Workshop for 2006 Biennial OBDII Update and Emission Warranty Changes

Advanced Engineering Section
Mobile Source Control Division
California Air Resources Board

CARB Workshop
November 16, 2005
El Monte, CA

Discussion Points

- Background
- Gasoline Monitoring Changes
- Other OBD II Changes
- Enforcement Regulation Changes
- Emission Warranty Regulation Changes
- Diesel Monitoring Changes

Background

- Since its inception, OBDII regulation has been subject to biennial reviews
  - Report back to the Board on manufacturers' progress in meeting the requirements and propose changes, as needed
- Discuss proposed changes today
  - Follow up with a staff proposal in early 2006 for a ~March 2006 Board Hearing

Background (cont)

- Discussion today will also include proposed changes to Emission Warranty regulations
  - Primarily updating the high-priced components definition
- Format for today's discussion
  - Staff presentation on portion of changes followed by discussion of those items

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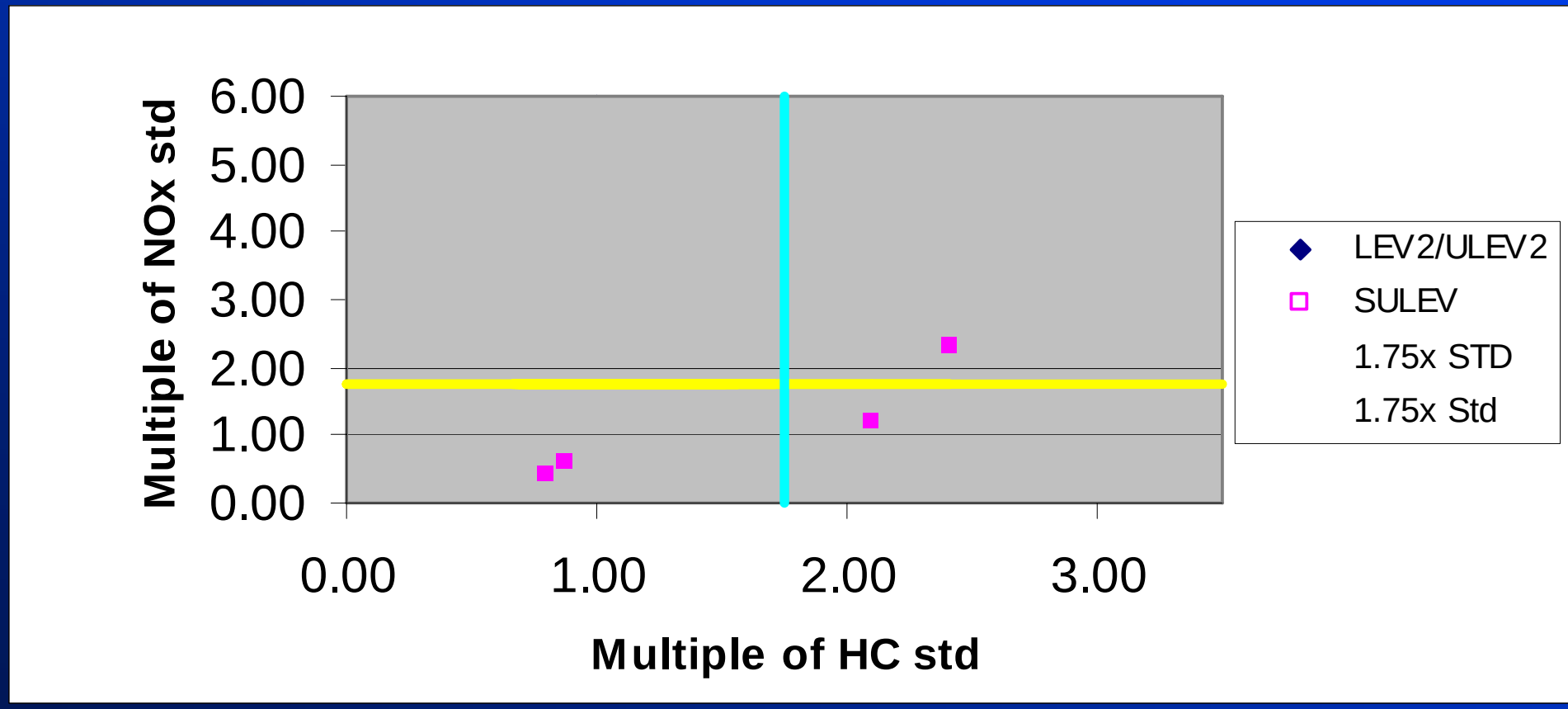
NOx Catalyst Monitoring

- Industry proposed 3.5 times the NOx standard as permanent NOx threshold
- Demonstration data indicate that 1.75 criterion is met on most demonstration vehicles
- Intend to retain final threshold of 1.75 x NOx standard for 2007 and subsequent model years
  - Industry has not justified need to extend 3.5 threshold

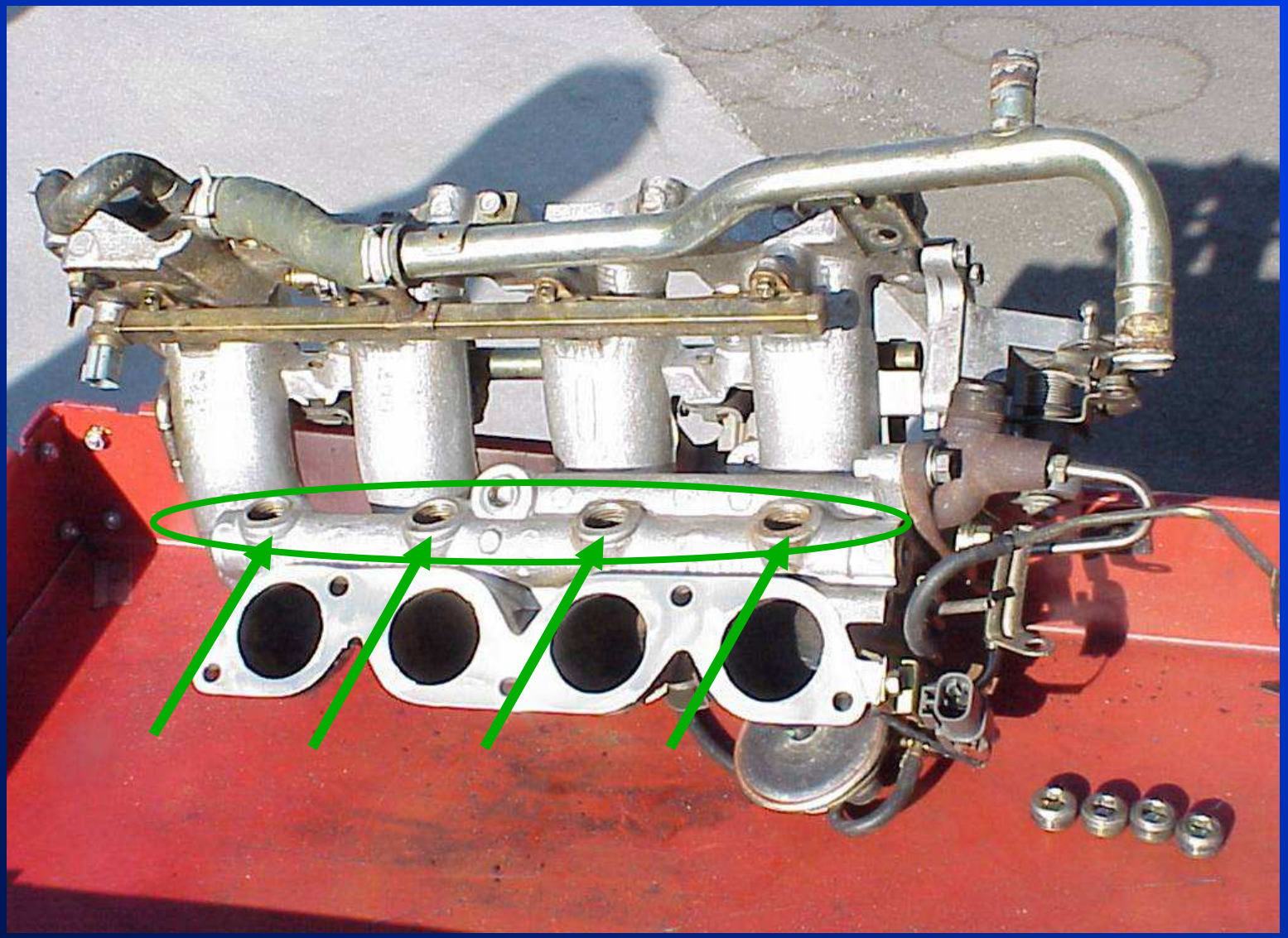
Catalyst Monitor Demo Data



Cylinder A/F Imbalance Background

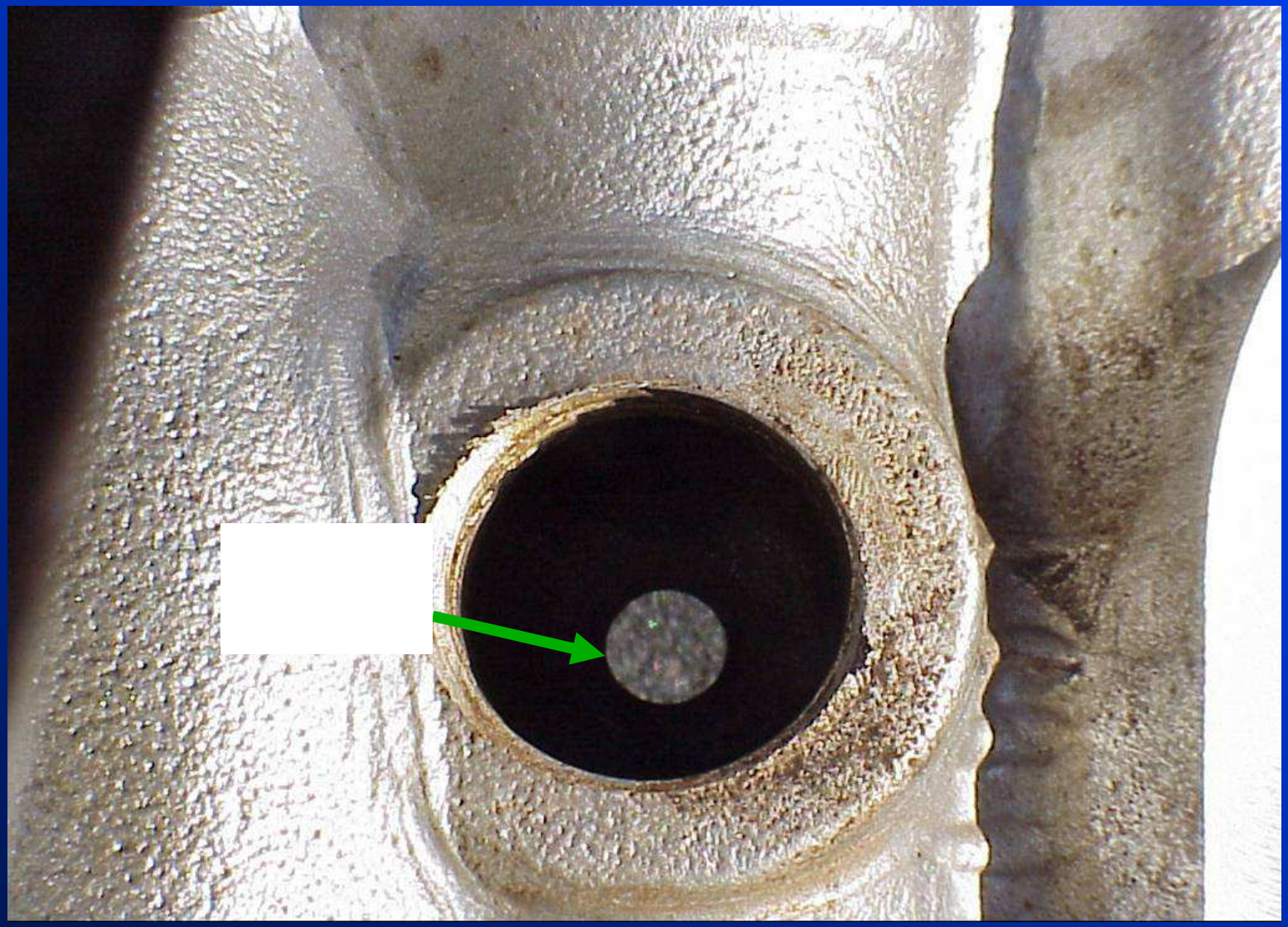
- Field testing has revealed a failure mode OBDII generally does not comprehend
  - Proposing an additional monitoring requirement to cover this
- Problem appears to be cylinder to cylinder differences in air/fuel ratio that are improperly corrected by fuel control
  - Can be caused by fuel injector variation, intake air delivery variation, or uneven EGR distribution

1997 Nissan Altima Intake Manifold



Zooming in on a plugged EGR orifice

Same EGR orifice after cleaning



Cylinder A/F Imbalance Background

- Imbalance can have a significant emission impact
  - NOx emissions on Altima:
    - 160k cat: 3.0x std before EGR cleaning, 2.4x std after
    - 0k cat: 1.1x std before EGR cleaning, 0.5x std after
  - Data from another manufacturer with varied fuel injection quantity
    - FTP emission impact from 0 to >5x std (depending on which cylinder) with ~25% quantity shift
- Many times front O2 sensor does not see all cylinders equally
  - Location of sensor in manifold collector
  - Oversensitive or “blind” to specific cylinders
  - Causes improper fuel system correction

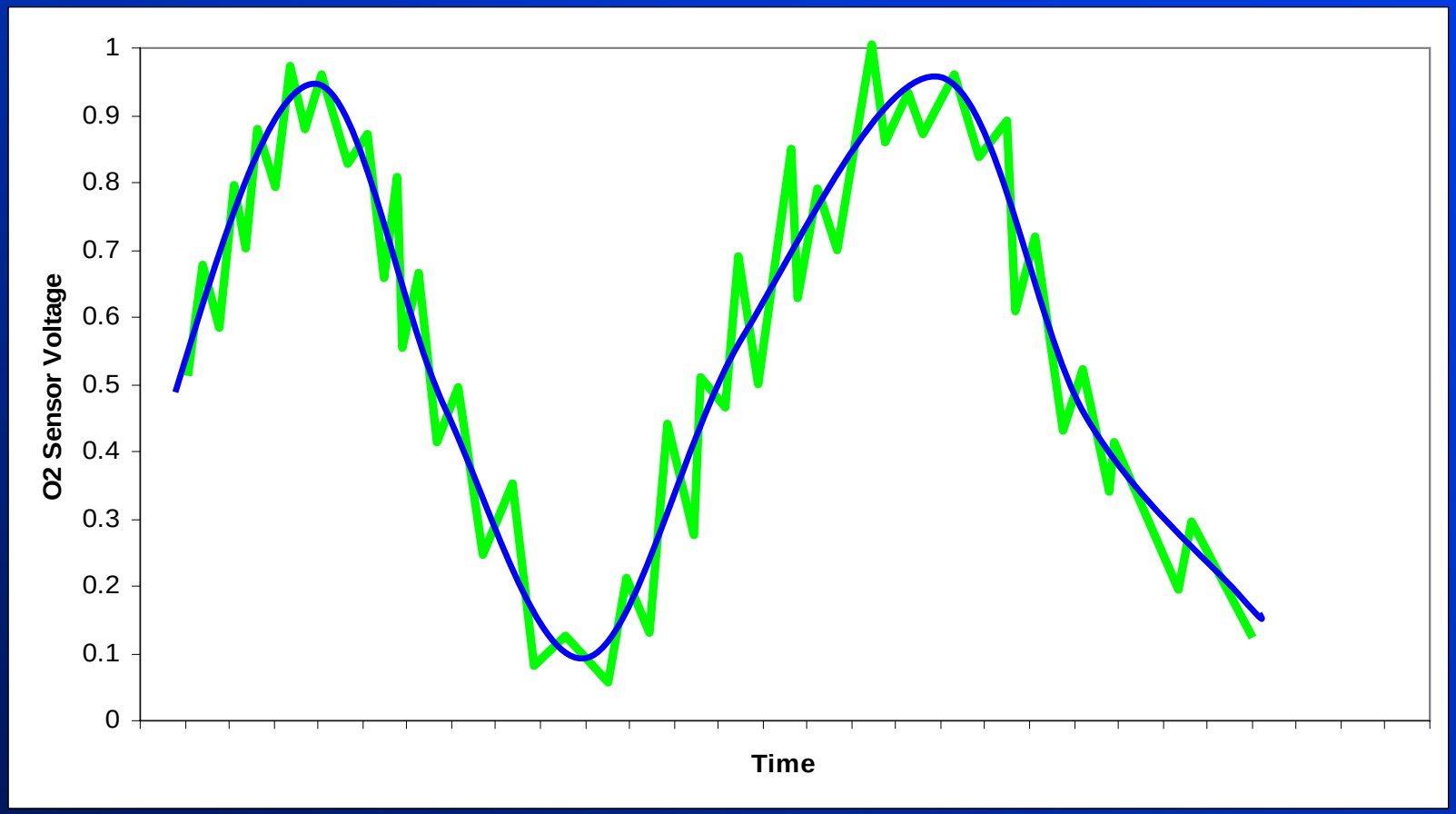
Cylinder A/F Imbalance
Proposed Monitoring Requirements

- Detect an air-fuel ratio cylinder imbalance in one or more cylinders that prevents the fuel delivery system from maintaining emissions
- Emission Threshold: 1.5 x FTP standards
- Phase-in:
  - 25/50/75/100% for 2011/2012/2013/2014 model years
  - 100% in 2011MY for vehicles equipped with multiple EGR flow delivery passageways to deliver exhaust gas to individual cylinders or groups of cylinders

Cylinder A/F Imbalance
Possible Monitoring Strategies

- Problem first observed on a Geo Metro (Suzuki) with intake valve deposits
  - Caused cylinder A/F variations from internal EGR
- Investigation by Suzuki revealed front O2 sensor overcompensating for one cylinder
  - Close look at front O2 data by Suzuki showed “noise”
- Investigation by another manufacturer also showed some potential in front sensor signal analysis

Front Oxygen Sensor “Noise”



Cylinder A/F Imbalance
Possible Monitoring Strategies (cont)

- Rear O2 sensor signal often shows signs of cylinder imbalance as well
  - Geo Metro did not have rear O2 fuel control and rear sensor output was consistently lean (non-stoich)
- Rear sensor analysis alone might not be sufficient
  - Depending on catalyst and sensor configuration, rear sensor might not provide sufficient data
- Monitoring of rear O2 fuel control values not likely sufficient to cover all cases
  - This will remain a separate monitoring requirement

Rear Oxygen Sensor Monitoring

- Current requirement includes:
  - To the extent feasible, detect a fault when the rear sensor is no longer reliable for monitoring
- Proper catalyst monitoring is a key concern
  - In-use vehicles confirm suspicion that deteriorated rear sensors affect catalyst monitor (i.e., catalyst malfunction is detected after rear O2 sensor is replaced)

Rear Oxygen Sensor Concerns

- Ideal situation is that rear sensor is either:
  - Good enough to robustly detect a “threshold” catalyst; or
  - Detected as faulty rear sensor and turns on MIL
- Very few manufacturers meet this ideal situation
  - Most have a gap between where the sensor is no longer sufficient for catalyst monitoring and where it can be detected as malfunctioning
  - Even so, catalyst DTCs are a significant % of failures on high mileage cars in I/M
  - More malfunctioning catalysts will be properly identified in I/M with improved rear sensor monitoring

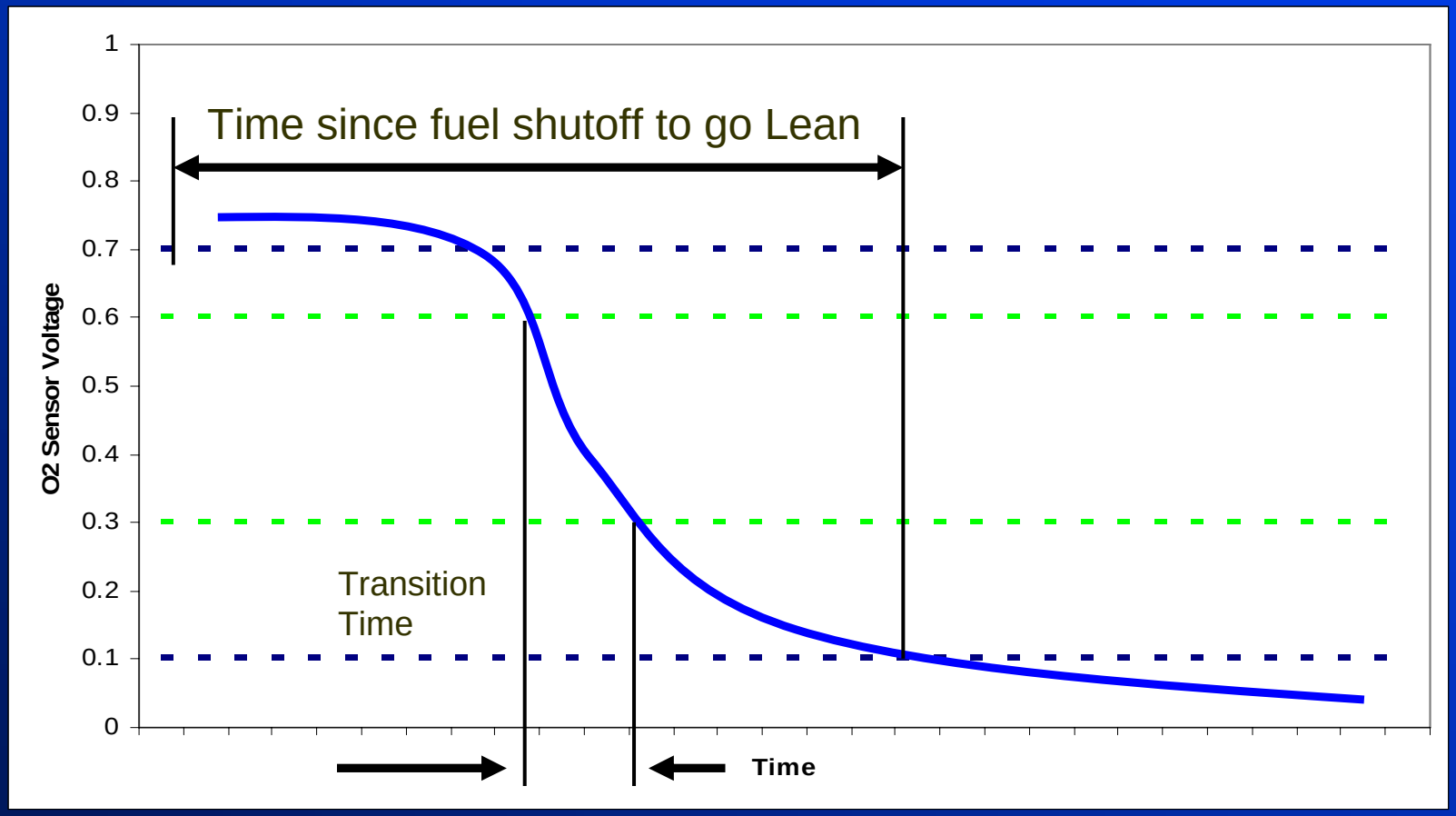
Rear Oxygen Sensor Regulation Changes

- Add specification as to minimum acceptable monitor:
  - Use experience from what manufacturers have been doing
  - Demonstration that ideal situation is met eliminates need for further improvement
- Require “two-prong” rich-to-lean monitoring
  - Verify sensor goes lean enough, fast enough during mandatory, intrusive fuel cut
  - Isolate sensor response from catalyst effects and transport time as much as possible

Rear Oxygen Sensor Changes (cont'd)

- The OBD II system shall, at a minimum, detect a slow rich to lean response malfunction during a fuel shut-off event (e.g., deceleration fuel cut event)
  - Monitor the sensor response time from a rich condition (e.g., 0.7 Volts) prior to the start of fuel shut-off to a lean condition (e.g., 0.1 Volts) expected during fuel shut-off conditions
  - Monitor the sensor transition time in the intermediate sensor range (e.g., from 0.55 Volts to 0.3 Volts)
  - Diagnostics should be calibrated to the extent feasible with application specific data ("corporate" calibrations are unacceptable)
- Required tracking and reporting of in-use monitoring frequency for 2010 model year

Rear Oxygen Sensor Monitoring



Further Rear O2 Investigation

- Still investigating feasible methods for lean-to-rich monitoring
  - Current strategies include enrichment or immediately following re-fueling after DFCO
  - No proposed regulatory changes at this time

Comprehensive Components

- Added exemption provisions under transfer case requirements
- Components/systems that are driven by the engine and affect emissions due to added engine load may be exempt if:
  - They are not related to the control of fueling, air handling, or emissions, AND
  - They are not used as part of the diagnostic strategy for any other monitored system or component.
- E.g., electronic power steering

Comprehensive Components cont'd

- Components/systems that affect emissions due to added electrical load may be exempt if:
  - They are not related to the control of fueling, air handling, or emissions, AND
  - They are not used as part of the diagnostic strategy for any other monitored system or component.
- E.g., smart charging system component malfunctions

Comprehensive Components - Hybrids

- Manufacturers shall submit monitoring plan of the hybrid components for ARB approval
- Monitoring required for
  - All components/systems used as part of the diagnostic strategy for any other monitored system or component
  - All energy input devices to the electrical propulsion system
  - Battery and charging system performance, electric motor performance, and regenerative braking performance
- Monitoring of performance accessory loads is not required

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Permanent DTCs

- The proposal requires the implementation of permanent DTCs as was done in HD OBD
- Feedback from I/M programs is showing an increase in readiness status loopholes
  - CA Smog Check allows up to two monitors to be not ready at the time of inspection w/o failing the OBD test
  - Running all monitors may be too burdensome
  - What we are really interested in are monitors that have detected a fault and commanded the MIL on

Structure of Permanent DTCs

- Any DTC that is commanding the MIL on must be logged as a permanent fault code
  - Permanent DTCs must be stored in memory that survives a battery disconnect and all scan tool clear code commands (e.g., Mode $04 clear, reset KAM, enhanced comm mode clearing, etc.)
- Permanent DTC can only be erased by the vehicle's OBD II system. The following are two examples for clearing:
  - (1) If the fault is healed or fixed and MIL goes off, the permanent DTC can bee erased at the time the MIL goes off
  - (2) If the Mode $03 DTC is cleared with a scan tool, the permanent DTC is not erased, but can be cleared after the specific monitor that set the MIL has run and reached a pass judgment
- Still working on the best format to retrieve PDTCs. Some possible solutions are creating a new mode in SAE J1979 or creating a new request as a subpart of the existing Mode $09

Permanent DTCs

- NVRAM Memory Requirements
  - Enough memory must be allocated to store a minimum of four permanent DTCs
  - Additionally, misfire and fuel system permanent DTCs must also store similar conditions in NVRAM to allow for proper erasure
- Permanent DTCs will be fully implemented in the 2010 MY
  - Not proposing phase-in requirements but all vehicles must comply in the 2010 MY

DDV and PVE Changes

- DDV and PVE Selections
  - Existing Selection Requirements:
    - 1 - 5: 1 DDV; 2 PVE
    - 6 - 10: 2 DDV; 4 PVE
    - 11+: 3 DDV; 6 PVE
  - New Selection Requirements:
    - 1 - 5: 1 DDV; 2 PVE
    - 6 - 15: 2 DDV; 4 PVE <= changed
    - 16+: 3 DDV; 6 PVE <= changed

PVE Testing

- Section (j)(1) – J1699 Testing
  - The regulation makes specific references to the J1699-3 test
  - The time to complete and submit test data has been extended from 1 month to 2 months after production
- Section (j)(2) – MIL Demonstration Testing
  - No Changes
- Section (j)(3) Rate-Based
  - The time to collect and submit rate-based data has been extended from 6 months to 12 months after production

Rate-Based Changes

- Interim 0.100 Ratio
  - The interim 0.100 ratio has been extended by one year for each phase-in year (Section (d)(3.2.1)(D))
- PM Filter Monitoring
  - Added language to allow the PM filter monitor and other monitors designed to execute on active regen events to increment the denominator every 500 miles
  - Required to meet 0.336 ratio

Rate-Based

- Background Rate-Based Calculations
  - For 0.020” Leak
    - Ratio of 0.26 = 50% in 2 weeks with MIL ON and 81% in 4 weeks
  - For 0.040” Leak
    - Ratio of 0.52 = 77% in 2 weeks with MIL ON and 90% in 4 weeks

MIL Circuit Monitoring

- I/M Programs & Bulb Check
  - Not obvious to a technician to initiate KOEO on keyless ignition vehicles
  - KOEO procedures are not standardized
  - More MFGs using Keyless ignition
- MIL Circuit Monitoring
  - OBD II system must be able to detect burned out bulb/circuit faults and report MIL status as “commanded on”
  - Requirement for 2010 MY and subsequent keyless ignition vehicles

Mail-Out

- Standardized Templates Referenced in Regulation
  - OBD II Certification Application
    - Existing Mail-Out #95-20
  - Misfire Data
    - Probability of Detection table Mail-Out #96-05, and
    - Misfire Disablement plot
  - Cal ID/CVN
    - Electronic submission per specified format
    - Allows for data to be efficiently uploaded into database
  - Rate-Based Data (j)(3)
    - Electronic submission and hardcopy

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Enforcement Regulation (1968.5) Updates

- Non-substantive changes
  - Updated references to sections within 1968.2
  - Modified to comprehend additive and multiplicative thresholds
- Rate-based
  - Aligned in-use rate-based compliance with longer roll-out of 0.100 ratio

Enforcement Regulation (1968.5) Updates (cont.)

- Change to Mandatory Recall criteria
  - Currently includes "…cannot be tested so as to obtain valid test results in accordance with the procedures of the California I/M program…"
  - Also references a BAR inspection manual
- Specific criteria now enumerated in 1968.5(b)(6)(C)(ii)
  - Same intent, but eliminated reference to other documents
  - Listed each item that needs to be communicated properly to ensure successful testing

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Emission Warranty Background

- Sections 2035, 2037, and 2038 are relevant
  - 2035 is definitions
  - 2037 is “defects” warranty
  - 2038 is “performance” warranty
- Current warranties essentially require:
  - 3yr/50k for all emission parts including anything that turns on the MIL (“defects”) plus anything that causes an I/M fail (“performance”)
  - 7yr/70k for “high-priced” parts
    - Meet a CPI adjusted cost for repair and are on a parts list

Emission Warranty Changes

- Sections 2035 and 2038 modified
- Non-substantive modifications
  - Reformatting and clean-up of 2035 and 2038
- For reference, 2035(c)(2) defines “warranted part” as:
  - “any part…which affects any regulated emission… subject to California emission standards”
- And, 2037(b)(2) requires:
  - 3yr/50k defects coverage for “warranted parts”

Emission Warranty Changes (cont.)

- Section 2037(c) modified
- Definition of "high-priced" parts changed
  - Cost numbers/equation unchanged
  - Changed coverage from:
    - Meets cost number and is on the "Emission Warranty Parts List," last amended February 22, 1985
  - To:
    - Meets cost number and is subject to 3 yr/50k defects coverage as a "warranted part"
  - Would apply starting with 2007 MY vehicles produced after June 1, 2006