CRC Project E-90-2a
Evaluation of Inspection and Maintenance OBD II Data to Identify Vehicles that May be Sensitive to E10+ Blends

Background

- CRC Project E-90 investigated long-term fuel trim for vehicles arriving at I/M stations for their periodic inspection.
- There is concern that vehicles near their lean-limit on E0 or E10 may log an OBD malfunction if operated on E15 or E20, even though within design tolerances.
- Although very useful data were collected in E-90, the number and range of vehicles tested were limited.
- A data source that can supplement the results from E-90 is OBD data from I/M programs.
- This project identified specific vehicle models that have a propensity to fail for lean operation in customer service on E10 and lower ethanol blends; that propensity could be exacerbated when operating with E15 or E20.

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Scope of Work

- Identify I/M program data to analyze
  - Seek data from E0 and E10 areas; E5.7 also to be considered.
  - Analyze data from an area that changed from E0 to E10.
  - Recommend methods to adjust I/M results to reflect on-road performance.
- Identify specific DTCs to analyze (DTC = Diagnostic Trouble Code)
  - Lean-limit failures identified by P0171/P0174 DTCs; mfr-specific codes may also signify a lean-limit failure.
  - Rich failure modes assessed to establish ratio of lean/rich failures.
- Analyze data and identify sensitive vehicles
  - Compare results to vehicles identified in E-90.
  - Manufacturers to assess validity of fuel effect for specific make/model/myr/displacement categories identified in the I/M data.
  - Use results to help select vehicles for follow-up testing in E-90-2b.

CRC Project E-90-2a
Draft Results

- Sierra Research was selected as the contractor.
- Analysis focused primarily on two I/M data sets:
  - Atlanta, which was at ~E2* in 2007 and E10 in 2009.
  - Southern California, which was at E6 in 2009 and E10 in 2010.
- VIN characters were used to identify specific make, model, model year, and displacement categories.
- Lean-limit failure rates were determined before and after the step-change in ethanol content.
  - Only initial I/M tests were included in the analysis.
  - Vehicle categories with more than 100 tests were targeted.

* Some E10 had entered the Georgia market in 2007; the average ethanol in the gasoline pool was 2%.

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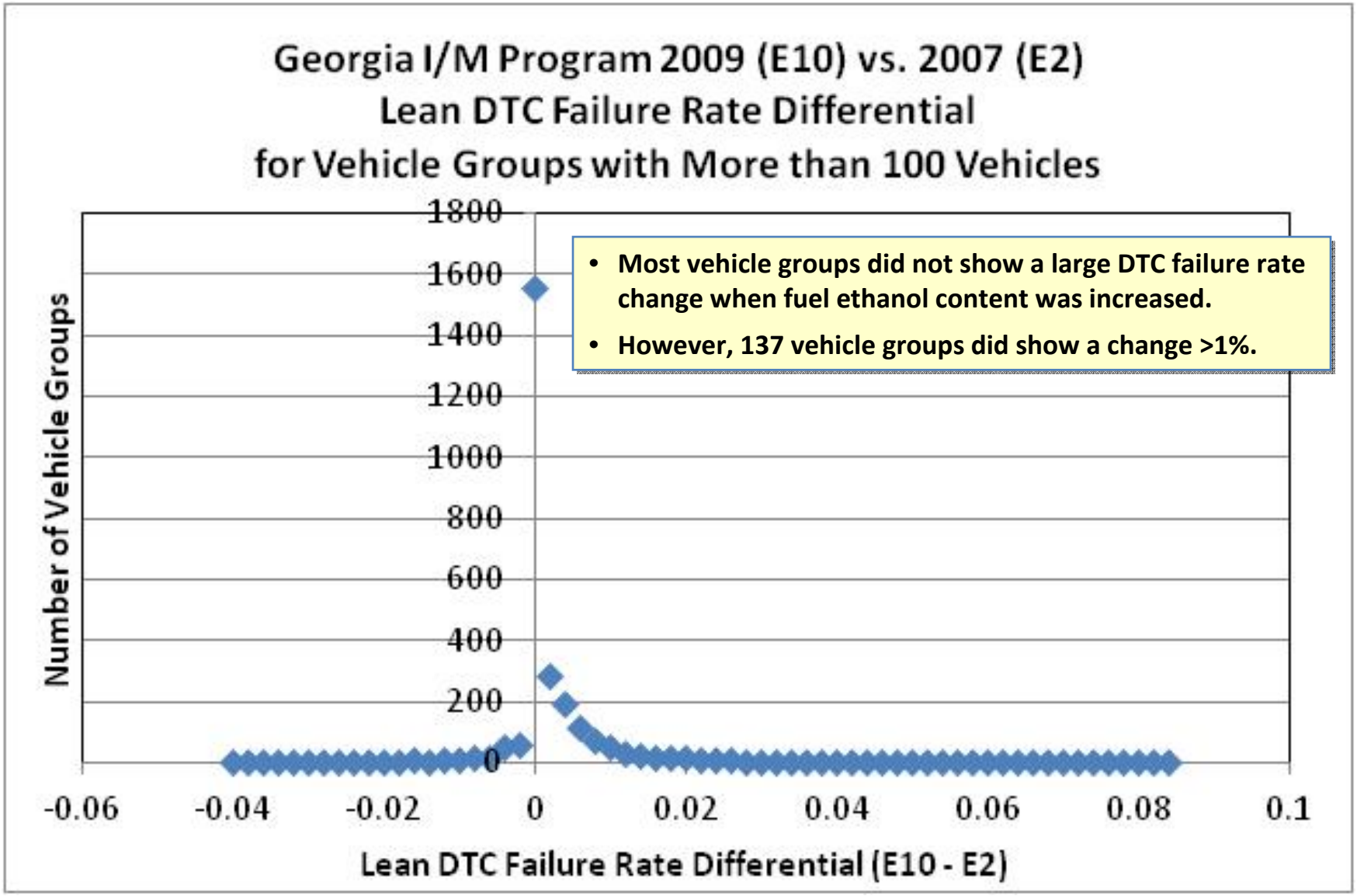
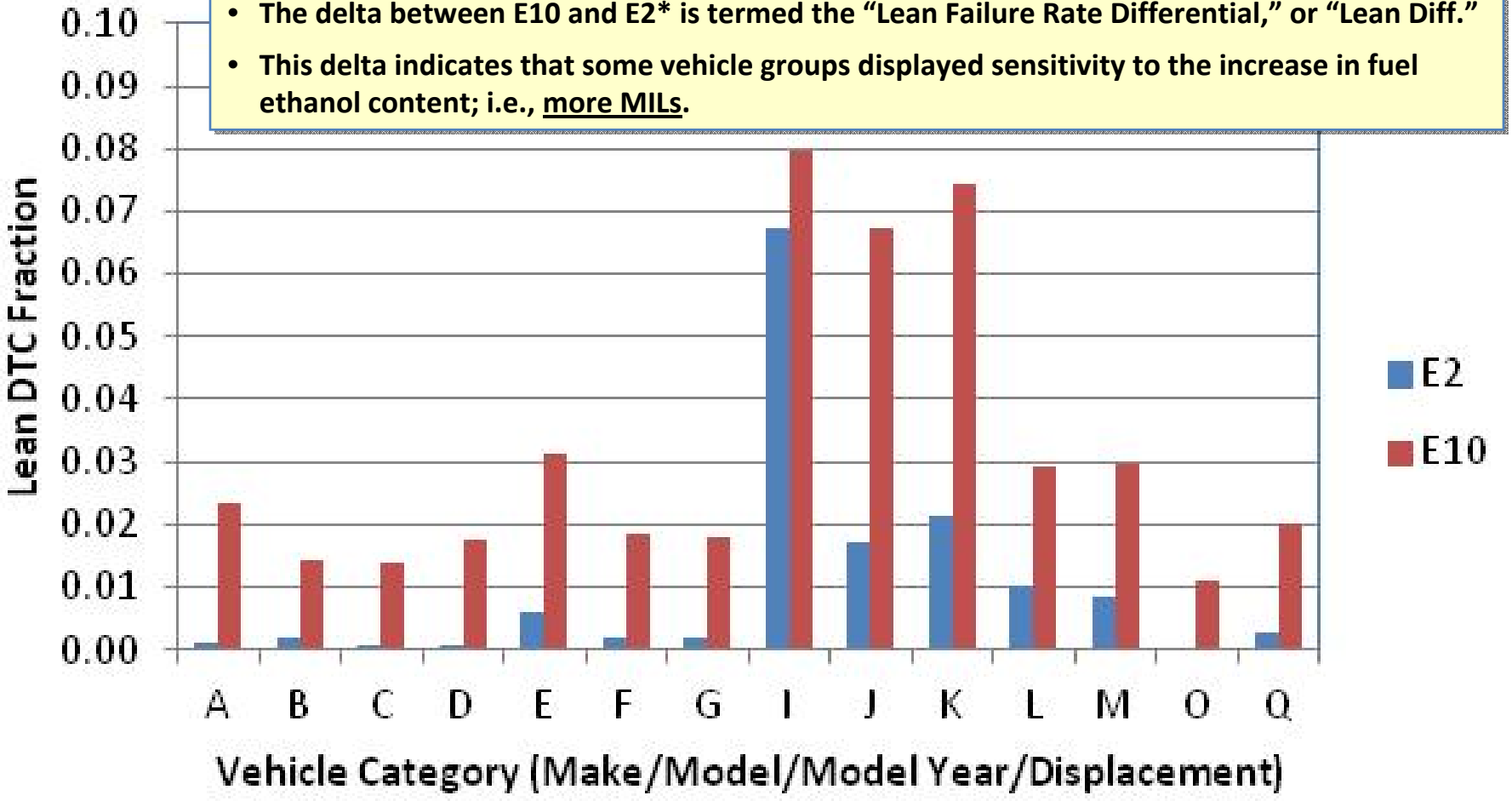
Caveats and Limitations

- It is assumed that the increase in lean DTCs for some vehicle categories when ethanol content changed is a result of the fuel change. Fleet aging could play a small role, and was therefore considered in the results.
- I/M data generally under-report in-use failure rates as a result of pre-inspection repair. (For example, if motorists know they will fail the test if the MIL is on, they will typically get the problem repaired prior to the test, or the station may neglect to report the failure.)
- Sierra estimates the actual lean failure rate (observed on roadside) is seven times greater than what was observed in the California I/M program.


Georgia I/M Program 2009 (E10) vs. 2007 (E2)
Lean DTC Failure Rate Differential
for Vehicle Groups with More than 100 Vehicles
Number of Vehicle Groups
1800
1600
1400
1200
1000
800
600
400
200
0
-0.06
-0.04
-0.02
0
0.02
0.04
0.06
0.08
0.1
Lean DTC Failure Rate Differential (E10 - E2)
• Most vehicle groups did not show a large DTC failure rate change when fuel ethanol content was increased.
• However, 137 vehicle groups did show a change >1%.

Selected Georgia I/M Results - Lean DTC Failures
CY2007 (E2) vs. CY2009 (E10)

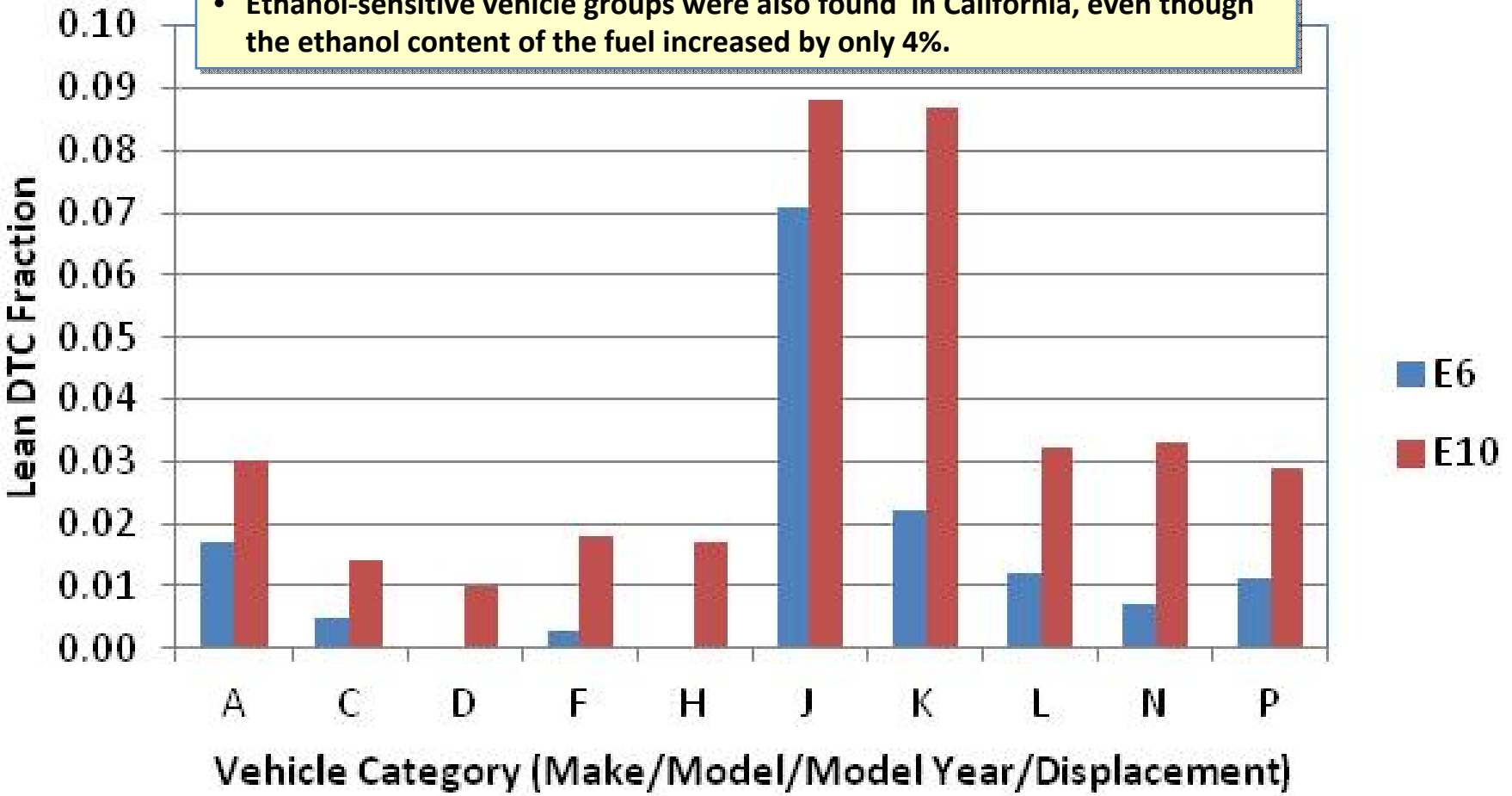
- **The delta between E10 and E2* is termed the "Lean Failure Rate Differential," or "Lean Diff."**
- **This delta indicates that some vehicle groups displayed sensitivity to the increase in fuel ethanol content; i.e., more MILs.**



* "E2" reflects roughly 20% market penetration of E10 and 80% of E0.

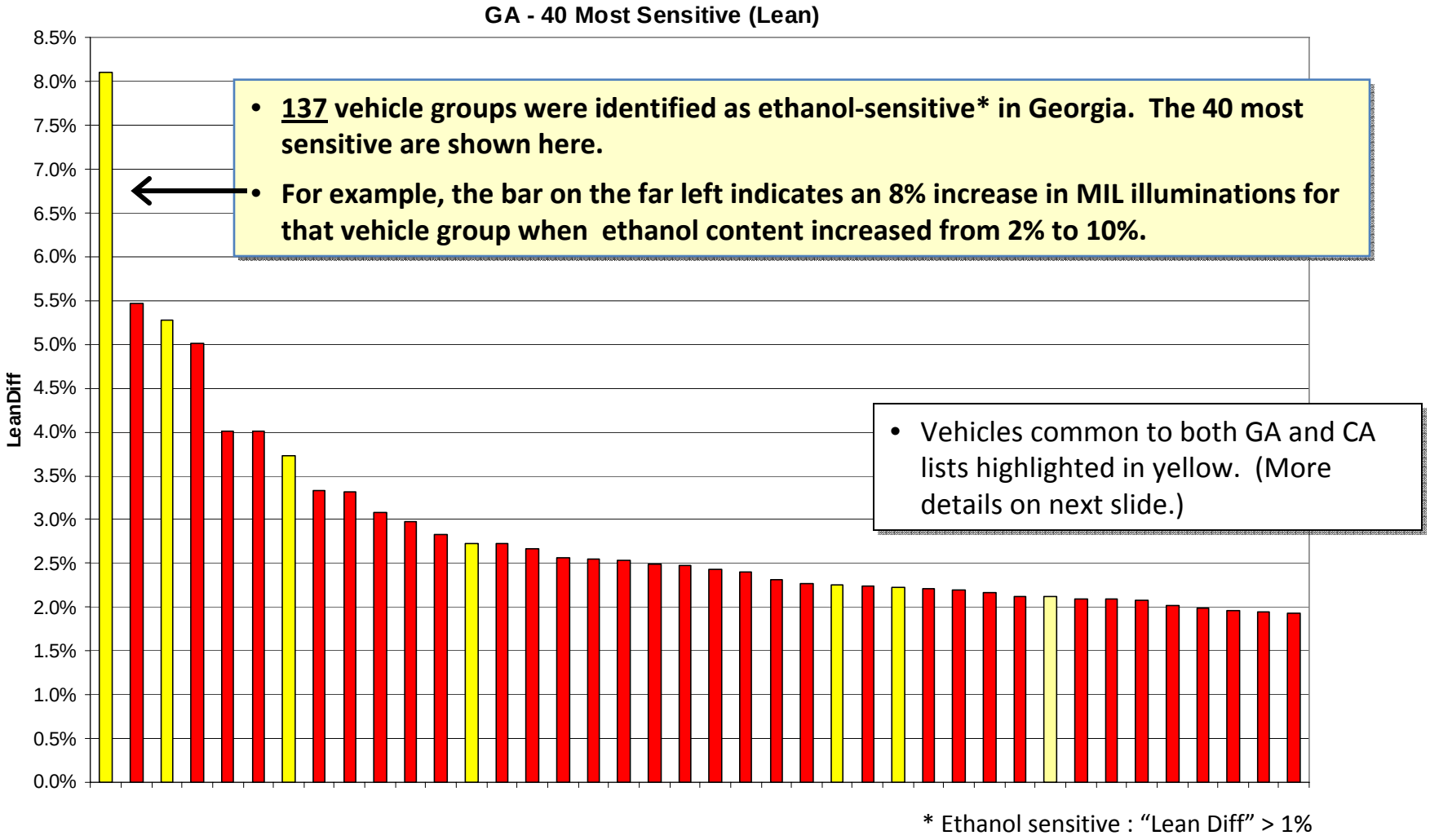
Selected California I/M Results - Lean DTC Failures
CY2009 (E6) vs. CY2010 (E10)

- **Ethanol-sensitive vehicle groups were also found in California, even though the ethanol content of the fuel increased by only 4%.**



- Same letter code represents same make and model in California and Georgia.
- "E6" reflects nearly 100% penetration of E6 in California.

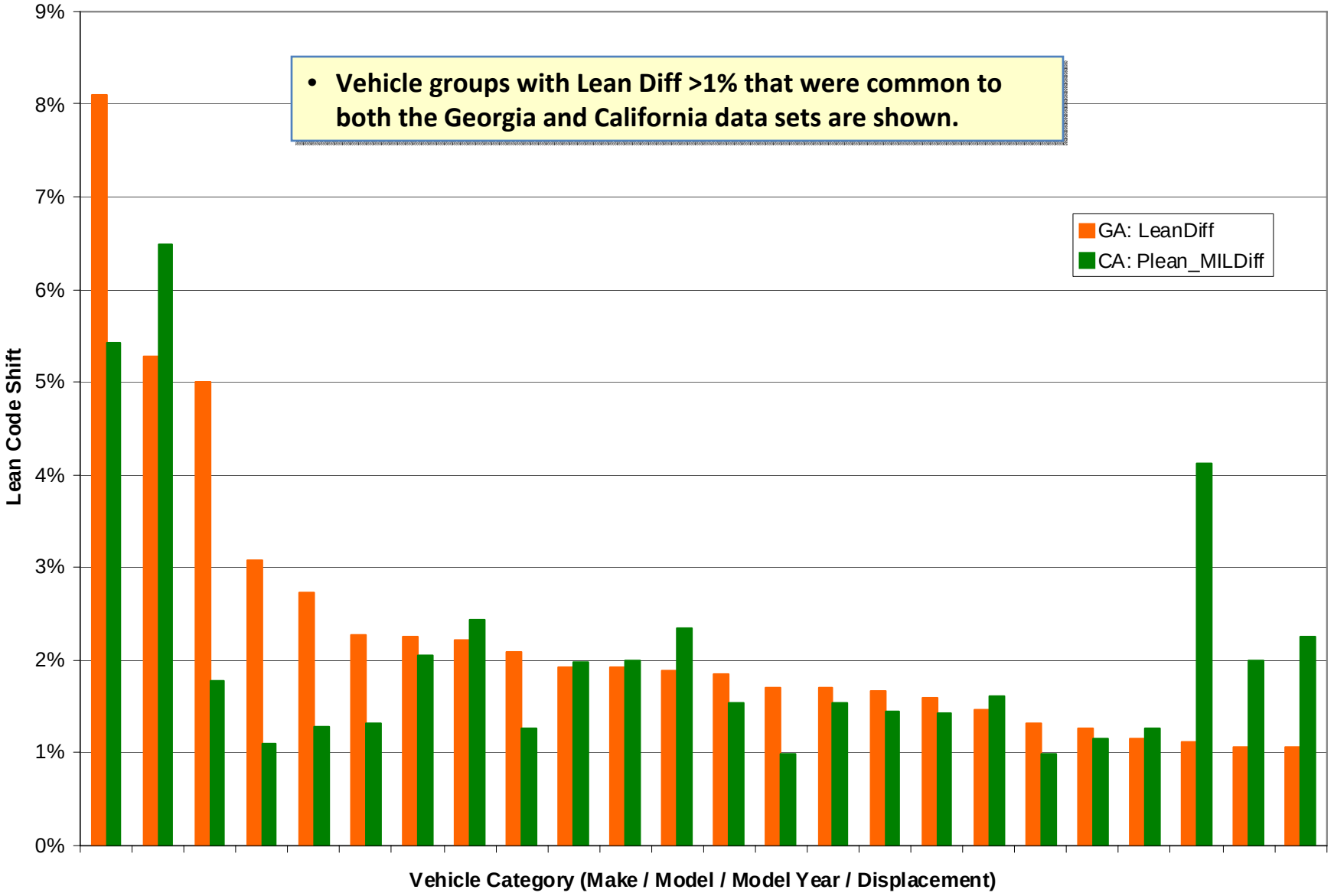
Georgia I/M "Lean Diff" Results for the 40 Most Sensitive Vehicle Groups (i.e., Make/Model/Model Year/Displacement)



* Ethanol sensitive : "Lean Diff" > 1%

24-Vehicle List: Lean Code Shift Comparison

Sorted by GA: LeanDiff



CRC Project E-90-2a
Summary of Draft Results

- A substantial number of vehicle groups experienced an increase in lean-limit failures that exceeded “normal” deterioration.
- These results confirmed the observations of the E-90 pilot program; i.e., the number of MIL illuminations increased when the ethanol content of the fuel increased.
- Therefore, CRC will proceed with the next phase of this project (E-90-2b), in which sensitive models will be tested on road with ethanol blends up to E20. The results from the 2a phase, coupled with manufacturer input, will provide the basis for vehicle selection in the 2b phase.

CRC Project E-90-2b
Vehicle Testing

Scope of Work

- Document the change in fuel trim and other engine parameters as vehicles are operated on a range of ethanol blends (E0 → E20) under real-world, on-road conditions.
- Determine if the MIL will illuminate and/or DTCs will be set on sensitive vehicles when exposed to E15 and/or E20.
- Determine if a vehicle with an illuminated MIL induced by E15 or E20 still meets its emissions category target, using a standard cold-start FTP-75 test mode.

CRC Project E-90-2b
Vehicle Testing

Significance

- This project will represent the first time that on-road testing has taken place with potential OBD-sensitive vehicle models operating on mid-level ethanol blends.

- Key engine and OBD parameters will be recorded in real time throughout the 200-mile driving cycle.