

---

CRC E-90 Project, Phase 1

# E15/E20 Tolerance of In-Use Vehicle OBD-II Systems

---

Mid-Level Ethanol Blends  
Research Coordination Group  
May 5<sup>th</sup>, 2010

*Jeff Jetter, Honda R&D Americas, Inc.*



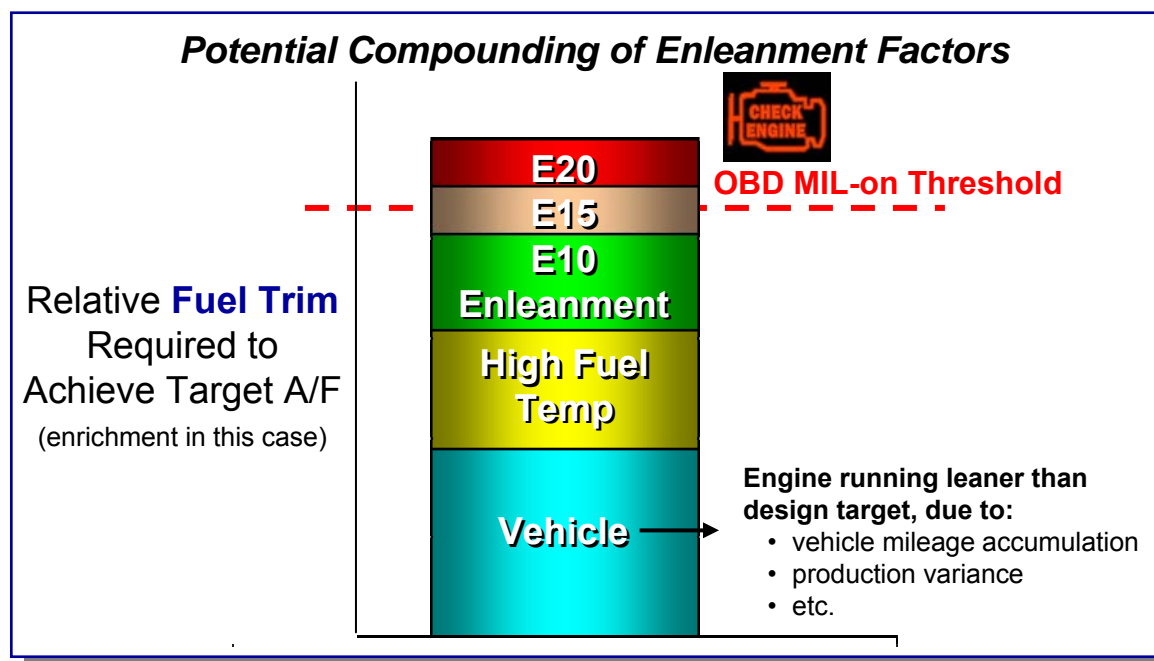
- Current vehicles and OBD-II systems were designed to function properly with ethanol blends from E0 to E10. (non-FFVs)
- In order for the OBD-II system to meet the regulated requirements, the criteria for MIL illumination are set very “tight.”
- There is a concern among major auto OEMs that the use of intermediate ethanol blends could illuminate MILs in a substantial fraction of in-use vehicles, often when there is no actual effect on emissions.\*

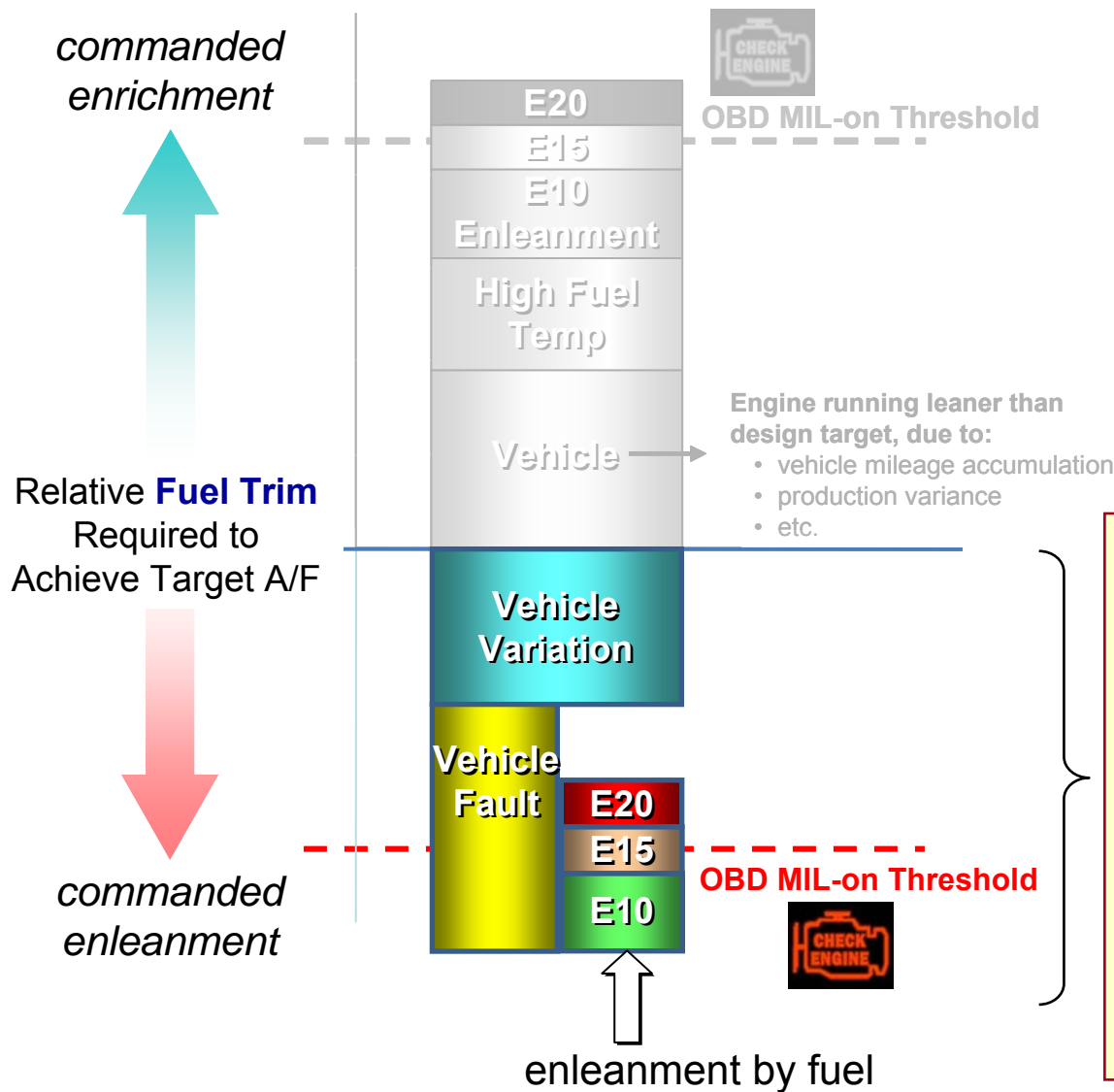
## Example →

- A vehicle operating close to an OBD-II threshold level exceeds the MIL-on criterion when fueled with E20.

### \* Notes:

- The only possible “repair” would be to remind customers not to misfuel with intermediate blends.
- Note that some state I/M programs rely solely upon OBD-II; tailpipe emission testing is not performed.

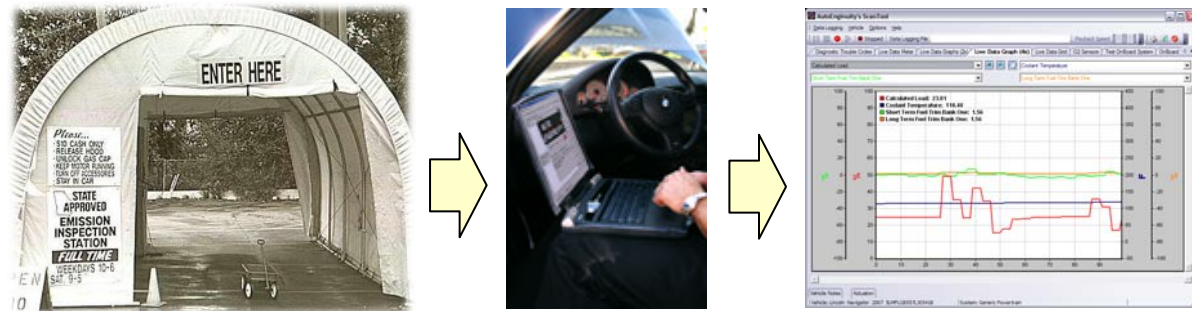




- In the case of vehicles running too rich, ethanol-induced enleanment can move the vehicle back from beyond the OBD threshold.
- That is, the use of E15 or E20 can mask a true malfunction.

## Objective

- Collect OBD and related data (e.g. long-term fuel trim) from in-use vehicles running on E0 and E10 to determine MIL illumination potential with higher ethanol concentrations.



Data collection after vehicles complete their I&M inspection

## Technical Approach

- Recruit vehicles at selected Inspection/Maintenance (I/M) stations.
- Use scan tools to download engine data through the OBD port, under specific conditions of operation.
- Determine proximity of the data to the MIL illumination thresholds.



# Test Locations

Site	Local Fuel	# of Vehicles Tested
Austin, TX	E0*	140
Plano (DFW), TX	E10	225
Chicago, IL	E10	218



Chicago, IL



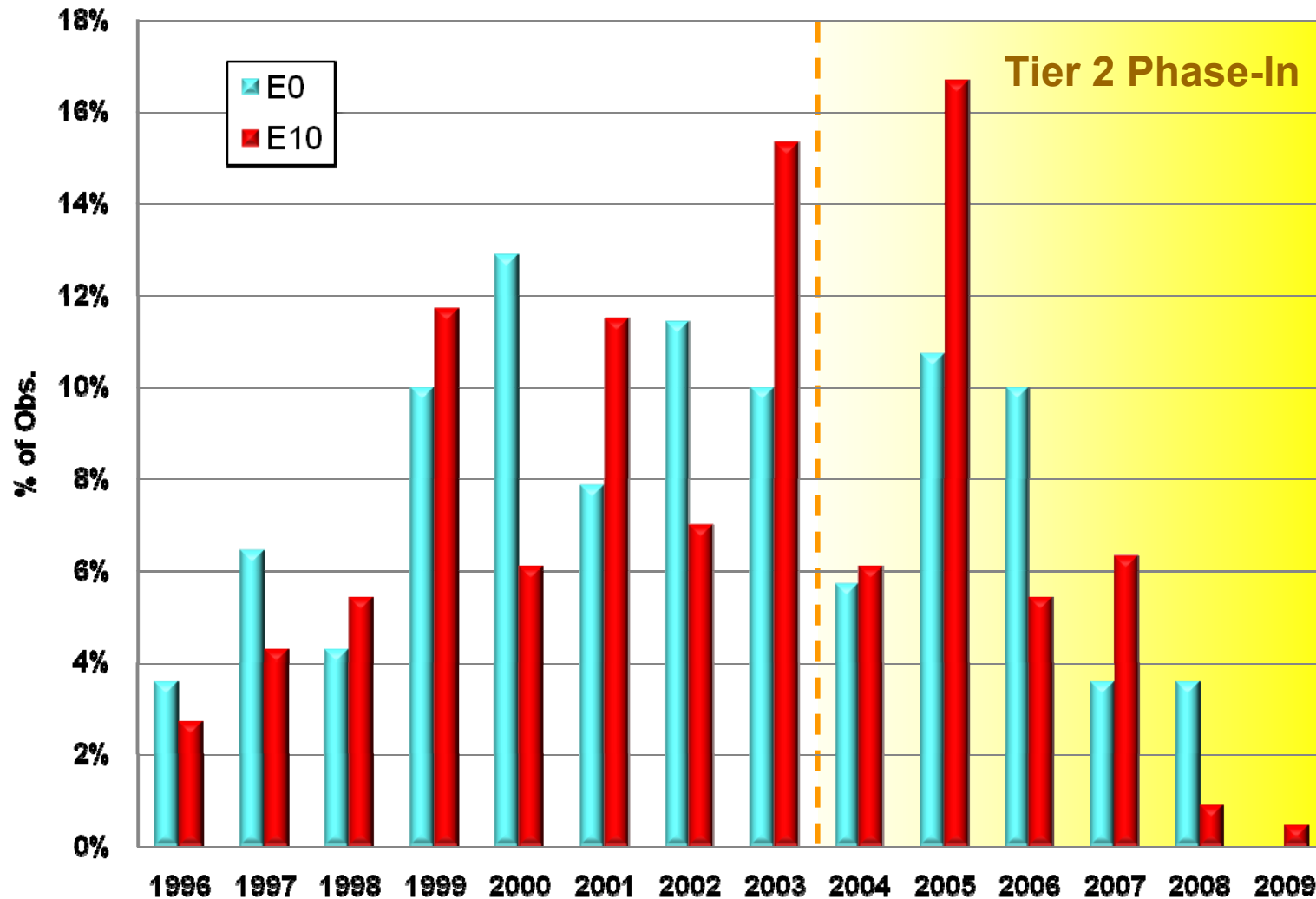
Plano, TX



Austin, TX

\* E0 confirmed with city fuel survey performed concurrently with test program

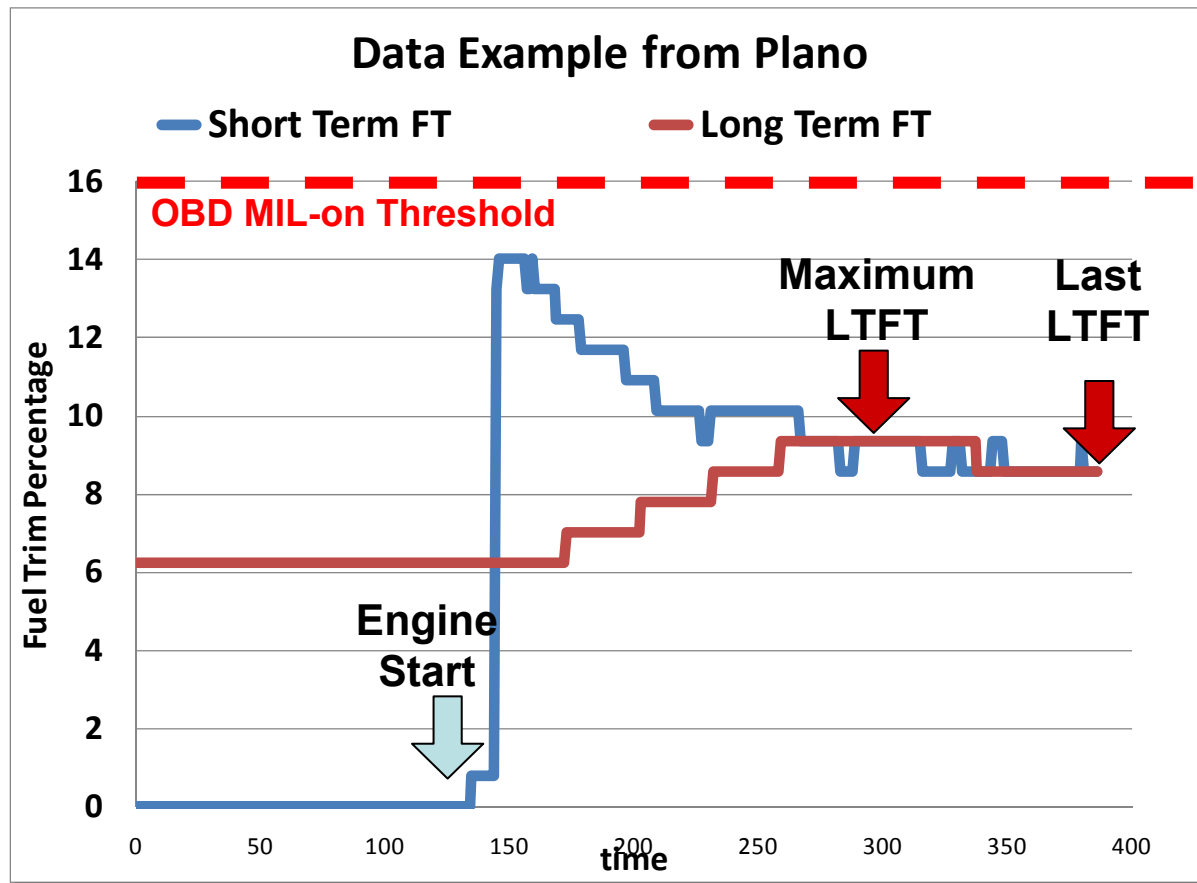
# Distribution of Model Years Tested



- Note: There are about 176 million OBDII-equipped vehicles currently registered.

# Example of Raw Data

- LTFT (Long-Term Fuel Trim) is monitored by the OBD-II system. If too much enrichment (high LTFT) is requested, the threshold is reached and the MIL illuminates.

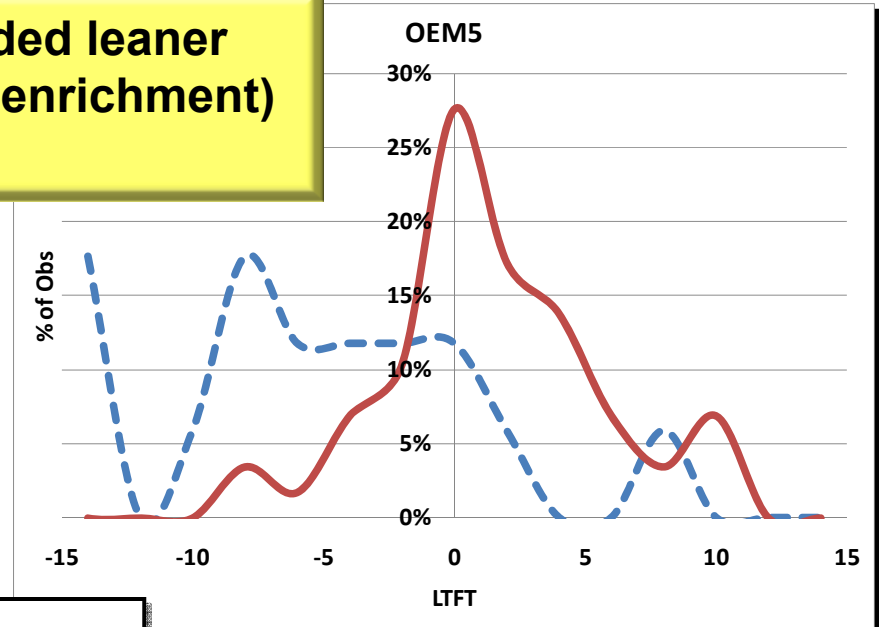
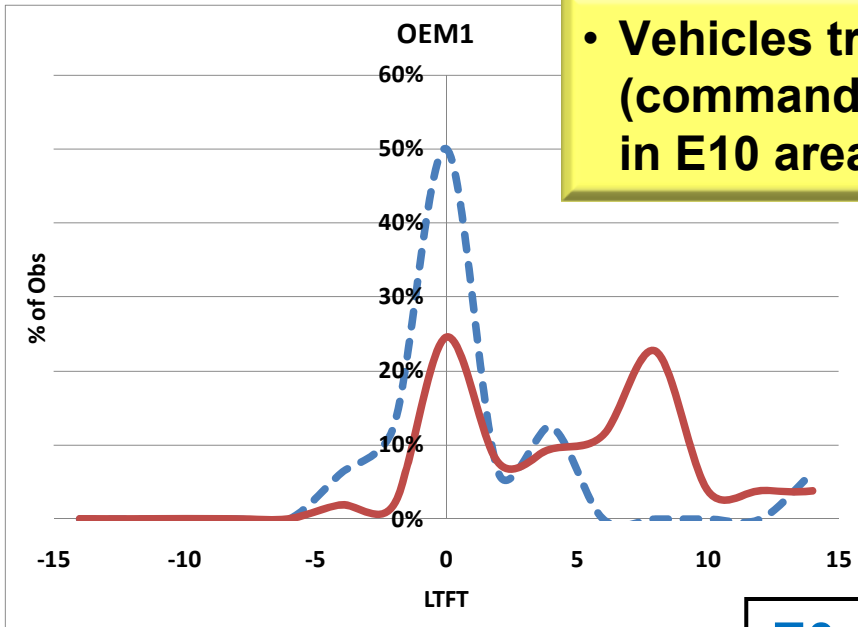


Example threshold, for illustrative purposes only

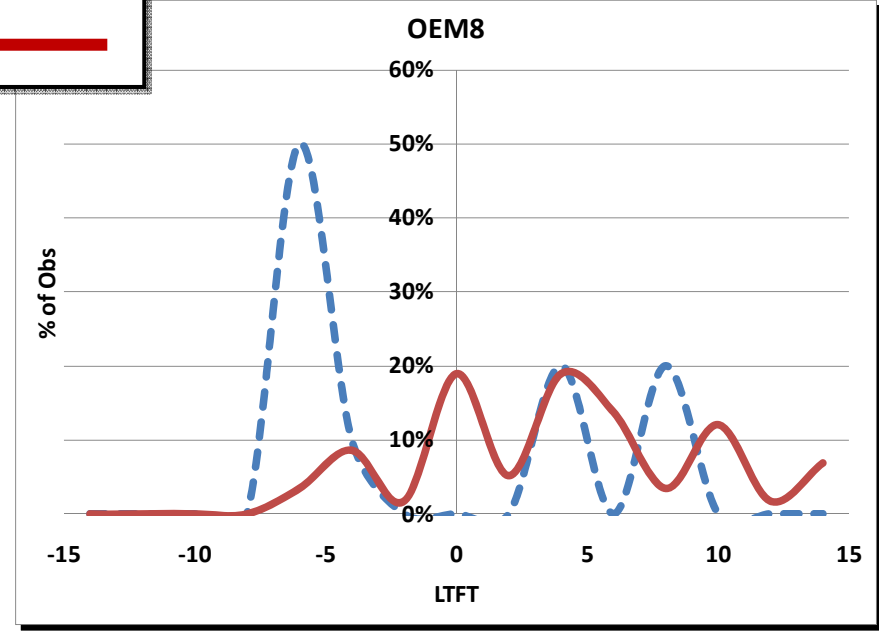
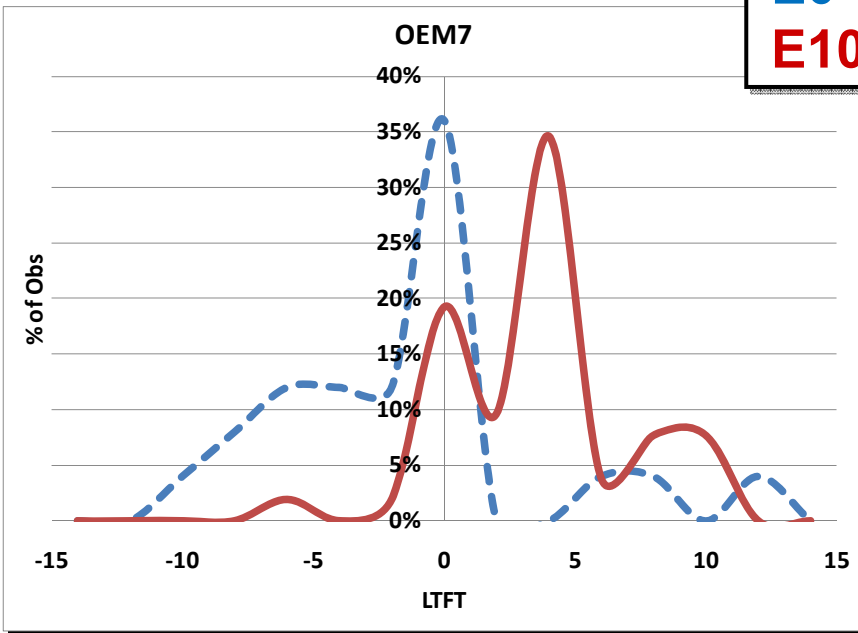
- “Maximum and Last LTFT” were the values recorded for data analysis.

# Examples of OEM-Specific LTFT Results

• Vehicles trended leaner (commanded enrichment) in E10 areas.



E0 ---  
E10 —

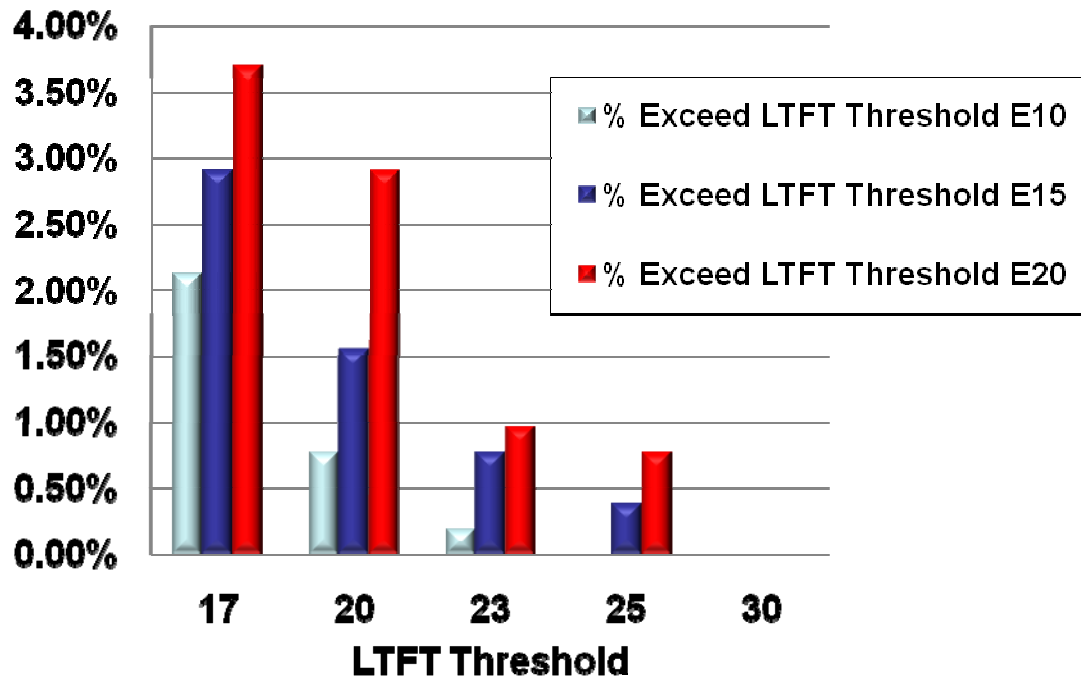


- Two approaches were used:
  1. Individual tests (raw data) were subjected to hypothetical LTFT increases, based on observed E0 → E10 trends.
  2. LTFT data were converted to normal distribution curves based on the mean and standard deviation of the raw data, and subjected to LTFT increases as above.

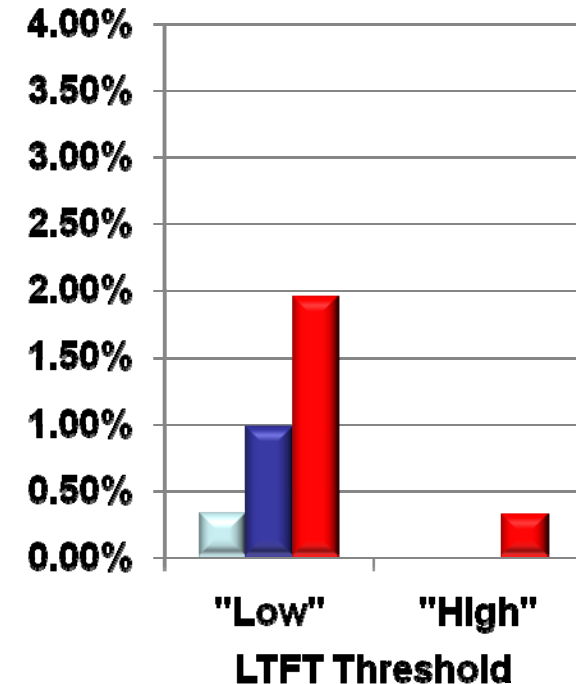
# Projection of MIL Illumination Events

## Approach 1 (based on individual tests)

% of Vehicles Exceeding MIL-on Thresholds  
( Combined Data )



% of Vehicles Exceeding MIL-on Thresholds  
( OEM-Specific Data )



### Caveats:

- Data are combined; i.e., not matched to OEM-specific thresholds.
- Therefore, potential problems within the sample population are over-estimated at low thresholds, and under-estimated at high thresholds.

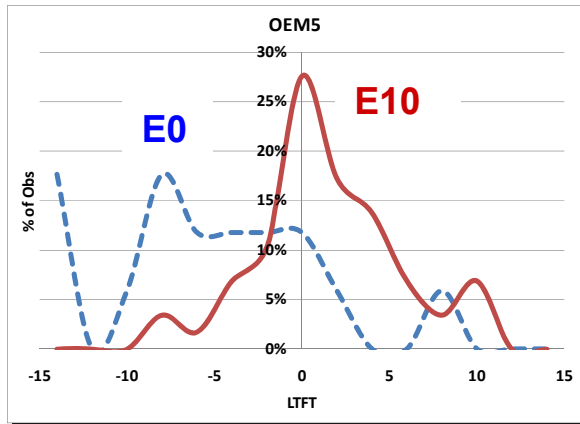
### Caveats:

- "Low" and "High" categories represent a range (grouping) of thresholds.
- Data are matched by OEM, not by model.

# Projection of MIL Illumination Events

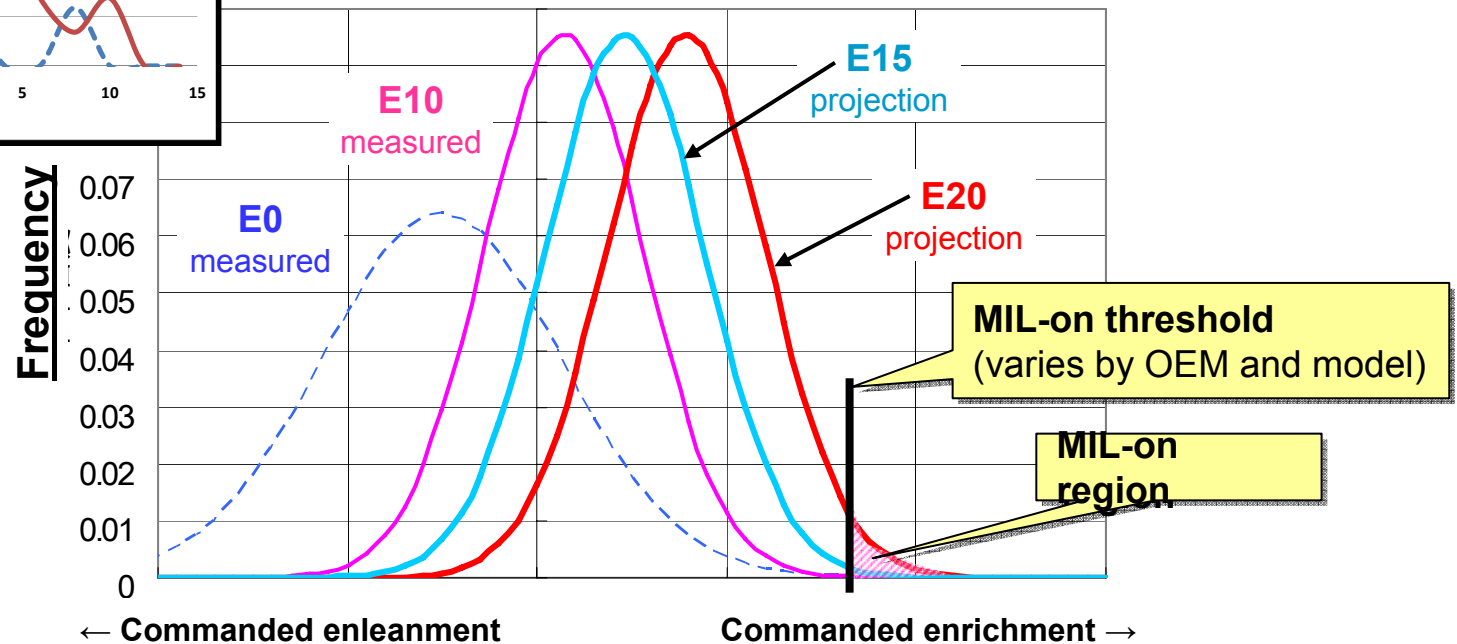
## Approach 2 (based on distribution curves)

### Raw vehicle data (OEM-5)



• Assumption:  $\Delta \text{LTFT}_{E0 \rightarrow E10} = \Delta \text{LTFT}_{E10 \rightarrow E20}$

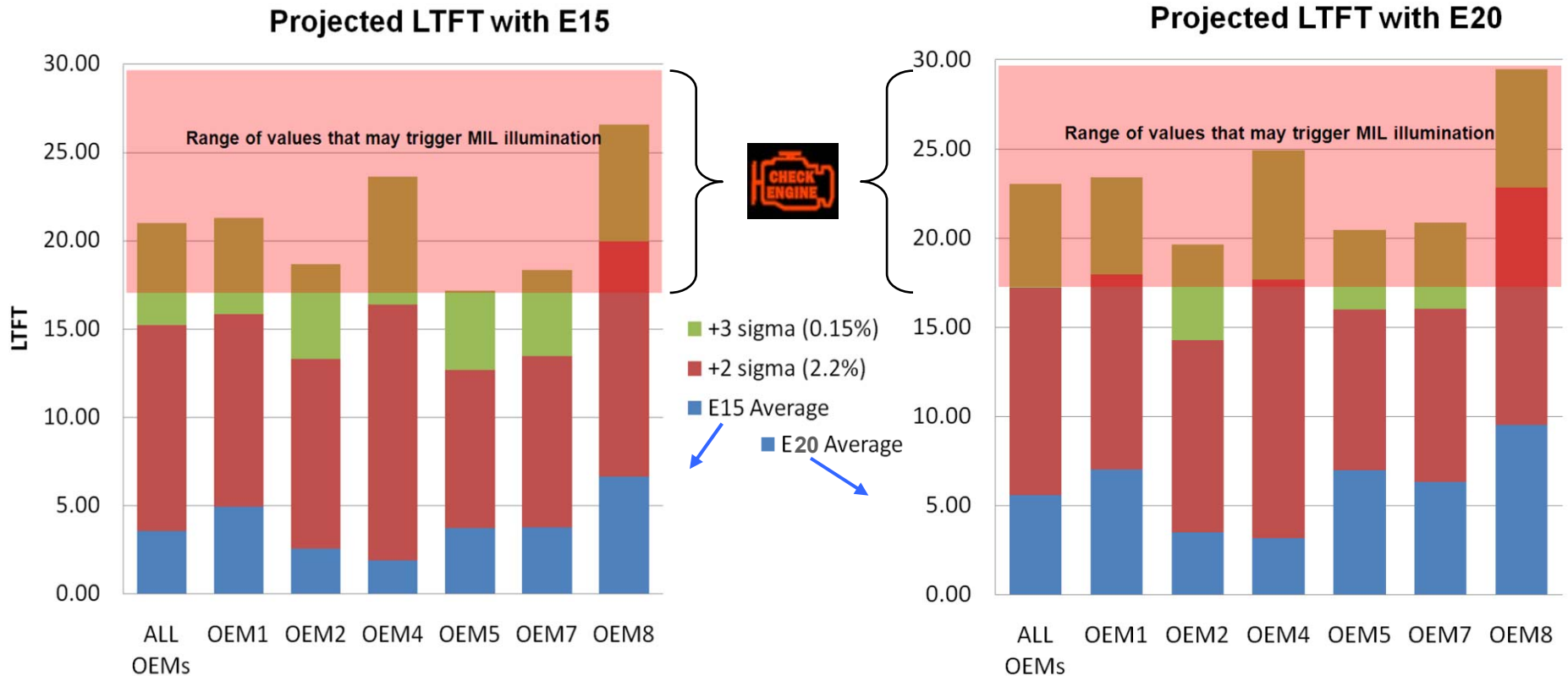
### LTFT Max\* distribution



- Results indicate that E15 or E20 will very likely illuminate the MIL in some problem-free vehicles.
- Fleets with relatively low MIL-on thresholds are the most susceptible.

# Projection of MIL Illumination Events

## Approach 2 (based on distribution curves)



- The +3 sigma tail is definitely in the region where MILs could be illuminated.
- A few tenths of a % can represent a substantial problem for high-volume models.
- For reference, 1% of the registered on-road OBDII-equipped fleet represents about 1.76 million vehicles.

- The MIL illumination range shown above (17% → 30%) is based upon a survey of OEMs.

- Operation on E10 increases LTFT over E0 levels for most vehicles. The sensitivity varies by OEM, but all OEMs show increases in LTFT.
- The tests conducted in this study provide evidence that operation on E15 or E20 will very likely cause a subset of problem-free vehicles to illuminate their malfunction indicator light (MIL) due to excessively lean operation.
  - The fraction depends on the assumed LTFT threshold and the fuel ethanol content and is roughly estimated to be of the order of a percent or so. A more precise estimate of this fraction cannot be made with the available data.
  - One percent of the registered on-road OBDII-equipped fleet represents about 1.7 million vehicles.
- There is also evidence that operation on E15 and E20 may cause some vehicles that currently have illuminated MILs due to rich operation to appear to be problem-free.
- The report is on CRC's website.

Next steps: Phase 2a and 2b, to be performed in series.

## Phase 2a:

- Supplement Phase 1 results through I&M station data mining; i.e., search for specific vehicle models that may be sensitive to enleanment by ethanol-blended fuels.
- In addition, OEMs will mine internal DTC data collected from the field; e.g., lean codes.
- *Status: RFQ issued, contractor chosen . Approximate completion date: Late July, 2010.*

## Phase 2b:

- Based on results of E-90 Phases 1 and 2a, procure vehicles from the market and test with various blends up to E20.
- Testing will include emission measurements, driveability evaluations, and monitoring of OBD-related parameters.
- *Status: SOW currently being balloted. Approximate completion date for this phase: 4<sup>th</sup> quarter 2010.*