

# HEAVY DUTY OBD PROGRAM UPDATE

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California Air Resources Board

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California Environmental Protection Agency



# HD OBD - Agenda

- Standardization: SAE J1939-84
- Demonstration Engine Aging
- NOx Control Performance Tracking Concept
- IRAF/UAF Concept
- ARB HD OBD Confirmatory Test Program
- Other Present and Future HD OBD Related Activities

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## J1939-84 Dynamic Testing

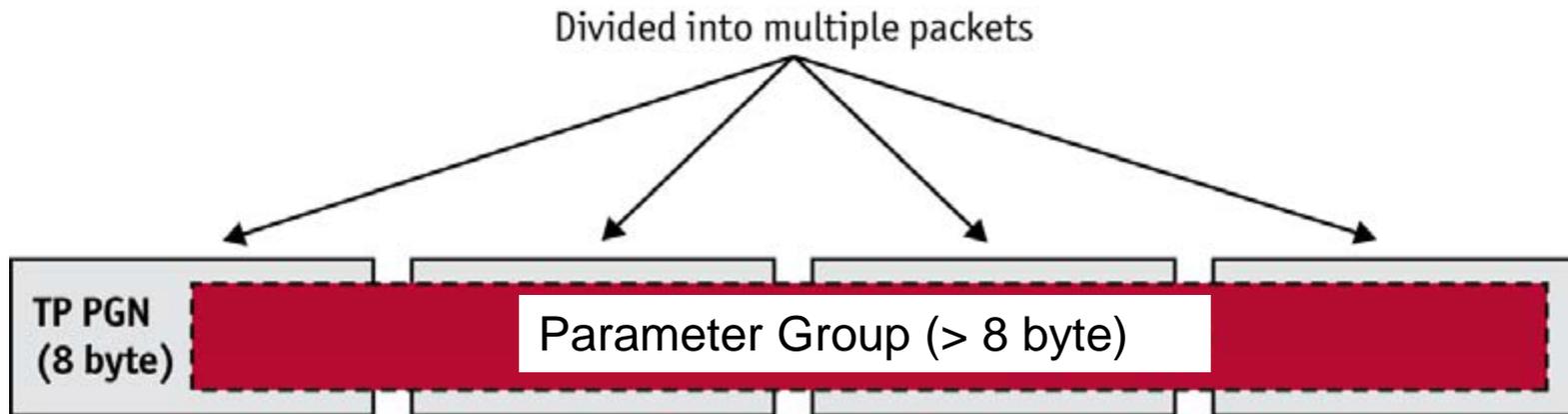
- Will propose adding an SAE J1939-84 “dynamic test”
- Dynamic test would demonstrate production vehicles are capable of setting readiness and properly incrementing all rate-based data
- Manufacturers would be required to run the dynamic test to completion and submit logfile to ARB
- Testing has revealed that HD OBD vehicles not properly incrementing numerators and denominators and not setting readiness to ‘complete’

## J1939-84 Dynamic Testing...cont.

- The requirement currently exists in section (I)(2.3.3) for verifying numerators and denominators
- The logfile would simply provide a standardized format for data submissions
- Would be post certification and the logfile should be submitted to ARB 6 months after start of production
- Same test format as found in SAE J1699 dynamic test: clear codes, run vehicle on-road until all monitors execute, overnight soak is acceptable where required by monitoring strategies
- Failures flagged if incrementing numerators or denominators too fast or too slow or readiness not set after sufficient number of drive cycles

## J1939 DM7/DM30 Test Results

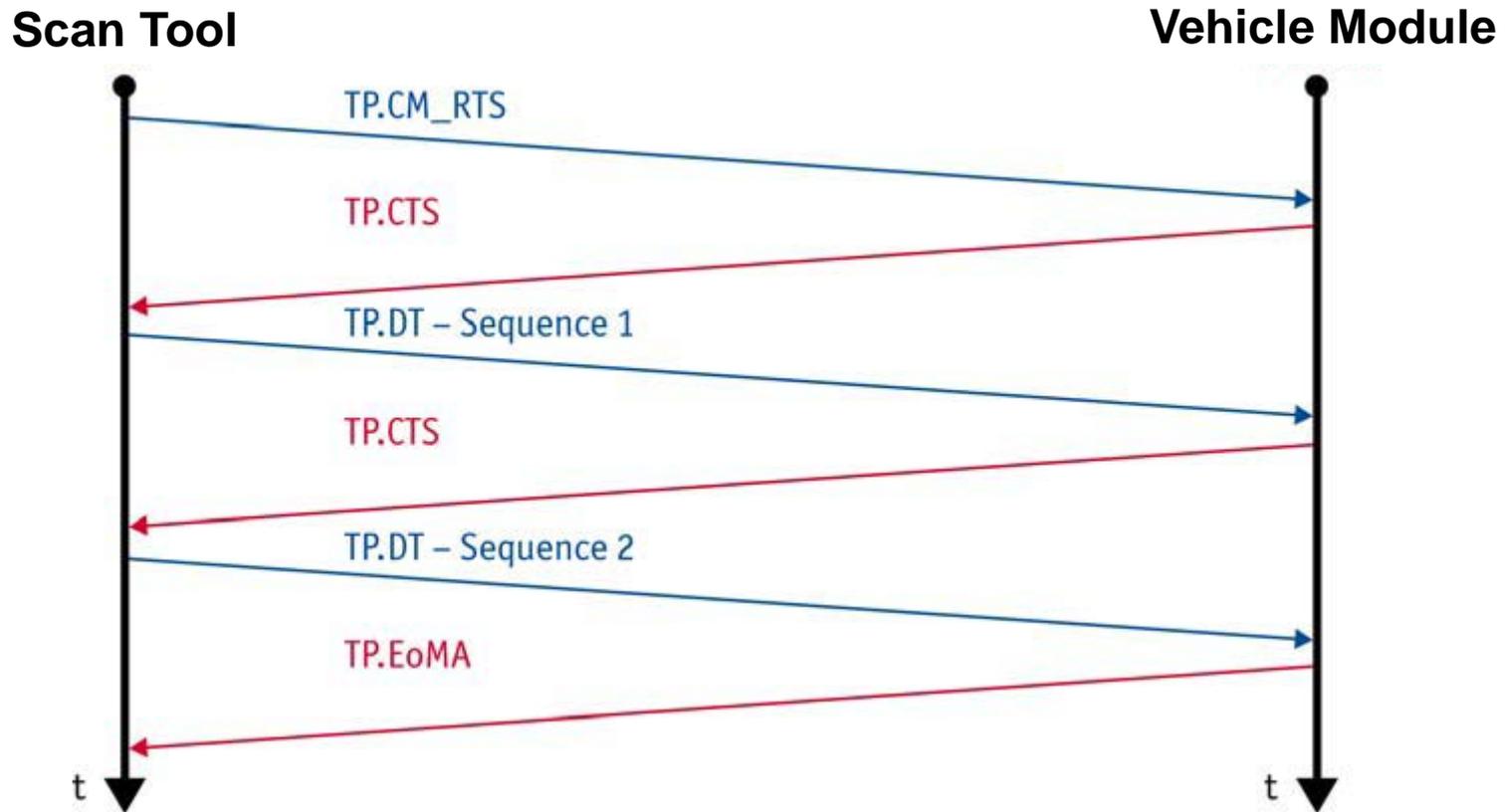
- Test results sent through TPCM windows have created timing errors
- TPCM windows are necessary when parameter groups contain more than 8 bytes of data



# HD OBD – Standardization: SAE J1939-84

## J1939 DM7/DM30 Test Results...cont.

- TPCM is a peer-to-peer transmission (not BAM or broadcast) and requires a handshaking process to initiate



## J1939 DM7/DM30 Test Results...cont.

- Problems may occur when multiple TPCM windows/sessions are started simultaneously on the same network.
  - Other modules not aware of existing TPCM window
  - May result in message delays and message transmission failures
- Test result output may need to be revisited in SAE J1939

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# HD OBD – Demonstration Engine Aging

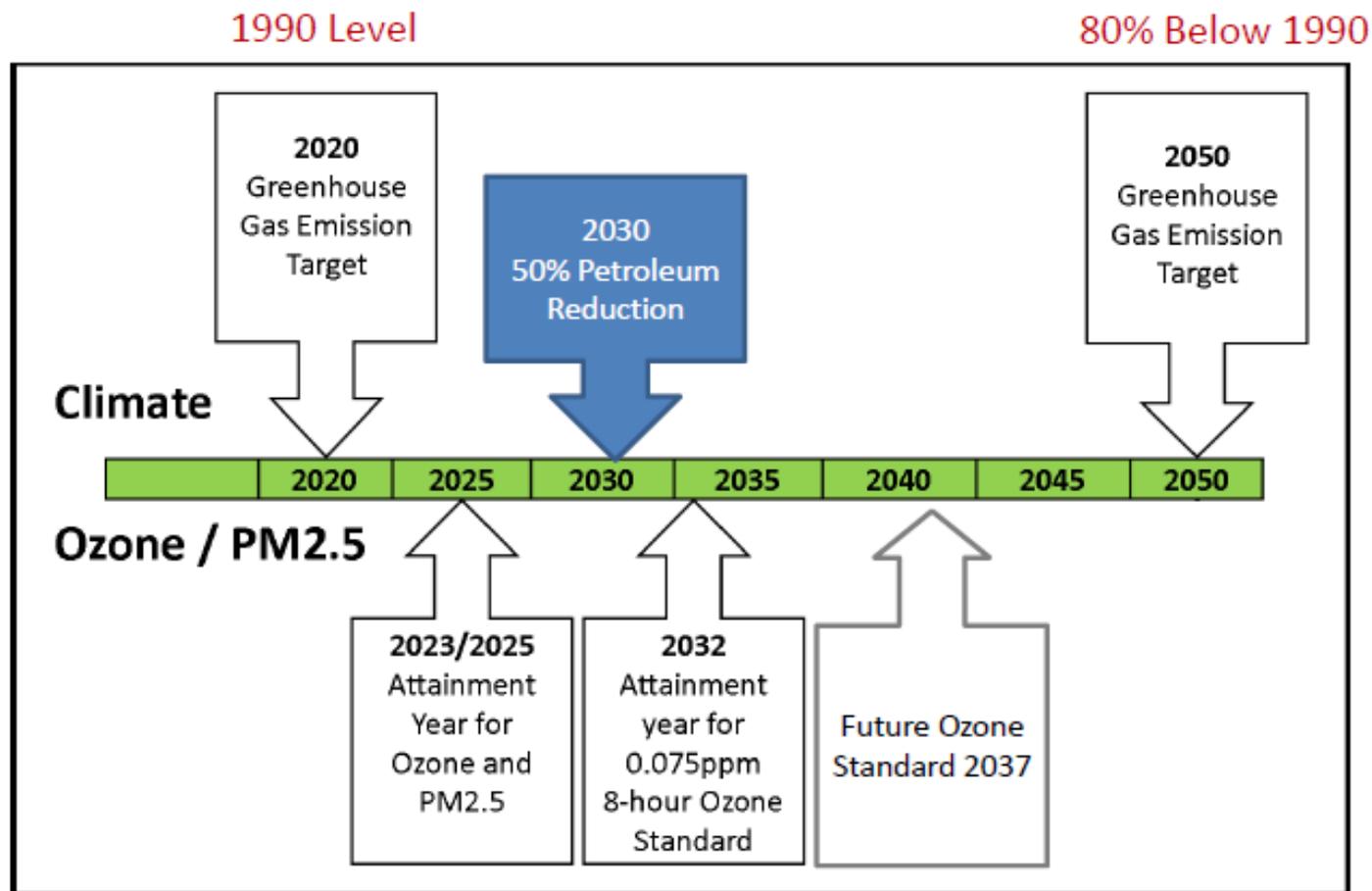
- Per section 1971.1 (i)(2.3.3), manufacturers are required to collect emission and deterioration data from an actual high mileage system to validate aging processes for the 2016 and subsequent model years
- Staff are not approving manufacturers use of new components or sensors to represent full useful life
- Staff are not approving a de-greened engine. Must be some hours under rated-load cycle or similar
- Minimum aging required on engine, aftertreatment, and sensors (e.g., ~1000 to 2000 hours on rated-load cycle) followed by additional aftertreatment (DOC/DPF/SCR) aging to reach full useful life
- Manufacturers also required to observe controller correction/adaptation values at full useful life and compare to rapid aging method values to ensure sufficient minimum aging on system

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# NOx Control Performance Tracking Concept

## Emission Reduction Timeline

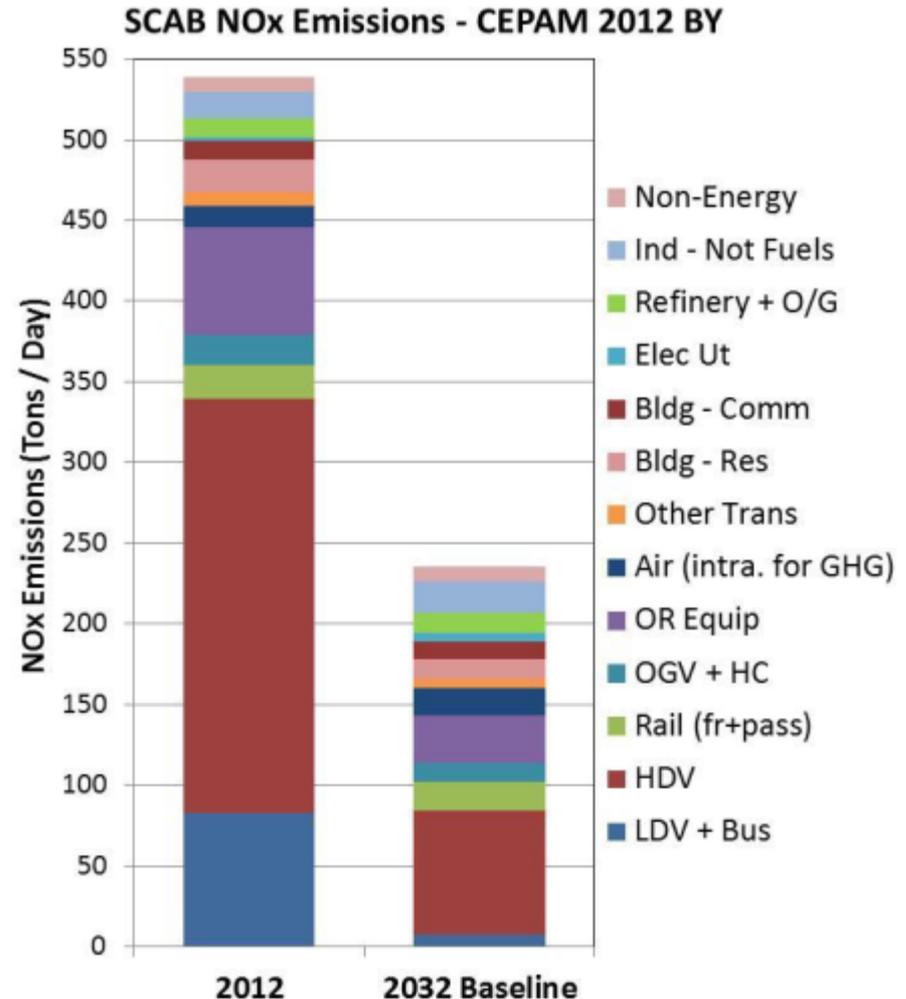


Preliminary NOx Target:  
~65-70% Below 2031

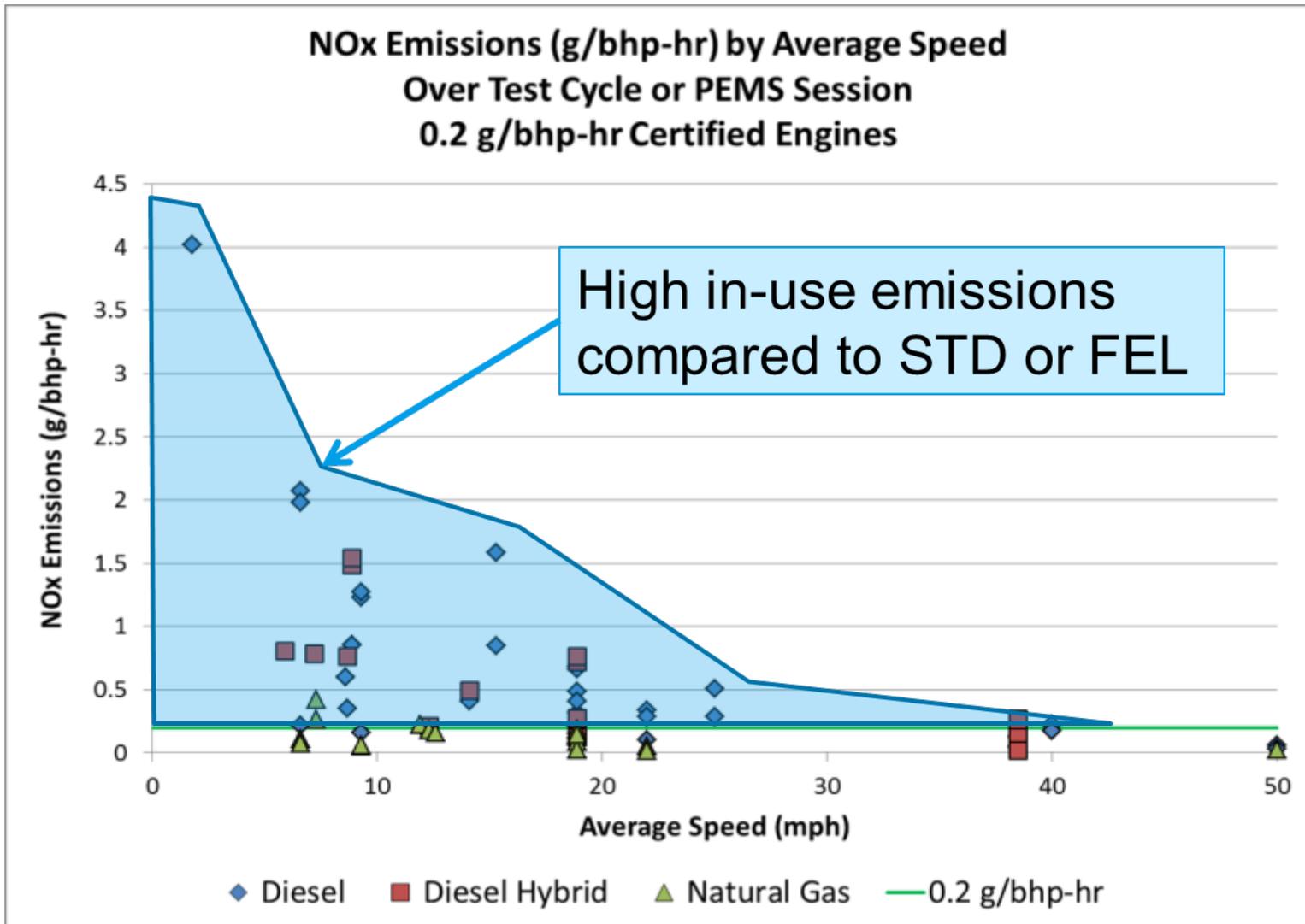
# NOx Control Performance Tracking Concept

## Background

- Major NOx reductions are needed from the heavy duty sector
- Better understanding needed of conditions where in use emission are occurring and magnitude of those emissions
- As ambient air quality standards and consequent tailpipe standards become more stringent, we need to ensure we are solving the right problems



# NOx Control Performance Tracking Concept



# NOx Control Performance Tracking Concept

- Needed data parameters from vehicle: NOx sensors, modeled engine out NOx, SCR temp, modeled exhaust flow, modeled SCR conversion...
- Calculate NOx in g/bhp-hr
- Store weighted average NOx conversion in bins along with engine runtime
- *Example:*
  - 0 mph: 0.4 g/bhp-hr, 500 minutes, ...*
  - 1 to 25 mph: 0.3 g/bhp-hr, 40,000 minutes, ...*
  - 25 to 50 mph: 0.2 g/bhp-hr, 120,000 minutes, ...*
- Could look at other metrics for binning the data for characterizing in use NOx control

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# HD OBD – IRAF/UAF Concept

## Current Status

- $EF_A = EF_L * (1 - F) + EF_H * F$
- Staff have discovered unrealistic proposals in IRAF/UAF calculations
- Manufacturers are using regeneration frequency factors, F, that are not represented by any in-use driving (e.g., regen frequencies that are far less than highway/SET)
- Is  $EF_L$  hot or cold? Is  $EF_L$  equal to FTP emissions?
- OBD requires accurate calculations for UAF so that emissions threshold monitors can be properly calibrated

## Concept Proposal

- Staff are proposing that a composite frequency,  $F'$ , be calculated using SET and FTP frequencies
- $F' = F_{ftp} * \text{offset} + F_{set} * (1 - \text{offset})$ 
  - Offset=% city driving (determined by vehicle application, such as long haul versus vocational)
  - $F_{ftp}$ =frequency on FTP
  - $F_{set}$ =frequency on SET
- This equation sufficiently bounds  $F'$ 
  - such that:  $F_{ftp} > F' > F_{set}$
- Provides a more realistic approximation for the in-use regeneration frequencies

# HD OBD – IRAF/UAF Concept

- The table below demonstrates that the calculations for  $F'$  are bounded by  $F_{ftp}$  and  $F_{set}$  for all in-use driving conditions (0% city driving to 100% city driving)

City Driving %	F-ftp	F-set	F'
0	0.20	0.05	0.05
10	0.20	0.05	0.065
20	0.20	0.05	0.08
30	0.20	0.05	0.095
40	0.20	0.05	0.11
50	0.20	0.05	0.125
60	0.20	0.05	0.14
70	0.20	0.05	0.155
80	0.20	0.05	0.17
90	0.20	0.05	0.185
100	0.20	0.05	0.20

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# HD OBD – Confirmatory Test Program

- Staff are currently testing five major HD truck manufacturers over local city and highway drive cycles
- Concerns that many major monitors may not be executing over the road
- Staff verifies monitor performance using readiness data, test results, and IUMPR
- Manufacturers should test their OBD systems on the road before releasing into production, especially monitors that were calibrated to run on the RMC cycle
- Monitors that do not run in-use may be subject to remedial action

# HD OBD – Confirmatory Test Program

- Staff noticed that some vehicles may not be properly setting readiness to ‘complete’
- Readiness criteria are not always identical to IUMPR reporting criteria
- Regulation (section (j)(2.18)) requires certification documents to include a list of all components/systems required to track and report in-use performance noted by fault code used to increment the numerator for each component/system

# HD OBD – Confirmatory Test Program

Monitoring Group	HD OBD regulation	Monitor	IUMPR	Readiness
Fuel System Monitoring	(e)(1.2.1)	Fuel System Pressure Control	Not Required	Included
	(e)(1.2.2)	Injection Quantity	Required	Included
	(e)(1.2.3)	Injection Timing	Required	Included
Diesel Misfire Monitoring	(e)(2.2.1)	Continuous Misfire During Idle	Not Required	Included
EGR/VVT System Monitoring	(e)(3.2.1)	EGR Low Flow	Not Required	Included
	(e)(3.2.2)	EGR High Flow	Not Required	Included
	(e)(3.2.3)	EGR Slow Response	Required	Included
	(e)(3.2.5)	EGR Cooler Performance	Required	Included
	(e)(3.2.6)	EGR Catalyst Performance	Not Required	Included
	(e)(10.2)	VVT Target Error, Slow Response	Required	Included
Boost Pressure Control System Monitoring	(e)(4.2.1)	Underboost	Not Required	Included
	(e)(4.2.2)	Overboost	Not Required	Included
	(e)(4.2.3)	Boost Slow Response	Required	Included
	(e)(4.2.4)	Charge Air Undercooling	Required	Included
NMHC Converting Catalyst Monitoring	(e)(5.2.2)	NMHC Conversion Efficiency	Required	Included
	(e)(5.2.3)(A)	Exotherm for PM Filter Regeneration	Required	Included
	(e)(5.2.3)(B)	Feedgas to Assist SCR System	Required	Not Included
	(e)(5.2.3)(C)	NMHC Conversion Capability for PM Filter Regeneration	Required	Not Included
	(e)(5.2.3)(D)	Ammonia Slip Catalyst	Required	Not Included
NOx Converting Catalyst Monitoring	(e)(6.2.1)	NOx Conversion Efficiency	Required	Included
NOx Adsorber Monitoring	(e)(7.2.1)	NOx Adsorber Capability	Required	Included
	(e)(7.2.2)	Active/Intrusive Desorption	Not Required	Included
PM Filter Monitoring	(e)(8.2.1)	Filtering Performance	Required	Included
	(e)(8.2.2)	Frequent Regeneration	Not Required	Included
	(e)(8.2.5)	Missing Substrate	Not Required	Included
	(e)(8.2.6)	Active/Intrusive Injection for PM Filter Regeneration	Not Required	Included
Exhaust Gas Sensor Monitoring	(e)(9.2.1)(A)(i)	Upstream Sensor Performance Faults	Required	Included
	(e)(9.2.1)(A)(iv)	Upstream Sensor Monitoring Capability	Not Required	Included
	(e)(9.2.1)(B)(i)	Downstream Sensor Performance Faults	Required	Included
	(e)(9.2.1)(B)(iv)	Downstream Sensor Monitoring Capability	Not Required	Included
	(e)(9.2.2)(A)	NOx and PM Sensor Performance Faults	Required	Included
	(e)(9.2.2)(D)	NOx and PM Sensor Monitoring Capability	Required	Included

# HD OBD – Confirmatory Test Program

<b>Monitoring Group</b>	<b>HD OBD regulation</b>	<b>Monitor</b>	<b>IUMPR</b>	<b>Readiness</b>
EGR/VVT System Monitoring	(e)(3.2.1)	EGR Low Flow	Not Required	Included
	(e)(3.2.2)	EGR High Flow	Not Required	Included
	(e)(3.2.3)	EGR Slow Response	Required	Included
	(e)(3.2.5)	EGR Cooler Performance	Required	Included
	(e)(3.2.6)	EGR Catalyst Performance	Not Required	Included
	(e)(10.2)	VVT Target Error, Slow Response	Required	Included

# HD OBD – Confirmatory Test Program

- Staff also studying on-road emission impacts of malfunctions using PEMS
- This emissions data cannot be used for compliance but may help to compare on-road malfunction emissions to OBD demonstration data collected during engine dyno testing
  - Might also provide better understanding of emission impact of malfunctions real world conditions in whole vehicle applications.

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# Other Present and Future HD OBD Related Activities

## HD OBD Regulatory Update

- Timing: to be determined, following completion of light duty update

## HD OBD for Alternative Fuel Implementation

- HD OBD begins in 2018 MY
- Potential market growth
  - Interest in low NOx engines, renewable fuels, petroleum reduction

# Other Present and Future HD OBD Related Activities

## HD In Use Inspection Programs

### Near Term Activity

- **Periodic Smoke Inspection Program (PSIP)**
  - Existing annual fleet self inspection program
  - SAE J1667 opacity test and equipment
  - DPF equipped vehicles with visible smoke shall be inspected and repaired to manufacturer's specifications by authorized service facilities
  - ARB is planning revisions to set appropriate opacity limits for J1667 test for trucks with particulate filters
  - Incorporation of EMD/HD OBD?

### Longer Term Activity

- HD Inspection and Maintenance program development
- Will use HD OBD for vehicles meeting HD OBD
- OBD staff will continue to test as many trucks as possible to facilitate program implementation

## Innovative Technology Regulation

### Background

- Provide certification/OBD approval flexibility to facilitate market launch of zero and near zero emission truck and bus technologies while maintaining ability to ensure anticipated air quality benefits

### Concept

- Tiered approach would allow most flexibility for the initial introduction with decreasing flexibility through progressive tiers
- Tiers defined by time and/or volumes

## Innovative Technology Regulation

### Next Steps

- Workshop scheduled for September 28, 2015
- Board Hearing tentative target is early 2016
- Webpage

[www.arb.ca.gov/msprog/itr/itr.htm](http://www.arb.ca.gov/msprog/itr/itr.htm)

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