Workshop for 2015 OBD II Regulations Update

Emission Compliance, Automotive Regulations, and Science Division

California Air Resources Board

October 30, 2014

El Monte, CA

California Environmental Protection Agency
Air Resources Board

OBD II Regulatory Update

Projected Schedule (subject to change)

- Public Workshop – El Monte, CA
  - Date: Thursday, October 30, 2014: 9am-3pm
- Finalization of OBD II Regulatory Package
  - Projected date: January/February timeframe
  - Finalization of all proposed OBD II amendments
- 45-Day Notice Package
  - Projected publication date: April 2015
  - Includes notice, staff report, and proposed regulatory language
- Board Hearing
  - Projected date: May 2015

OBD II Regulatory Update

Highlights of Proposed Changes to OBD II Regulations

- LEV III emission malfunction thresholds
  - NMOG + NOx thresholds
  - Includes proposed PM thresholds for diesel and gasoline vehicles
- A/F cylinder Imbalance monitor requirements
- Changes to hybrid vehicle requirements
  - More details regarding monitoring requirements of hybrid components
  - Plug-in hybrid-related changes
  - Changes related to IUMPR/data stream for hybrids
- Non MIL provisions
  - Includes components related to safety
- Smart devices
- Comprehensive component monitoring
  - Test-out requirements
- Fault code standardization
- Purge and PCV

Proposed LEV III Thresholds for Gasoline

Exhaust Standards		Monitor Thresholds (except catalyst monitor)				Catalyst Monitor Threshold			
Vehicle Type	**Vehicle Emission Category**	**NMOG + NOx Mult.**	**CO Mult.**	**PM Mult.**	**PM THD (mg/mi)**	**NMOG + NOx Mult.**	**CO Mult.** [1]	**PM Mult.**	**PM THD (mg/mi)**
Passenger Cars, Light-Duty Trucks, and Chassis Certified Medium-Duty Passenger Vehicles	LEV160	1.50	1.50	N/A	17.5[1]	1.75	1.50	N/A	17.5[1]
	ULEV125								
	ULEV70	2.00				2.00			
	ULEV50								
	SULEV30	2.50	2.50			2.50	2.50		
	SULEV20								
Chassis Certified Medium-Duty Vehicles (except Medium-Duty Passenger Vehicles)	All Medium-Duty Vehicle Emission Categories	1.50	1.50	1.50[2]	17.5[3]	1.75	1.50	1.50[2]	17.5[3]

1. Applies to 2019+MY LEV III vehicles
2. Applies to 2019+MY LEV III vehicles not included in the phase-in of the PM standards set forth in title 13, CCR section 1961.2(a)(2)(B)2
3. Applies to 2019+MY LEV III vehicles included in the phase-in of the PM standards set forth in title 13, CCR section 1961.2(a)(2)(B)2

PM Phase-in for MDVs

Title 13, CCR section 1961.2(a)(2)(B)2:

LEV III Particulate Emission Standard Phase-in for Medium-Duty Vehicles, Other than Medium-Duty Passenger Vehicles	
Model Year	**Total % of MDVs certified to the 8 mg/mi PM Standard or to the 10 mg/mi PM Standard, as applicable**
2017	10
2018	20
2019	40
2020	70
2021 and subsequent	100

Proposed LEV III Thresholds for Gasoline

PM Thresholds for Gasoline

- Current Requirement: fault detection before emissions exceed "1.5 times the applicable standards" (e.g., 1.5 x 10 =15 mg/mi PM)
  - ARB currently does not enforce PM thresholds for gasoline – presumed non-issue with current standards and technologies
  - ARB currently has limited PM data for malfunctions on gasoline vehicles
    - PM data not routinely provided by manufacturers as part of demonstration tests
- Concerns as PM standards drop with LEV III standards
  - 10 mg/mi to 3 mg/mi to 1 mg/mi
  - Possible significant PM increase with malfunctions on gasoline direct injection engines

Proposed LEV III Thresholds for Gasoline

Proposal: PM Requirements for Gasoline

- Absolute PM threshold of 17.5 mg/mi for 2019+ MY LEV III vehicles certified to <=10 mg/mi PM standard
- Multiplicative PM threshold of 1.5 x PM standard for 2019+ MY LEV III vehicles certified to >10 mg/mi PM standard
- PM threshold for Catalyst Monitor starting 2019+ MY LEV III vehicles
- Demonstration Testing
  - Manufacturers provide PM data for all monitors tested starting with the 2016 MY LEV III applications
    - Pre-2019 MY will not have proposed PM thresholds.
  - PM data to be used to evaluate PM thresholds and propose necessary future changes

Proposed LEV III Thresholds for Chassis Certified Diesels

Exhaust Standards		Monitor Thresholds[1]			Aftertreatment Monitor Thresholds[2]			DPF Filtering Performance Monitor Threshold			
Vehicle Type	Vehicle Emission Category	NMOG + NOx Mult.	CO Mult.	PM Mult.	NMOG + NOx Mult.	CO Mult.[3]	PM Mult.[3]	NMOG + NOx Mult.[3]	CO Mult.[3]	PM Mult.	PM THD (mg/mi)
Passenger Cars, Light-Duty Trucks, and Chassis Certified Medium-Duty Passenger Vehicles	LEV160	1.50	1.50	2.00	1.75	1.50	2.00	1.50	1.50	N/A	17.5
	ULEV125										
	ULEV70	2.00			2.00			2.00			
	ULEV50										
	SULEV30	2.50	2.50		2.50	2.50		2.50	2.50		
	SULEV20										
2016MY-2018MY Chassis Certified Medium-Duty Vehicles (except Medium-Duty Passenger Vehicles)	All Medium-Duty Vehicle Emission Categories	1.50	1.50	2.00	1.75	N/A	N/A	N/A	N/A	1.75[4]	17.5[5]
2019+MY Chassis Certified Medium-Duty Vehicles (except Medium-Duty Passenger Vehicles)	All Medium-Duty Vehicle Emission Categories	1.50	1.50	1.50[4] or 2.00[5]	1.75	1.50	1.50[4] or 2.00[5]	1.50	1.50	1.50[4]	17.5[5]

1. Applies to (f)(4)-(f)(7), (f)(9.2.2), (f)(12)-(f)(13)
2. Applies to (f)(1)-(f)(2), (f)(8), and (f)(9.2.4)(A)
3. Applies to 2019+MY LEV III Vehicles
4. Applies to vehicles not included in the phase-in of the PM standards set forth in title 13, CCR section 1961.2(a)(2)(B)2
5. Applies to vehicles included in the phase-in of the PM standards set forth in title 13, CCR section 1961.2(a)(2)(B)2

Proposed LEV III Thresholds for Chassis Certified Diesels

Thresholds for Diesel

- Current Requirement: Not all monitors have NMHC, NOx, CO, and PM thresholds
  - DPF Filtering Performance Monitor - PM threshold
  - NOx Catalyst and NOx Adsorber - NMHC and NOx threshold
  - NMHC Catalyst and Catalyzed PM Filter NMHC Conversion - NMHC threshold
- Problems:
  - LEV III standards combine NMOG + NOx, so NMHC only threshold not possible anymore
  - Future aftertreatment solutions may combine functions to control multiple pollutants (e.g., SCR on DPF for NOx and PM)
- Medium-duty chassis PM standards at issue
  - Current PM standards as high as 60 or 120 mg/mi before dropping to 10 mg/mi or 8 mg/mi during 2017-2021MY PM phase-in
    - 1.5 x standard should be readily feasible for higher PM standards

Proposed LEV III Thresholds for Chassis Certified Diesels

Proposal Summary:

- DPF Filtering Performance Monitor:
  - Absolute PM threshold of 17.5 mg/mi for LEV III vehicles certified to <=10 mg/mi PM standard
  - PM threshold of 1.75 x PM standard for all threshold monitors through 2018 MY for MDV vehicles that are not included in the MDV PM phase-in
  - PM threshold of 1.5 x PM standard for all threshold monitors for 2019+MY MDV vehicles that are not included in the MDV PM phase-in
  - NMOG + NOx and CO thresholds for DPF Filtering Performance Monitor for 2019+MY LEV III vehicles
- PM and CO added thresholds for NMHC Catalyst, NOx Catalyst, Catalyzed PM Filter NMHC Conversion, and NOx Adsorber for 2019+MY LEV III vehicles
  - Generally, PM threshold of 2.0 x PM standard
- NMOG + NOx threshold in lieu of NMOG threshold for NMHC Catalyst and Catalyzed PM Filter NMHC Conversion for all MY LEV III vehicles

Other LEV III-Related Issues

Direct Ozone Reduction (DOR) System Monitoring

- Current requirement:
  - NMOG credit ≤ 50% of the applicable FTP NMOG standard, manufacturer shall implement a functional monitor. If NMOG credit > 50% of the applicable FTP NMOG standard, manufacturer shall implement a threshold monitor.
  - Manufacturers may modify any of the applicable NMOG malfunction criteria by adding the NMOG credit to the required NMOG malfunction criteria (e.g., (1.5 x NMOG standard) + DOR system NMOG credit).
- Issue: Current requirement not appropriate for LEV III vehicles, since the LEV III standards are now NMOG + NOx.
- Proposal:
  - NMOG credit < or = 5mg/mi, manufacturer shall implement a functional monitor. If NMOG credit > 5mg/mi, manufacturer shall implement a threshold monitor.
  - Manufacturers may modify any of the applicable NMOG + NOx malfunction criteria by adding the NMOG credit to the required malfunction criteria (e.g., (1.5 x NMOG+NOx standard) + DOR system NMOG credit).

Other LEV III-Related Issues

Advanced Clean Car Technologies Not Currently Identified in the Regulation

- Example: Lean-burn systems can include both gasoline and diesel emission control technologies (e.g., NOx traps and SCR systems)
  - OBD II regulation should acknowledge usage of both instead of subjecting manufacturers to non-specific gasoline monitoring requirements (e.g., "other emission control or source system" requirements)
- Proposal: Require manufacturers to submit a plan for approval of monitoring strategies for emission controls
  - Approval based on appropriateness of monitoring requirements in gasoline and diesel sections with respect to the components, systems, and control strategies in the vehicle
    - Gasoline lean-burn systems may include monitors based on gasoline misfire, diesel boost pressure control, diesel EGR system, and gasoline and diesel aftertreatment monitoring requirements
  - Monitoring plan limited to technologies that affect NMOG, CO, NOx and PM.
- Greenhouse gas impacts not being included in this regulation update.

Gasoline Air-Fuel Ratio Cylinder Imbalance Monitor Changes

- **Current Requirement:**
  - Monitoring Requirement: Detect cylinder imbalance fault before emissions exceed 4.0x/3.0xstd in interim years (for SULEV and remaining standards respectively), then 2.5x/1.5xstd for 2014+MY
  - Enforcement Requirement: Mandatory recall thresholds set at greater than twice the malfunction criteria
- **Issues:**
  - Current monitor thresholds not appropriate for some LEV III applications (refer to proposed LEV III gasoline thresholds table)
  - Industry also requested higher thresholds for LEV III applications due to the changing emission control system structure (e.g., less space between catalyst and engine for placement of A/F sensor), which may make it harder to detect faults at lower thresholds
  - Industry requested delay in requiring final monitor thresholds for LEV II applications

Gasoline Air-Fuel Ratio Cylinder Imbalance Monitor Changes (cont.)

Proposed Amendments for LEV II Applications

- Monitoring Requirements: Delay first year of 2.5x/1.5xstd threshold from 2014MY to 2015MY
  - Can carry over 4.0x/3.0xstd threshold to 2015MY if vehicle was first certified in 2011-2014MY
- Enforcement Requirements: Proposed mandatory recall thresholds:
  - For 2013-2016MY: > twice the interim malfunction criteria
    - PC/LDT SULEV: > twice the 4.0xstd threshold (> 8.0xstd)
    - All others: > twice the 3.0xstd threshold (> 6.0xstd)
  - For 2017+MY: > twice the malfunction criteria
    - PC/LDT SULEV: > twice the 2.5xstd threshold (> 5.0xstd)
    - All others: > twice the 1.5xstd threshold (>3.0xstd)

Gasoline Air-Fuel Ratio Cylinder Imbalance Monitor Changes (cont.)

Proposed Amendments for LEV II Applications (cont.)

	2011	2012	2013	2014	2015	2016	2017+
PC/LDT SULEV	4.0x	4.0x	4.0x	4.0x	2.5x*	2.5x	2.5x
Recall	12.0x	12.0x	8.0x	8.0x	8.0x	8.0x	5.0x
All other	3.0x	3.0x	3.0x	3.0x	1.5x*	1.5x	1.5x
Recall	9.0x	9.0x	6.0x	6.0x	6.0x	6.0x	3.0x

* - may carryover 4.0x or 3.0x threshold if vehicle was first certified in 2011-2014MY

Gasoline Air-Fuel Ratio Cylinder Imbalance Monitor Changes (cont.)

Proposed Amendments for LEV III Applications

- Monitoring Requirements: Proposed thresholds:
  - LEV160/ULEV125/MDV chassis-cert:
    - 2014MY: 3.0x NMHC+NOx and CO stds
    - 2015+MY: thresholds according to LEV III thresholds on slide 4 (2019+ includes PM thresholds)
  - ULEV 50/70:
    - 2014-2018MY: 3.0x NMHC+NOx and CO stds
    - 2019+MY: thresholds according to LEV III thresholds on slide 4 (includes PM thresholds)
  - SULEV 20/30:
    - 2014-2018MY: 4.0x NMHC+NOx and CO stds
    - 2019+MY: thresholds according to LEV III thresholds on slide 4 (includes PM thresholds)

Gasoline Air-Fuel Ratio Cylinder Imbalance Monitor Changes (cont.)

Proposed Amendments for LEV III Applications (cont.)

- Enforcement Requirements: Proposed mandatory recall thresholds
  - For LEV160/ULEV125/MDV chassis: > twice the NMHC+NOx and CO malfunction criteria
    - 2014MY: > twice the 3.0xstd threshold (> 6.0xstd)
    - 2015+MY: > twice the 1.5xstd threshold (> 3.0xstd)
  - For ULEV50/70 and SULEV 20/30:
    - 2014-2022MY: > twice the interim NMHC+NOx and CO malfunction criteria (ULEV is twice the 3.0xstd threshold, SULEV is twice the 4.0xstd threshold)
    - 2023+MY: > twice the NMHC+NOx and CO malfunction criteria
  - PM threshold for all LEV III applications
    - 2019+MY: > twice the PM malfunction criteria (twice the 1.5xstd threshold or twice the 17.5mg/mi threshold)

Gasoline Air-Fuel Ratio Cylinder Imbalance Monitor Changes (cont.)

Proposed Amendments for LEV III Applications (cont.)

	2014	2015-2018	2019-2022	2023+
LEV160	3.0x	1.5x	1.5x	1.5x
ULEV125	3.0x	1.5x	1.5x	1.5x
Recall	6.0x	3.0x	3.0x	3.0x
ULEV70	3.0x	3.0x	2.0xNMHC+NOx 1.5xCO	2.0xNMHC+NOx 1.5xCO
ULEV50	3.0x	3.0x	2.0xNMHC+NOx 1.5xCO	2.0xNMHC+NOx 1.5xCO
Recall	6.0x	6.0x	6.0x	twice the malfunction criteria
SULEV30	4.0x	4.0x	2.5x	2.5x
SULEV20	4.0x	4.0x	2.5x	2.5x
Recall	8.0x	8.0x	8.0x	5.0x
MDV	3.0x	1.5x	1.5x	1.5x
Recall	6.0x	3.0x	3.0x	3.0x

2019+MY LEV III PM: monitor threshold is 1.5xPMstd (for MDV not part of PM phase-in) or 17.5 mg/mi PM threshold - recall threshold is twice the malfunction criteria (3.0xstd or 35 mg/mi)

Gasoline Air-Fuel Ratio Cylinder Imbalance Monitor Changes (cont.)

Standardization Requirements

- Manufacturers must output test results for cylinder imbalance beginning in 2019 MY
- Manufacturers must track and report in-use monitor performance data for cylinder imbalance beginning in 2019 MY

- Standardization requirements are for dedicated cylinder imbalance monitors

Hybrid Vehicle Amendments

Amendments to Monitoring Requirements

- Current Requirement: Manufacturers propose monitoring plan under comprehensive component section
  - For hybrids, manufacturers shall submit a plan to the Executive Officer for approval of the hybrid components determined by the manufacturer to be subject to monitoring in section (e)(15.1.1). In general, the Executive Officer shall approve the plan if it includes monitoring of all components/systems used as part of the diagnostic strategy for any other monitored system or component, monitoring of all energy input devices to the electrical propulsion system, monitoring of battery and charging system performance, monitoring of electric motor performance, and monitoring of regenerative braking performance.

- Proposing more specific requirements after years of experience
- Proposal for all hybrids will address:
  - Battery – functional threshold, level of pinpointing (cell vs. module vs. pack)
  - Cooling systems (e.g., battery, inverter) – monitor actively controlled components, monitor for temperature control
  - Performance checks of electric motor, generator, and regenerative braking system

Hybrid Vehicle Amendments

Battery State of Health

- Monitor the Battery State of Health for malfunctions that reduce battery performance and capacity
- Proposal: Monitor hybrid batteries for a proper functional response.
  - Require manufacturers to submit a plan for determining the aged battery threshold
  - Approval based on following factors: the demonstrated proper detection of real world battery deterioration, emission impact of aged part, the effect of the aged part on other OBD II monitors and/or emission control strategies, and the method for determining the malfunction criteria including the deterioration/aging process

Battery State of Charge

- Monitor the Battery State of Charge for malfunctions that reduce battery performance and capacity
- Proposal: Monitor hybrid batteries for malfunctions that cause battery state of charge to exceed the desired operating range specified by the manufacturer.

Hybrid Vehicle Amendments

Battery Cell Balance

- Monitor the hybrid battery for malfunctions that affect the ability of the hybrid battery system to reach desired battery cell balance
- Monitor for the inability of hybrid battery system to reach desired battery cell balance.

Battery Malfunction Pinpointing

- Pinpointing still open for discussion
  - Pinpointing of malfunctions at the battery cell level
  - Pinpointing of malfunctions for the lowest level serviceable part

Hybrid Vehicle Amendments

Hybrid Thermal Management System Performance

- Monitor all components that are controlled for heating or cooling of hybrid components on hybrid vehicles
- Detect malfunction of input/output components used for the control of temperatures in hybrid components (e.g., battery, inverter, etc.) including but not limited to fans, heat exchangers, pumps, controllers, etc.
- The OBD II system shall detect a malfunction of a hybrid thermal management system when the system is unable to deliver the amount of cooling/heating necessary for other emissions control strategies or OBDII diagnostics. If no failure of the hybrid thermal management system can lead to disablement of emission control strategies or OBDII diagnostics, a functional monitor is required.

Regenerative Braking

- Monitor the regenerative braking system for malfunctions that may disable or affect the performance of regenerative braking
- Monitor components that are used as inputs/outputs to the regenerative braking system for functional response.
- The OBD II system shall detect a malfunction of the regenerative braking system when the system is unable to deliver the amount of braking torque commanded.

Hybrid Vehicle Amendments

Generator Performance

- Monitor for malfunctions of the electric generator system when the system is unable to deliver the commanded generator current.
- Monitoring should detect and pinpoint failures whether generator current is produced by engine torque and/or regenerative braking.

Drive Motor Performance

- Monitor for malfunctions of the drive motor when the system is unable to deliver the commanded torque.
- The OBDII system shall detect a malfunction of the drive motor when drive motor performance is no longer sufficient for other emissions control strategies and/or other OBDII diagnostics.

Hybrid Vehicle Amendments

Amendments to Charging System Monitoring Requirements

- Monitor for vehicle-side malfunctions
  - Monitor on-board charger for all faults that disable or default to reduced charging performance
  - Monitoring of charge status indicator light malfunctions not required
  - Provision for no-MIL or fault codes for indeterminate charging failures

Hybrid Vehicle Amendments

Amendments to Plug-in Hybrid Misfire Monitoring

- Current Monitoring Requirement: detect misfire before emissions exceed a specific emission threshold during first 1000 revs or subsequent 4x1000 revs
- **Issue**: less engine run time makes it harder to obtain enough 1000-rev periods to detect misfire malfunctions
- **Proposal**: change from detection at specific emission threshold to detection at 2% misfire rate during any 1000-rev period
  - Allow >2% threshold if emissions don't exceed a certain emission threshold
- **Current mandatory recall criteria**: based on emission threshold malfunction criteria, not percentage of misfire malfunction criteria
- **Proposal**: If monitor threshold is 2% misfire rate, mandatory recall criteria set at detection at ≥5% misfire rate
  - If monitor threshold is >2%, then recall criteria same as current (twice the emission threshold malfunction criteria)

Hybrid Vehicle Amendments

Amendments to IUMPR Requirements

- Plug-in hybrids currently have a minimum ratio of 0.100 through 2016 model year
  - Manufacturer concerns about less engine run time in-use with less opportunities to run monitors
  - Propose to allow 0.100 minimum ratio through 2019 model year

Hybrid Vehicle Amendments

Amendments to Data Stream Requirements

- Propose support of new hybrid data parameters
  - PID $9A hybrid-related parameters
    - Taken out of PID $51 “Type of fuel currently being utilized”
    - May include “hybrid/EV charging state” (charge sustaining/depleting), “hybrid/EV battery system voltage”, and “hybrid/EV battery system current”
- PIDs to characterize real world hybrid usage, fuel economy and performance of off-cycle technologies

Proposed Provisions for No MIL Illumination

Cases Where No MIL Illumination Would Be Accepted:

- Limited to Comprehensive Components

1. "Emissions-Neutral Default Action" taken when fault occurs
   - Component/system's use is altered or terminated such that:
     - No increase in emissions
     - OBD monitoring strategies remain compliant (e.g., malfunction criteria, frequency, robustness)
     - Default action is "latched" until diagnostic passes on a subsequent driving cycle or is cleared by external tool
2. "Safety Exclusive" Component/Systems
   - Component/system's purpose and function is purely safety – i.e., designed specifically and solely to prevent and/or mitigate unsafe conditions
   - Could affect emissions and/or OBD when
     - Actively responding to unsafe conditions
     - Faulted such that its response is active when unsafe conditions are not present

Proposed Certification Requirements for No MIL Exception When using Emissions-Neutral Default Action

Non MIL Diagnostics

- Emissions-neutral default action triggered by diagnostics that meet OBD monitoring performance requirements (e.g., failure mode, malfunction criteria, monitoring frequency, robustness)
- Located in diagnostic or emission critical ECU or ECU designed to ASIL C/D (ISO 26262)
- Monitoring strategies and default action must be detailed in OBD application

Demonstrate Emissions-Neutral Default Action:

- Causes no increase in emissions (NMOG, CO, NOx, and PM)
- Renders no OBD monitor non-compliant (i.e., monitoring frequency/accuracy).
- Latches across drive cycles until fault is cleared
- No propulsion qualifies as an emissions-neutral default action

Proposed Certification Requirements for No MIL Exception When using Emissions-Neutral Default Action (cont.)

- Communication of fault information through J1979 not required:
  - Fault Codes
  - Freeze Frame Information
  - Test Results
- PVE testing required to verify proper transition to default action
  - For safety related components/systems, flexibility provided to address unsafe/impractical test conditions.

Proposed OBD Exemption of Safety Exclusive Component/Systems

Applies to Component/Systems with Purely Safety Purpose/Function

- Components that are safety related but are also used for non safety functions (e.g., electronic throttle) do not qualify
- Qualifying components/systems exempt from OBD monitoring and standardization requirements
- Exempt components/systems must be listed in documentation with compliance statement that components/systems are limited to safety functions
- Possible Examples;
  - Traction Control System
  - Anti Lock Brakes

Smart Devices: Proposal to Clarify Requirements Definitions, Applicability, General Principle

Definition:

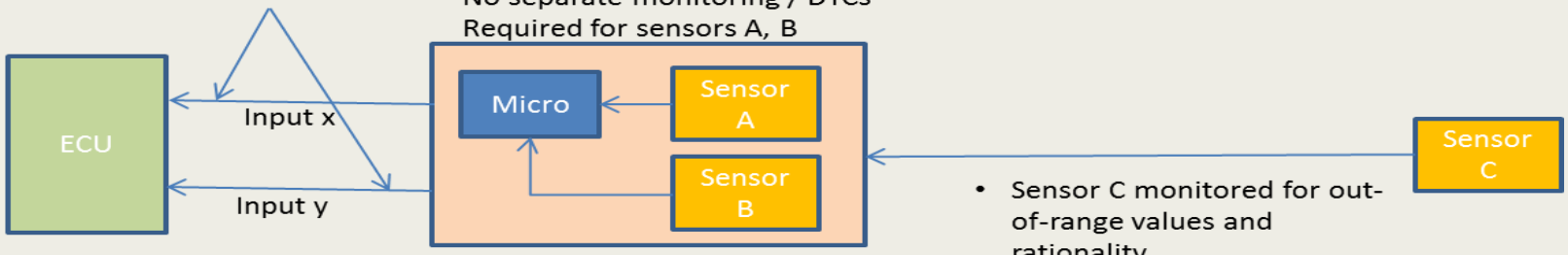
- Micro-controlled input and/or output device
- Not enough OBD content to be a Diagnostic or Emissions Critical ECU
  - Proposal is to harmonize definition of Diagnostic or Emissions Critical ECU with HD OBD regulation
- Generally replaced as single part per manufacturer repair procedures
- Subject to OBD regulation when inputs and/or outputs are:
  - Major monitor
  - Comprehensive component
  - Other emission control/source
- Level Playing Field
  - Requirements for smart/conventional devices to extent possible
  - More monitoring required as complexity increases

Smart Devices: Proposed Requirements

- General:
  - All external inputs/outputs of smart device individually subject to requirements
  - Internal sensors/functions don't have to be separately diagnosed unless specified
- Major Components (e.g., smart exhaust gas sensor)
  - Must meet all specified monitoring requirements
  - Faults detected before applicable emission thresholds exceeded or no longer sufficient as a monitoring device
- Emission-related inputs/outputs (comprehensive components)
  - Smart device inputs to ECU monitored for OOR values/rationality
  - ECU outputs to smart devices monitored for circuit continuity/function
  - Inputs to smart devices from other sources monitored for OOR values/rationality
  - Outputs from smart devices monitored for circuit continuity/function
  - Transmissions and hybrid batteries do not qualify
- Other emission controls/sources
  - Manufacturers submit monitoring plan for Executive Officer approval

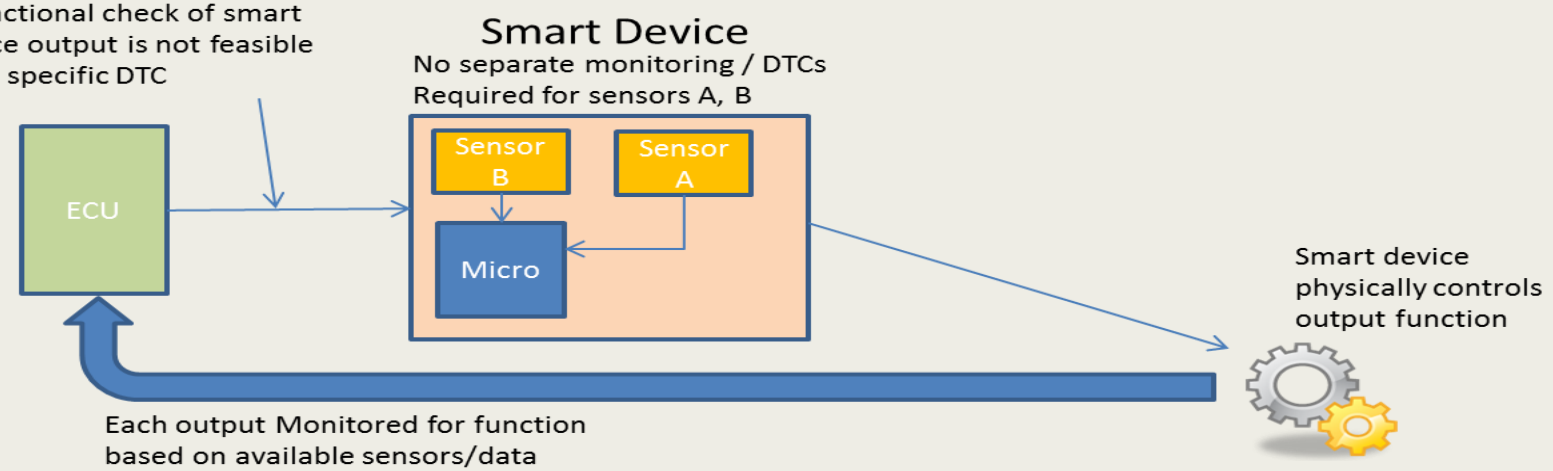
Smart Device Examples for Proposed Requirements

- Input x and input y separately monitored for out-of-range values and rationality
- Each input must use fault specific DTCs



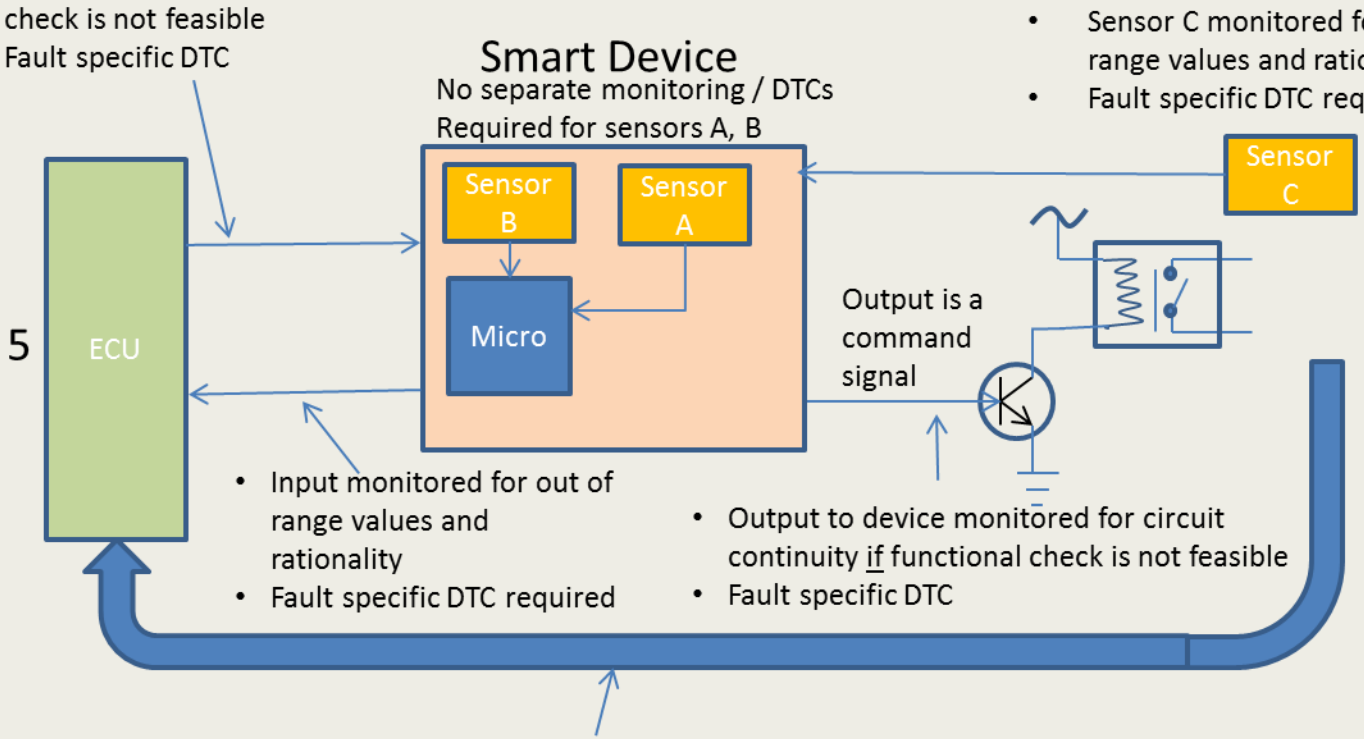
- Sensor C monitored for out-of-range values and rationality.
- Fault specific DTC required for Sensor C

- Monitored for circuit continuity if functional check of smart device output is not feasible
- Fault specific DTC



Smart Device Examples for Proposed Requirements

- Output to device monitored for circuit continuity if functional check is not feasible
- Fault specific DTC



- Sensor C monitored for out-of-range values and rationality.
- Fault specific DTC required

- Input monitored for out of range values and rationality
- Fault specific DTC required

- Output to device monitored for circuit continuity if functional check is not feasible
- Fault specific DTC

- Each output Monitored for function based on available sensors/data
- Fault specific DTC

Comprehensive Component Monitoring Requirements

Comprehensive Component Monitors

- Current Requirement: Monitor electronic powertrain components that affect emissions or are used as part of a diagnostic strategy
  - Emission impact evaluation based on reasonable in-use driving conditions resulting in worst-case emissions
    - Requires case-by-case analysis often resulting in custom drive cycle
- Proposal being considered:
  - "Test out" if no emission increase on cycles defined in regulation
    - Existing defined cycles (e.g., FTP, highway, SC03, US06, Unified)
    - Custom defined cycles for known technologies (e.g., modified FTP cycle with extended idles for stop start evaluation)
  - Keep current language as safeguard if defined cycles not appropriate
    - E.g., If technology gets some off cycle credit, special test maybe required
  - Maintain non-MIL exception (monitoring still required) for emission increases < 25% on SULEVs and < 15% on other standards
  - Not based on CO_2 impact

Standardization Requirements

Standardized Fault Codes and Fault Code Services (pending, confirmed, and permanent)

- J2012 has defined/limited ranges for standardized codes
  - OBD II fault codes use 2-byte structure
  - With growth in powertrain technologies and requirement for pinpointing, about half of reserved codes have been assigned
- Considering option to handle future expansion
  - Develop 4-byte structure (based on structure defined in UDS) in new J1979 mode
  - Maintain full support of current required J1979 modes
  - Update J1699 to test the first production vehicles

Standardization Requirements

Additional Datastream Parameters:

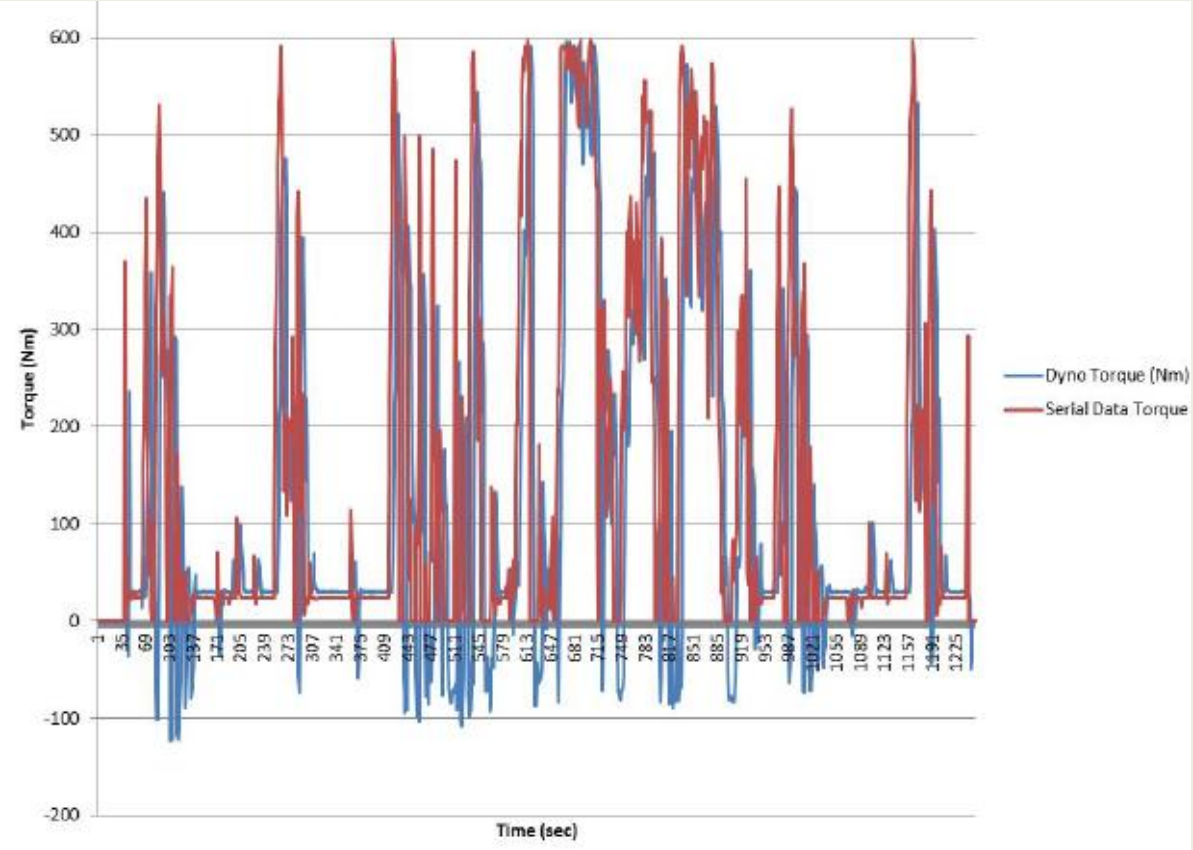
- Engine Reference torque (PID $63/SPN 544)
- Friction Losses (PID $8E/SPN 514)
- Parasitic losses (PID $?/SPN 2978)
- Actual Engine Percent torque (PID $62/SPN 513)…*already in regulation*
- DEF dosing status On/Off (PID/SPN ?)
- DEF dosing rate in ml/sec (PID/SPN ?)
- Cylinder fuel rate in mg/stroke (PID A2/SPN ?)
- Engine fuel rate in g/s (PID 9D/SPN ?)
- Vehicle fuel rate in g/s (PID 9D/SPN ?)
- NOx sensor correction in ppm (PID A1/SPN ?)

Proposal to add requirement to verify that net brake torque measured on engine dyno is equivalent to net brake torque calculated using scan tool output during DDV testing

Standardization Requirements

Engine Dyno/Scan Tool Torque Comparison over FTP & SET

- Drive Cycles FTP/SET:
  - Plot Net Brake Torque as measured by engine dyno, and
  - Plot Scan Tool Torque Output; where, Net Brake Torque = $63 * ($62 - $8E)
- Objective: verify that these data agree and that parasitic losses are *not* included in friction losses to support valid torque data for PEMs emission testing.



Standardization Requirements

Engine Dyno/Scan Tool Torque Comparison over FTP & SET (cont.)

- Parasitic losses should not be included in torque output used for PEMS emission measurements

WRONG: **Net Brake Torque = $63 * ($62 - $8E - parasitic)** **….biased-HIGH PEMs emissions**

WRONG: **Net Brake Torque = $63 * ($62)** **….biased-low PEMs emissions**

CORRECT: **Net Brake Torque = $63 * ($62 - $8E)** **….valid PEMs emissions** ✓

Standardization Requirements

Datastream Parameters to Characterize Fuel & Vehicle Usage

- Track MPG/CO2 in the real-world
  - Not just enable easier data logging but actually provide historical data
- Possible uses
  - FE/CO2 standards development
  - FE/CO2 standards compliance
  - Off-cycle CO2 credits evaluation
  - FE label evaluations
  - Data for inventory models

Standardization Requirements

Datastream Parameters to Characterize Fuel & Vehicle Usage (cont.)

- Ideas for possible PIDs for all vehicles to understand real world fuel economy and performance of off-cycle technologies
  - Odometer
  - Distance since reflash/ECM replacement
  - Distance (recent history)
  - Fuel consumed since reflash/ECM replacement
  - Fuel consumed (recent history)
  - PKE (positive kinetic energy) ~a*v
  - Number of Stops (used for stops/distance)

Standardization Requirements

Datastream Parameters to Characterize Fuel & Vehicle Usage (cont.)

- Total Propulsion System Active (PSA) time
- PSA time @ VSS <=1mph
- PSA time @ VSS >1 & <=30mph
- PSA time @ VSS >30 & <=60mph
- PSA time @ ambient < 50°F
- PSA time @ ambient > 86°F
- PSA time with Air Conditioning
- PID $7F (currently defined; proposed for all LDV/MDV)
  - Engine run time
  - Engine run time @ VSS <=1mph (idle)

Mode $09 counters and most proposed PIDs would be kept in NVRAM

Standardization Requirements

Datastream Parameters to Characterize Fuel & Vehicle Usage (cont.)

PHEV specific PIDs

- Total Distance
  - Cs distance
  - Cd engine-off distance
  - Cd engine-on distance
- Fuel Consumed
  - Cs fuel consumed
  - Cd fuel consumed
- Grid Power Consumed (kWh)
  - Cd engine-off consumed
  - Cd engine-on consumed

Other Monitoring Issues

Monitors that are often problematic with regards to OBD monitoring and certification

- Evaporative system monitor
- Positive Crankcase Ventilation system monitor

Evaporative System Monitor Changes

Purge Under Boost

- Current requirement: monitor all purge flow paths on a vehicle (e.g., turbocharged engines with low pressure and high pressure purge lines)
- Issue: Monitoring complications for vehicles with high load lines
  - Some high load lines designed to ensure purging and control evap under extreme driving conditions (e.g., >> US06 conditions)
    - Frequent robust monitoring can be a challenge
    - Some failure modes cause extreme evaporative emissions
    - Monitoring between “ejector” and intake air system can be difficult; ejector designs directly mounted to the intake system require design review

Evaporative System Monitor Changes

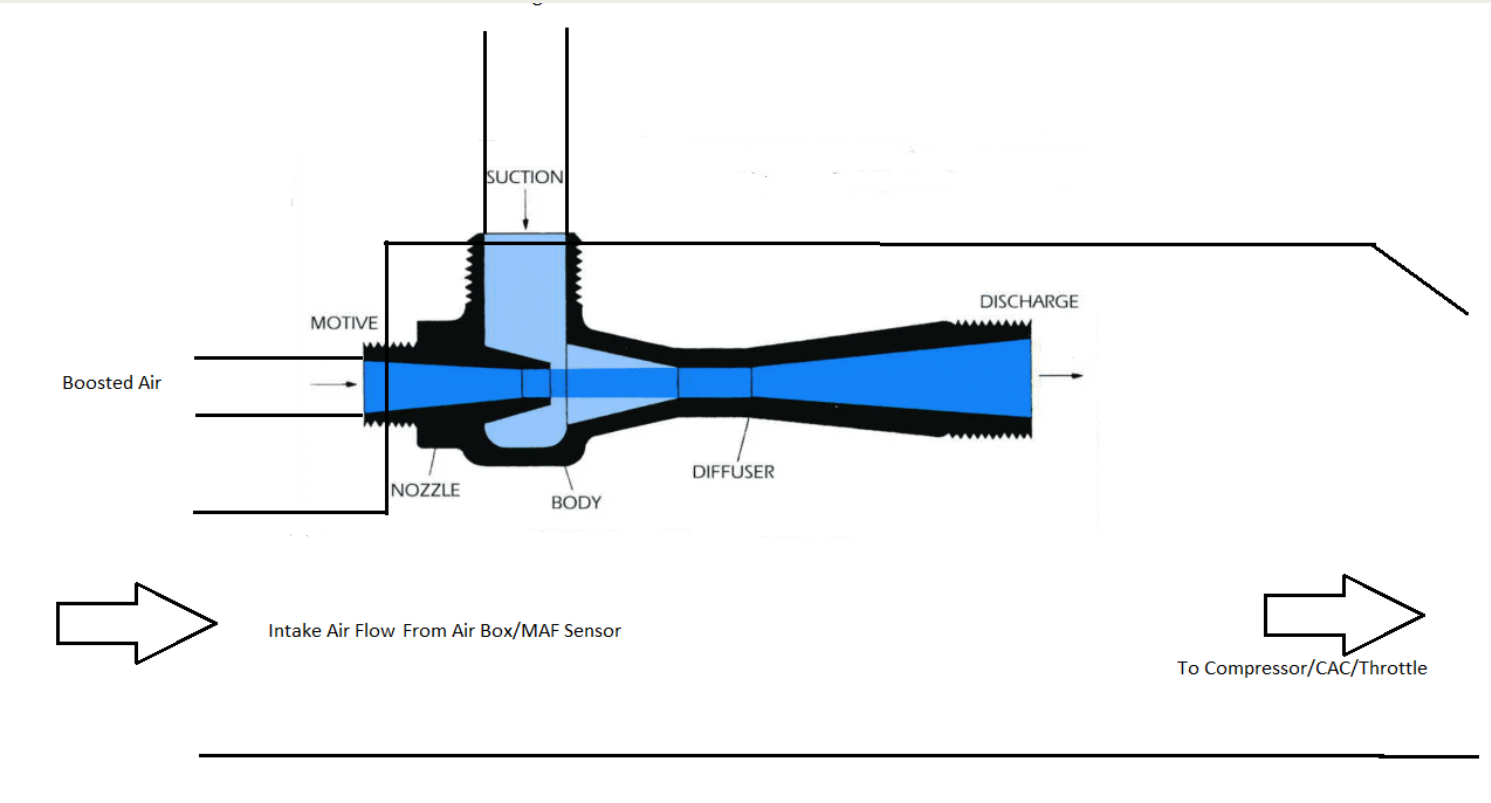
Purge Under Boost (cont.)

- Proposal being considered:
  - Protect against designs that can have failure modes that can result in gross emissions (e.g. relatively low-powered boosted engines that are frequently boosted under FTP drive conditions)
  - Test out - Specify test-out criteria in regulation to exempt monitoring of these lines that are not expected to be exercised frequently in use.
    - High load purge mass flow < 1% on US06 test cycle and = 0% on Unified test cycle

Evaporative System Monitor Changes

Purge Under Boost

- Proposal under consideration (cont.)
  - Ejector design review – Sunset external designs. Allow internal designs without design review



Evaporative System Monitor Changes

Purge Under Boost (cont.)

- Proposed in-use monitor performance requirements:
  - Numerator – Separate numerators for high load purge monitor and normal purge monitor
  - Denominator – Separate denominators for high load purge monitor and normal purge monitor
    - Currently required to increment based on cold start criteria
    - Propose to remove cold start criteria for both denominators
    - Propose to add 2 activations (>2s each) or 10s cumulative activation for high load purge monitor denominator
  - Minimum in-use ratios for Purge Monitors
    - Currently 0.520
    - Propose 0.336 for both purge monitors

Crankcase Ventilation System Monitor Changes

CV System Monitor

- Current Requirement: Monitor the CV system for disconnections and/or robust connections
- Issue: Targets connections but not overall system integrity – promotes robust connections but may not detect all system malfunctions and may hinder in-use CV system repairs
  - Objectivity in reviewing unmonitored system can be difficult and resource intensive
    - Time
    - Hands-on review of sample CV system parts

Crankcase Ventilation System Monitor Changes

CV System Monitor (cont.)

- Proposal being considered:
  - Prefer a solution that does not have design criteria for compliance
  - Require monitoring of CV system for leaks
    - Leak of minimum cross sectional area of external system
      - 0.25 inch diameter leak
    - Some manufacturers have added sensors/algorithms to their systems to detect disconnected lines. Such approaches may be capable of leak detection.
    - Exceptions to leak monitoring
      - All internal CV system (e.g., internal machined passages, no tubing or hoses)
      - 0.25 inch diameter leak results in a rapid loss of oil, engine stall, or other overt indication of a CV system malfunction that a vehicle operator is certain to have repaired

Other Proposed Amendments

Diesel OBD II Updates

- Generally align light-duty diesel requirements with past amendments made for medium-duty diesels
- Additional proposed amendments to SCR system monitoring requirements
  - **Current requirement**: Monitor for low reductant level and improper/wrong reductant
  - These conditions could be actual malfunctions of component/system on the vehicle or the result of driver action
    - E.g., repair a cracked tank versus driver has to refill tank with correct reductant to repair detected fault
  - **Proposal Under Consideration**: Allow manufacturers to be exempt from OBD monitoring requirements for low reductant level and wrong reductant if vehicle has an approved inducement strategy
    - Reductant level sensing system and reductant quality sensor required to be monitored under comprehensive component monitoring requirements

Other Proposed Amendments

Diesel OBD II Updates: Misfire Monitoring

- Current requirement: monitor for misfire on light-duty diesels only during idle and for faults that cause one or more cylinders to be continuously misfiring
  - 2010+MY with combustion/combustion quality sensors required to continuously monitor for misfire before emissions exceed specific threshold
- ARB plans to align requirements for light-duty diesels with those recently required for medium-duty diesels
- Proposal: Require continuous misfire monitoring on all light-duty diesels with phase-in during the 2019 – 2021MY
  - Detect fault when percentage of misfire ≥ 5%
  - May allow higher malfunction threshold if emissions don't exceed specific emission thresholds (i.e., proposed LEV III thresholds on slide 4)

Other Proposed Amendments

Freeze Frame Data

- Current requirement: Store and erase freeze frame data with storage and erasure of either pending DTC or confirmed DTC
  - Issue: No freeze frame data to assist repair technicians with troubleshooting/repairing pending DTC fault if freeze frame data stored with confirmed DTC
  - Proposal: Align with HD OBD regulation - Freeze frame data stored with pending DTC storage starting in 2019MY
    - Erase freeze frame data if pending DTC erased in next driving cycle
    - If pending DTC mature to confirmed DTC, may keep pending DTC freeze frame data or update with confirmed DTC – erasure of freeze frame data tied to erasure of confirmed DTC

Other Proposed Amendments

Freeze Frame Data (cont.)

- Current requirement: Only one frame of freeze frame data required to be stored and read by scan tool
  - Issue: May have freeze frame for one fault while another fault actually illuminated the MIL
  - Proposal: Require OBD II system to store and report to a scan tool a minimum of 4 frames of freeze frame data starting in the 2019MY
- Current requirement: Freeze frame data for diesel misfire fault has priority over (i.e., can replace) freeze frame data for diesel fuel system fault
  - Issue: No significant reason for this
  - Proposal: Require freeze frame data for diesel misfire and fuel system to have same priority (same as gasoline vehicles)

Other Proposed Amendments

In-use Monitor Performance Requirements

- Current requirement: General denominator is incremented based on conditions specified under section (d)(4.3.2)(B) for non-hybrids and section (d)(4.3.2)(K) for hybrids (including plug-ins)
  - (d)(4.3.2)(B) based on “time since engine start” while (d)(4.3.2)(K) based on “propulsion system active time” and “fueled engine operation”
- Issue:
  - Manufacturers requested allowance to use (K) criteria in lieu of (B) criteria on non-hybrid vehicles to allow for common software across product line
  - Not clear which general denominator is required for conventional vehicles vs. hybrid vehicles vs. plug-in hybrids
  - Need more information about driving cycles on plug-in hybrids

Other Proposed Amendments

In-use Monitor Performance Requirements (cont.)

- Proposal:
  - Manufacturers allowed to use (d)(4.3.2)(K) criteria in lieu of (d)(4.3.2)(B) criteria on non-hybrid vehicles
  - General denominator:
    - Non-hybrid vehicles: (d)(4.3.2)(B) or (K)
    - Conventional hybrids (not plug-in): (d)(4.3.2)(K)
    - Plug-in hybrids: new denominator based on (K) criteria without >10sec fueled engine operation condition starting 2019MY
  - Note: Plug-in hybrids required to track "general denominator" based on new denominator above and track denominator for monitors such as catalyst and oxygen sensor monitors based on (d)(4.3.2)(K)

Contact Info

- Official ARB documents available from
  - www.arb.ca.gov
- Direct link to OBD page:
  - http://www.arb.ca.gov/msprog/obdprog/obdprog.htm

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