure protocol, in-use performance monitor denominator definition, engine run time tracking

Emission Control Strategies

- For all emission control strategies, manufacturers should be monitoring to the extent they can
  - Verify enter and stay in control strategies when expected to
  - Detect faults when adaptive or control limits reached
  - Modifications made to EGR and boost pressure system monitoring requirements to partially address
- Bottom line: If you have an emission control strategy, you should be monitoring the inputs to ensure they are adequate for proper operation of the control strategy
  - Don’t expect to be exempt if existing reg doesn’t specifically call out your strategy or because you don’t tell ARB about it.

Boost Pressure Control Monitor

- Currently require slow response monitoring only for VGT systems
- Discussions with manufacturers have revealed these malfunctions can affect emissions on non-VGT systems as well
- Propose requiring slow response monitoring for “all” boost systems for 2013+ MY
  - Expected that most manufacturers will only need to perform a function check, not emission threshold check

MIL and Wait-to-start lamp

- Industry proposed to delete monitoring requirements for MIL and wait-to-start lamp circuit faults
  - Argued that lights are directly wired and controlled by instrument panel, not engine ECU – monitoring would require instrument panel changes and/or additional hardware
  - Indicated that LEDs are much less susceptible to burned out bulb failures

MIL and Wait-to-start lamp (cont.)

- Staff agrees for MIL circuit – delete monitoring requirement
  - Originally required to simplify inspections
  - Emission-related fault information can still be accessed during inspections to determine if fault present
- Staff does not agree for wait-to-start lamp – keep monitoring requirement
  - Fault has direct impact on emissions – engine may be cranked too soon causing repeated or prolonged cranking emissions

Future ARB Mail-Out

- A few sections which require specific formats reference a future ARB Mail-Out
  - CAL ID/CVN information, monitor checklists
- Mail-Out formats will be similar to those in ARB Mail-Out #MSC 06-23 for OBD II
  - Available in a few months, prior to early 2009 Hearing

Other Changes

- Proposing changes to harmonize with requirements in OBD II regulation
  - Modifications to permanent fault code erasure protocol, gasoline cold start strategy monitoring requirements, crankcase ventilation systems
  - Addition of diesel cold start strategy monitoring requirements
- Will be updating MDV requirements in OBD II regulation to match changes for HD OBD

Discussion Points

- Background
- Infrequent Regeneration Adjustment Factors
- In-Use Monitor Performance Ratios
- Diesel Monitors
- Other Monitors
- Standardization Changes
- Certification Demonstration Testing
- Enforcement Regulation

What is an Emission-Increasing AECD?

- Any approved AECD that reduces the effectiveness of emission controls under conditions expected to be encountered during normal operation, is needed for vehicle protection against damage, and is not classified as an NTE deficiency
  - Does not include AECDs activated solely based on any of the following: operation above 8000 ft, ambient temperature, initial engine warm-up, OBD failure detection, OBD monitor execution, or infrequent regeneration event execution
  - Example of EI-AECD: EGR shut-off or derate at high exhaust gas or coolant temperatures

Emission-Increasing AECD Tracking

- For diesels, require real-time tracking and cumulative logged data of EI-AECDs
  - Currently required for light- and medium-duty OBD II
  - Track engine run time with each EI-AECD active
  - Starts with 2013MY (mistakenly left out of workshop notice)
- Will be used to:
  - Identify non-robust emission control solutions
  - Identify abuse of AECD provisions
  - Improve certification process (in future model years) by focusing review on those that happen most frequently in-use

Emission-Increasing AECD Tracking (Cont.)

- Industry concerned about extra emission testing, confidentiality, and inclusion in OBD regulation
- EI-AECD determined by engineering analysis, not emission testing
- Doesn't improve the ability to reverse-engineer a competitor's strategies
- OBD regulation is only ARB regulation that dictates the data required to be provided to off-board tool

Service Information

- Currently requires manufacturers to make available basic OBD information to repair industry
  - Includes OBD repair procedures that only require use of generic scan tool or information for aftermarket scan tool industry to make similar tools
  - Can be superseded by stand-alone service information regulation (section 1969 of title 13, CCR) if it provides for comparable information in an equivalent timeframe

Service Information (cont.)

- Since 2005, section 1969 has been updated to include heavy-duty
  - But updates only apply to 2013+MY, while enhanced OBD required starting in 2010MY
  - Prior to 2013MY, manufacturers only required to make available information that they currently provide
    - Meaning, if they don't currently provide information to independent repair shops to access and diagnose OBD detected faults, they can continue to exclude them
    - Unacceptable to 'lock-out' independent repair shops from OBD repairs and/or make OBD detected faults a 'dealer-only' item

Service Information (cont.)

- Intend to keep current requirements in HD OBD regulation
  - Clause that allows section 1969 to supersede HD OBD requirements does not apply to 2010-2012MY
  - Will ensure aftermarket scan tool manufacturers and independent repair facilities not shut out during these years
  - Will prevent HD OBD from getting off to a bad start

Updates to SAE/ISO References

- SAE and ISO documents referenced in regulation have been updated with most recent versions
- Further updates may be made prior to the 2009 Hearing to publication dates for a few documents currently still being revised/balloted

Updates to Data Stream Parameters

For 2013+ MY

- Included new parameters already defined in J1979:
  - EGR temperature, variable geometry turbo control status, alcohol fuel percentage, type of fuel currently being used, PM sensor output
- Added some to be consistent with EOBD:
  - NOx reductant level, distance traveled while low/empty SCR reductant driver warning/inducement active
- Added some based on needs identified during ARB testing:
  - normalized trigger for PM filter regeneration, PM filter regeneration status, average distance (or engine run time) between PM filter regen events, NOx adsorber regeneration status, NOx adsorber deSOx status
- Probably still need help on PIDs for hybrid vehicles:
  - hybrid battery pack remaining charge, others for revised equivalent all-electric range testing

Off-Board Activation

- For 2013 MY, manufacturers required to implement capability for a generic scan tool to initiate a regeneration of the PM filter
- Intended to use Mode/Service $08 in J1979
  - Will need similar provision in J1939 if not already there
- Intended to help during emission testing:
  - Can trigger regen off-emission test to minimize test interruption from regens
- Intended to help technicians:
  - Troubleshooting or running monitors related to regen events
  - Re-initializing the system after off-board service/replacement of PM filter or ECM

Discussion Points

- Background
- Infrequent Regeneration Adjustment Factors
- In-Use Monitor Performance Ratios
- Diesel Monitors
- Other Monitors
- Standardization Changes
- Certification Demonstration Testing
- Enforcement Regulation

Demonstration Testing

- Current aging requirements
  - De-greened engine – aged 125 hrs
  - Aftertreatment system – aged to full useful life
- Manufacturers requested aging to lower mileage goals in initial years
  - Not enough time to develop aging procedure and collect data for validation
  - Also proposed aging only ‘critical components’ in aftertreatment system

Demonstration Testing (cont.)

- ARB agrees that interim relief needed
- ARB also believes total system aging (engine plus aftertreatment) important for the long term
  - Manufacturers liable in-use throughout useful life mileage
  - Dramatic advances in diesels increase uncertainty about engine and emission component durability/deterioration patterns
  - Insufficient knowledge to accurately account for cumulative effects of total system by aging only a portion of the system

Demonstration Testing (cont.)

- ARB's proposal
  - Phase-in schedule
    - Near-term: aging to lower mileage goals during initial years (shown in next slides)
    - Long-term: Require aging of the total system, including engine and aftertreatment system, to representative of full useful life prior to certification

Demonstration Testing (cont.)

Year	Aging data required at certification for accelerated aging	
	Engine	Aftertreatment System
2010-2012 MY	125 hours aging	Accelerated aged to best estimates of full useful life on aftertreatment components
Report in-use data in 2011	Collect data in 2011 on real world 2010 MY complete systems (with full useful life mileage for LHD, MHD and 185,000+ miles for HHD)	

Demonstration Testing (cont.)

Year	Aging data required at certification for accelerated aging	
	Engine	Aftertreatment System
2013-2015 MY	Best estimates accelerated aged to full useful life incorporating real world aging data from 2010 model year	Best estimates accelerated aged to full useful life incorporating real world aging data from 2010 model year
Report in-use data in 2014	Collect data in 2014 on real world 2010 MY complete systems (with full useful life mileage for HHD)	

Demonstration Testing (cont.)

Year	Aging data required at certification for accelerated aging	
	Engine	Aftertreatment System
2016 MY	Entire system accelerated aged to full useful life and validated with real world aging data from previous model year systems	

Demonstration Testing (cont.)

- Proposing amendments to scan tool data that must be collected
  - Demo testing one of the few times ARB sees threshold parts tested in a lab environment
  - Confirmatory testing by ARB found non-compliances in OBD data that was available but not reported
- Requiring 'snapshots' of virtually all OBD data to be collected
  - Including readiness status, engine run time tracking data, real-time PIDs, etc.
- Requiring data collection to be done more often
  - Immediately prior to or after each engine shutdown (e.g., end of each preconditioning cycle, end of cold start or hot start FTP cycle)

Discussion Points

- Background
- Infrequent Regeneration Adjustment Factors
- In-Use Monitor Performance Ratios
- Diesel Monitors
- Other Monitors
- Standardization Changes
- Certification Demonstration Testing
- Enforcement Regulation

HD OBD Enforcement Regulation

- Staff is developing draft regulatory language for a HD specific enforcement regulation (e.g., 1971.5)
  - Intend to structure as identically as possible to current OBD II (1968.5) regulation
- Biggest hurdle is emission testing for threshold monitor compliance

Planned structure

- Three ‘groups’ of non-compliances
  - OBD emission thresholds – Verify, with threshold part installed, MIL on at/before required emission levels.
  - In-use frequency- Verify monitors meet minimum in-use ratios.
  - “All other” – Verify any other aspect of compliance (e.g., SAE standards, proper MIL illumination, enable conditions, fault detection, connector location, etc.)

In-use frequency

- Uses data logged in ECU
  - Likely require ARB to get ~30 engine sample
- More complicated for monitors not logged in ECU (e.g., rationality monitors)
  - Requires off-board data loggers, etc. to measure numerators and denominators
- ARB finding of noncompliance
  - Based on average of 30 below minimum ratio, or
  - 2/3 of sample below minimum ratio

‘All other’ category

- Case by case process to determine noncompliance
  - Authority with ARB to determine appropriate procedure
- Vast majority of light-duty in-use issues have fallen into this category
  - E.g., monitors that don’t run/disable themselves/calibrated to always pass, noncompliance with SAE standards for communication protocol, connector wiring, etc.
- Mostly uses on-road testing with faults implanted by staff and discussions with manufacturer

Threshold Emission Testing

- To verify threshold component calibrated correctly
  - E.g., fault detected before emissions exceed 2.0x std
- Light-duty process
  - Requires 10 ‘properly maintained’ vehicles with fault implanted to be emission tested
  - $\geq$ 50% of 10 above threshold without fault detection indicates noncompliance
- Need to develop a process that works for engine-dyno certified products

Emission Testing Issues

- OBD monitors calibrated to engine dyno test
  - Either FTP or SET
  - No obvious link/metric to NTE
- PEMS not an obvious solution
  - Focus on NTE and not correlation to FTP or SET
- Possible Solutions:
  - Enforcement testing on engine dyno
  - Develop PEMS based screening/correlation procedure
  - Change metric for OBD calibration to something that can be measured by PEMS

Emission Testing Issues (cont.)

- Engine dyno test cell availability
  - No facility at ARB to test, limited at EPA
  - Manufacturer facilities heavily used already
  - Limited number of outside/contract lab facilities
- Costs
  - Expensive to remove engines from working in-use vehicles
  - Outside facilities costly per test
- Heavily reliant on engine manufacturer
  - Support needed to make engine ‘testable’ (e.g., simulating air-to-air coolers, etc.)

Proposal

- Engine dyno testing only realistic option at this time
  - Continue to look at PEMS, other concepts
- Must be done at manufacturer's or outside lab facility
  - Only choices currently available
- Combination of self-testing plus outside lab testing

Self-testing

- Ensure a few in-use engines are compliance tested each year
  - Structure number of engine families to be tested identical to demo testing
    - (e.g., 1-3 engine per year depending on number of engine families certified by manufacturer)
  - Similar language to demo testing to waive if all families have already been tested
  - Target in-use engines with <75% of useful life mileage
- Option to manufacturer to do testing in-house or contract out for it

Outside Lab Testing

- Independent verification of a few engines per year
  - At non-manufacturer facility likely contracted by ARB
  - Still will require manufacturer support (for hardware, configuration, set-up, etc.)
  - Testing and selection of engine(s) at discretion of ARB
- Several funding options all being pursued
  - ARB money
  - Divert some enforcement settlement money
  - Manufacturer paid through certification fees
  - Cost-share approach (e.g., ARB pays for first 5 and if failing, manufacturer pays for final 5 engines, etc.)
  - Likely will use a combination of all these

Screening First

- Both self-testing and ARB testing will likely use a screening of one engine followed by progressively more testing based on previous results
  - E.g., Require testing of one engine in an engine family
  - Run all emission threshold tests on the engine
- Follow-up testing with additional 2-4 engines from same engine family only if first engine fails
  - Follow-up testing focused on only running tests that first one failed on
- Second follow-up testing to get total sample of 10 engines based on results of first 5
  - E.g., if 3 out of first 5 fail, test 5 additional
  - Compliance based on all 10 ($\geq$ 50% fail)

Timeframe

- Regulatory language being drafted
  - Expect to release a draft by December
- Copying language from other sources where available
  - OBD II enforcement, tailpipe enforcement, surveillance testing, engine screening process for in-use/PEMS testing, etc.