
CRC E-90 Project, Phase 1

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

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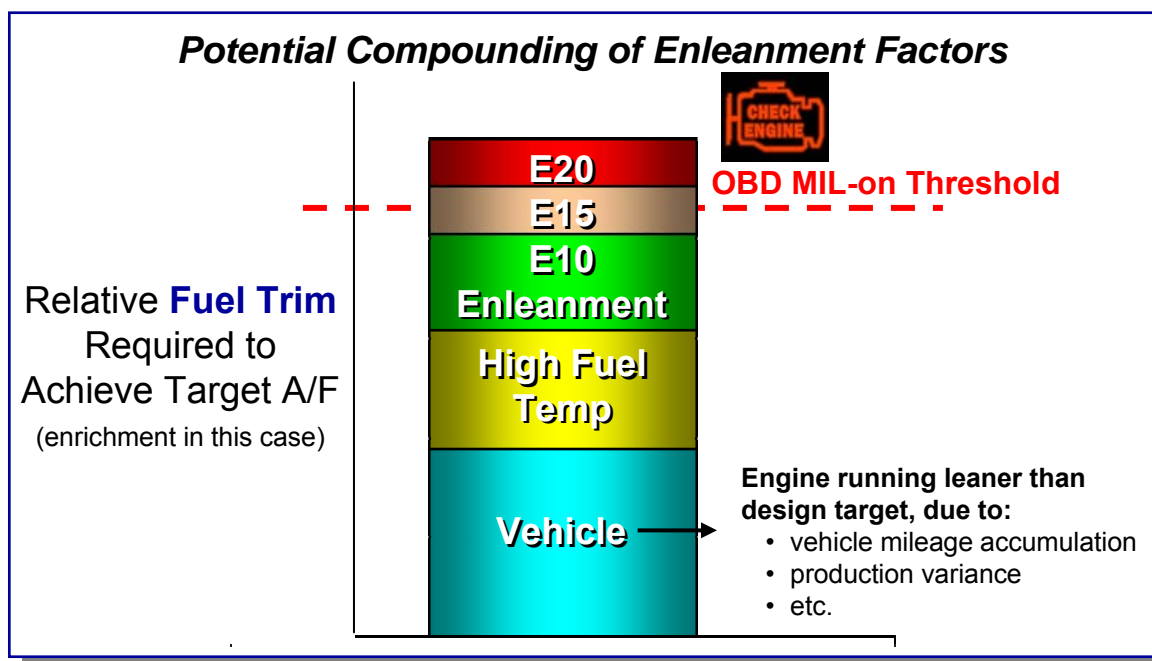
- Current vehicles and OBD-II systems were designed to function properly with ethanol blends from E0 to E10. (non-FFVs)
- In order for the OBD-II system to meet the regulated requirements, the criteria for MIL illumination are set very “tight.”
- There is a concern among major auto OEMs that the use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

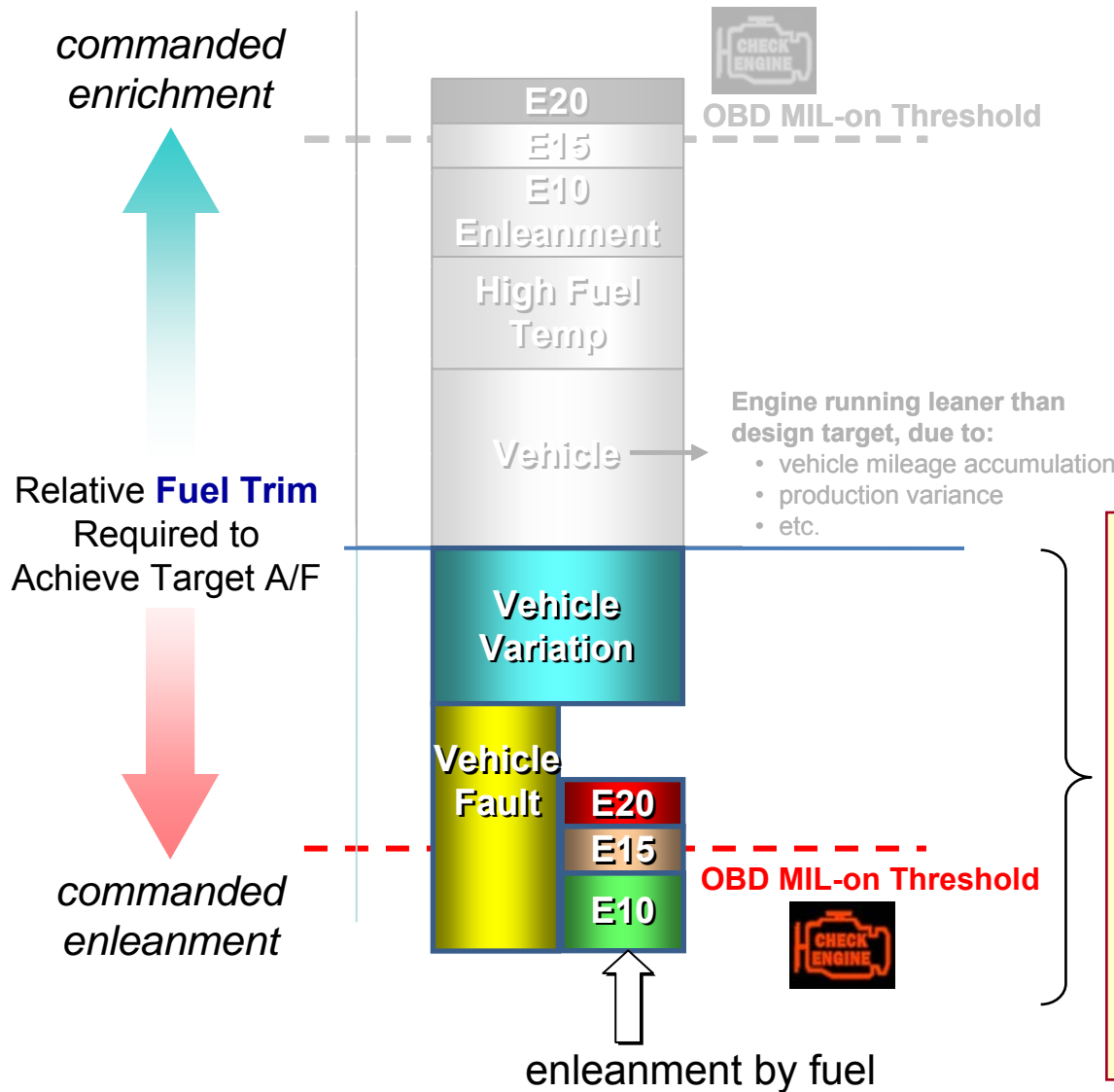
Example →

- 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.

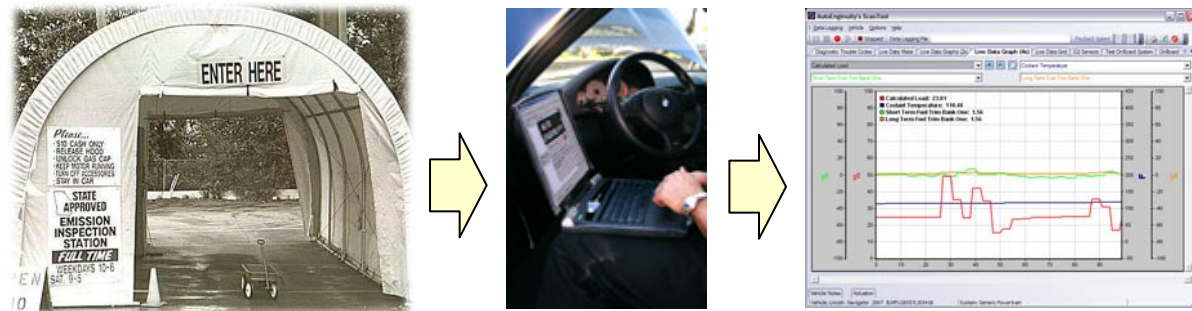




- In the case of vehicles running too rich, ethanol-induced enleanment can move the vehicle back from beyond the OBD threshold.
- That is, the use of E15 or E20 can mask a true malfunction.

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.

Vehicle Selection

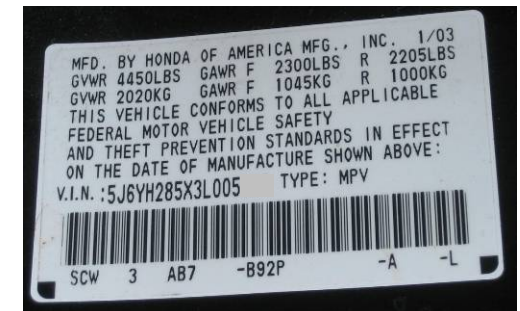
- Random, \geq 1996 model year.
- Log maintained of vehicles declining to participate, and total vehicles passing through I&M station on test days; (VIN, year, model, etc.).

Test Procedure

- Vehicle information acquired, including VIN and emission category. ↩
- Engine turned off for 10 minutes.
- Vehicle started. Data collected for 5 minutes (minimum).

Data Acquired

- Diagnostic Trouble Codes (DTCs), active and pending.
- Readiness status of OBD system.
- Fuel trim data after engine start, (long and short term).
- Additional parameters.



Test Locations

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



Chicago, IL



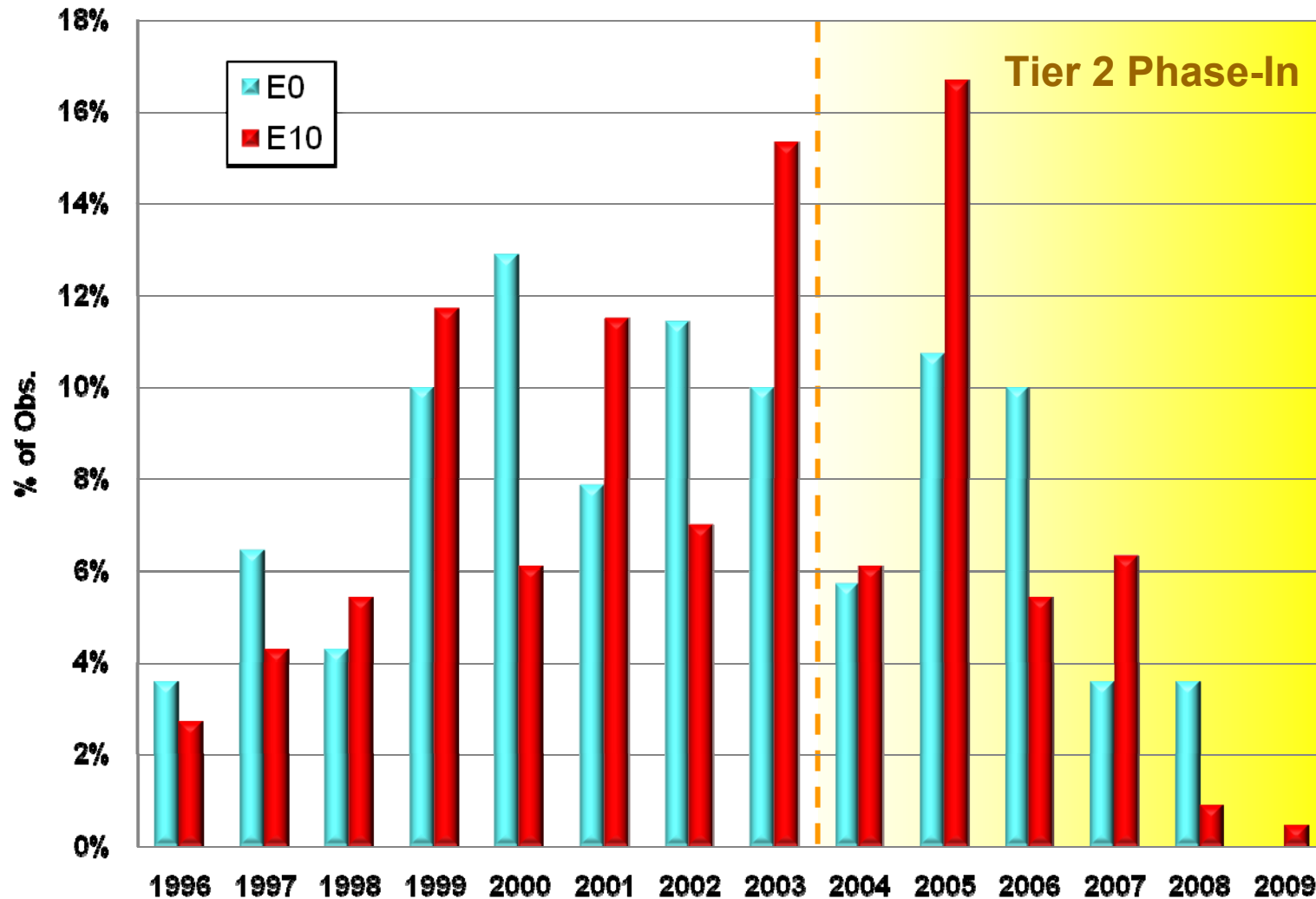
Plano, TX



Austin, TX

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

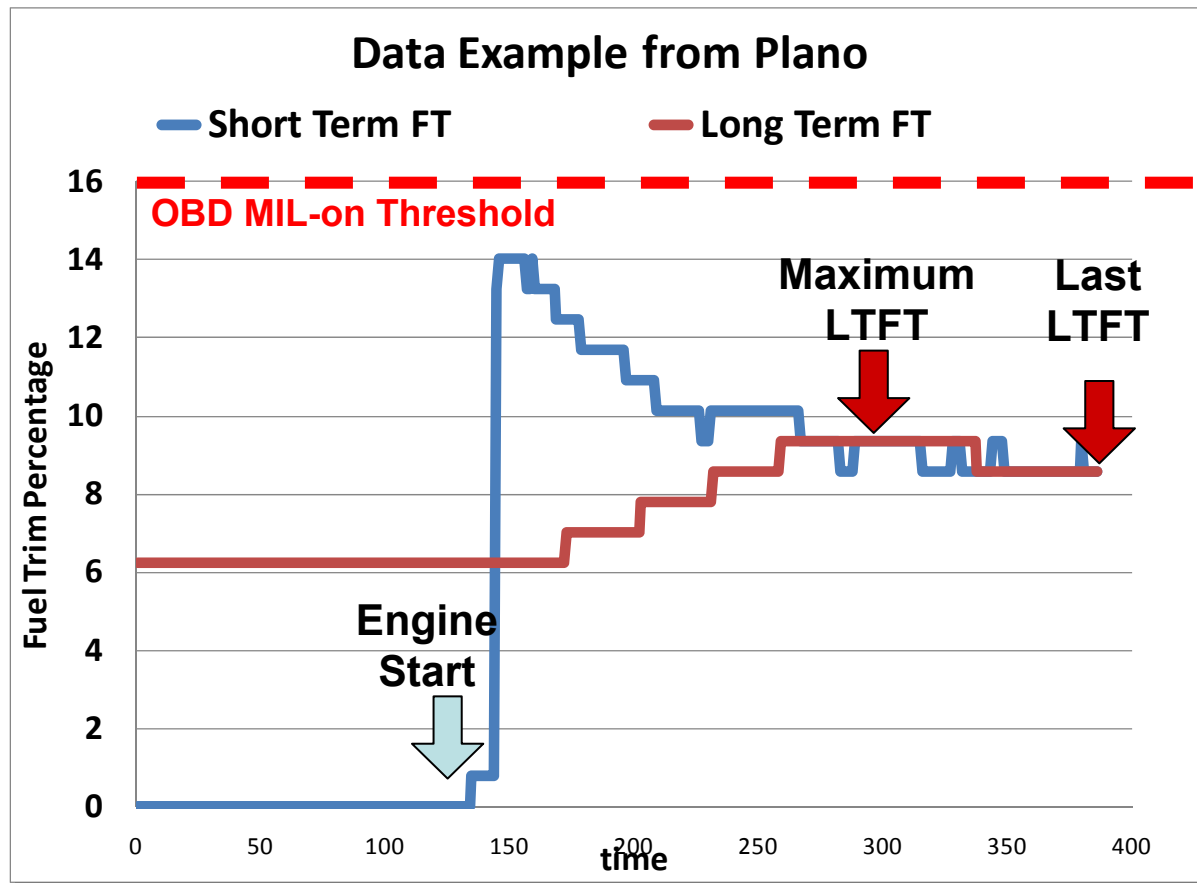
Distribution of Model Years Tested



- 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.

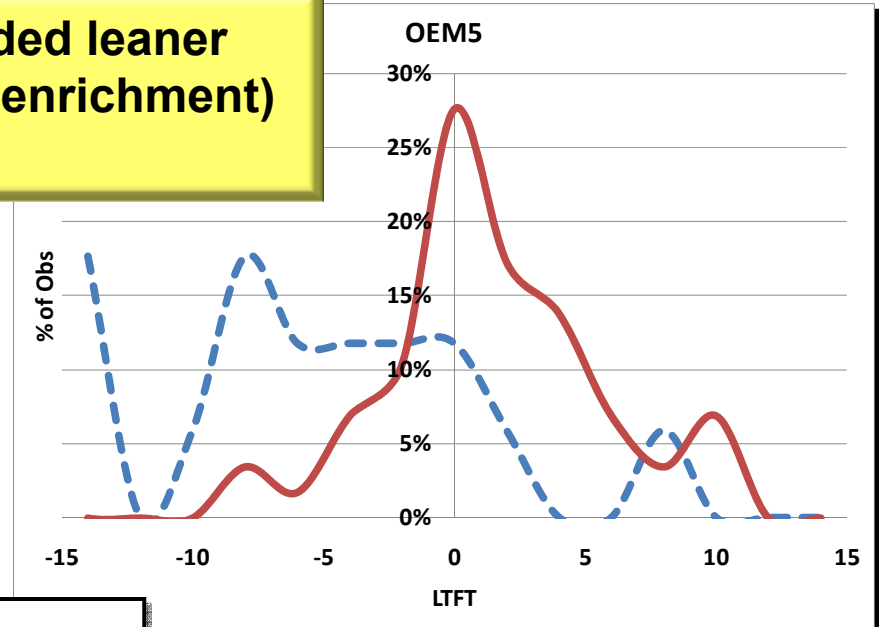
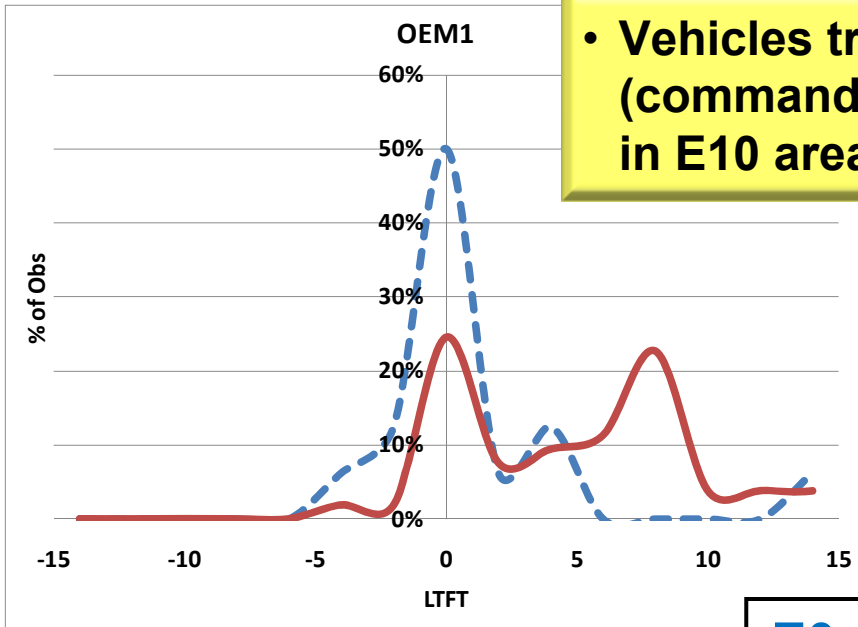


Example threshold, for illustrative purposes only

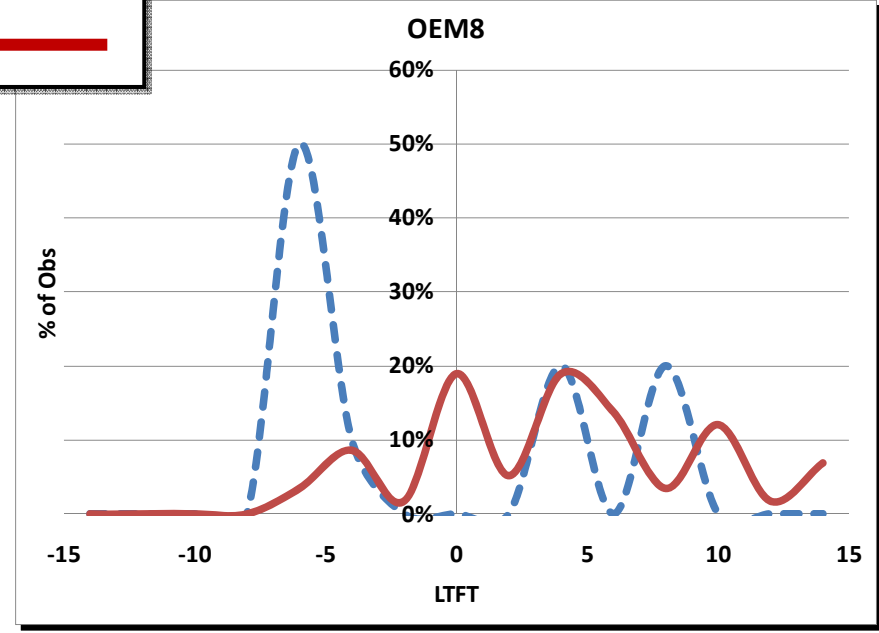
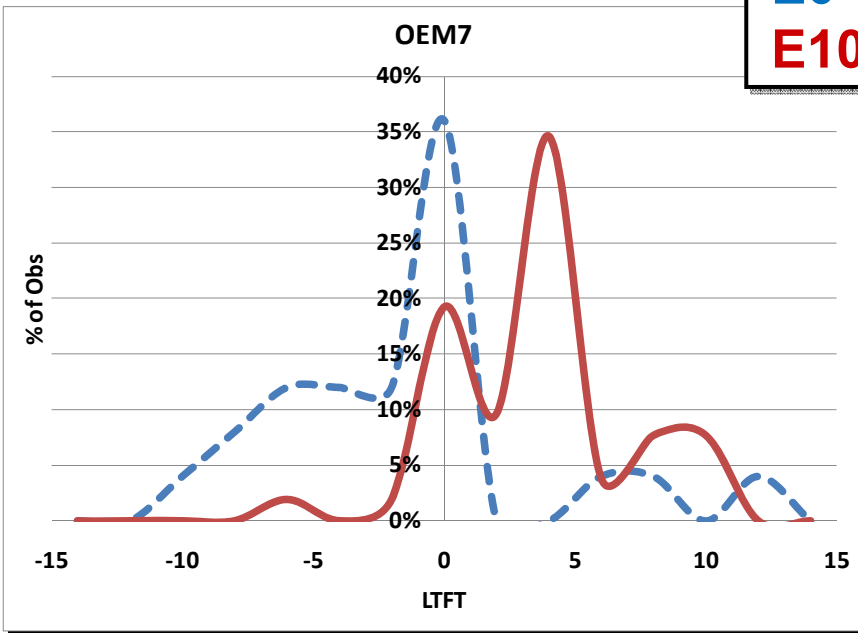
- “Maximum and Last LTFT” were the values recorded for data analysis.

Examples of OEM-Specific LTFT Results

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



E0 ---
E10 —

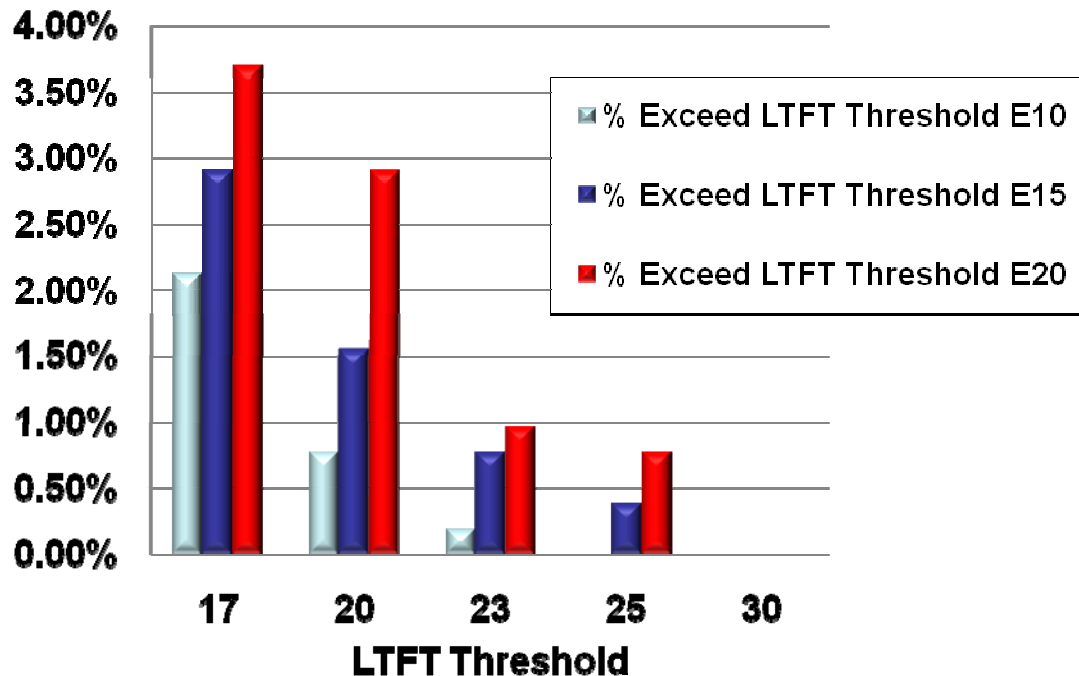


- Two approaches were used:
 1. Individual tests (raw data) were subjected to hypothetical LTFT increases, based on observed E0 → E10 trends.
 2. LTFT data were converted to normal distribution curves based on the mean and standard deviation of the raw data, and subjected to LTFT increases as above.

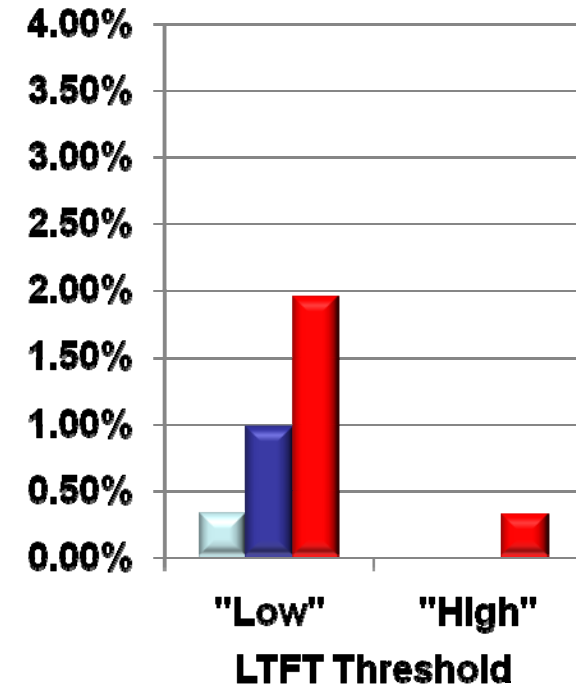
Projection of MIL Illumination Events

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.

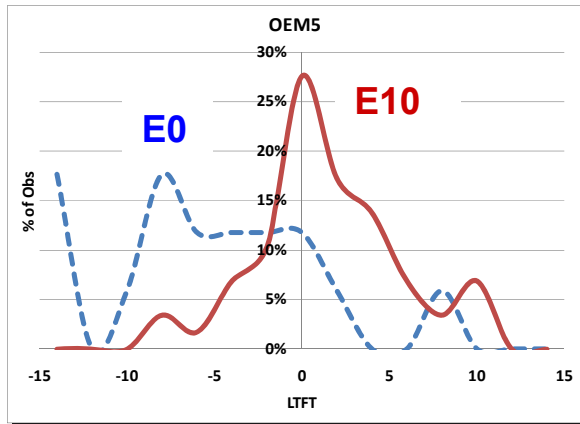
Caveats:

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

Projection of MIL Illumination Events

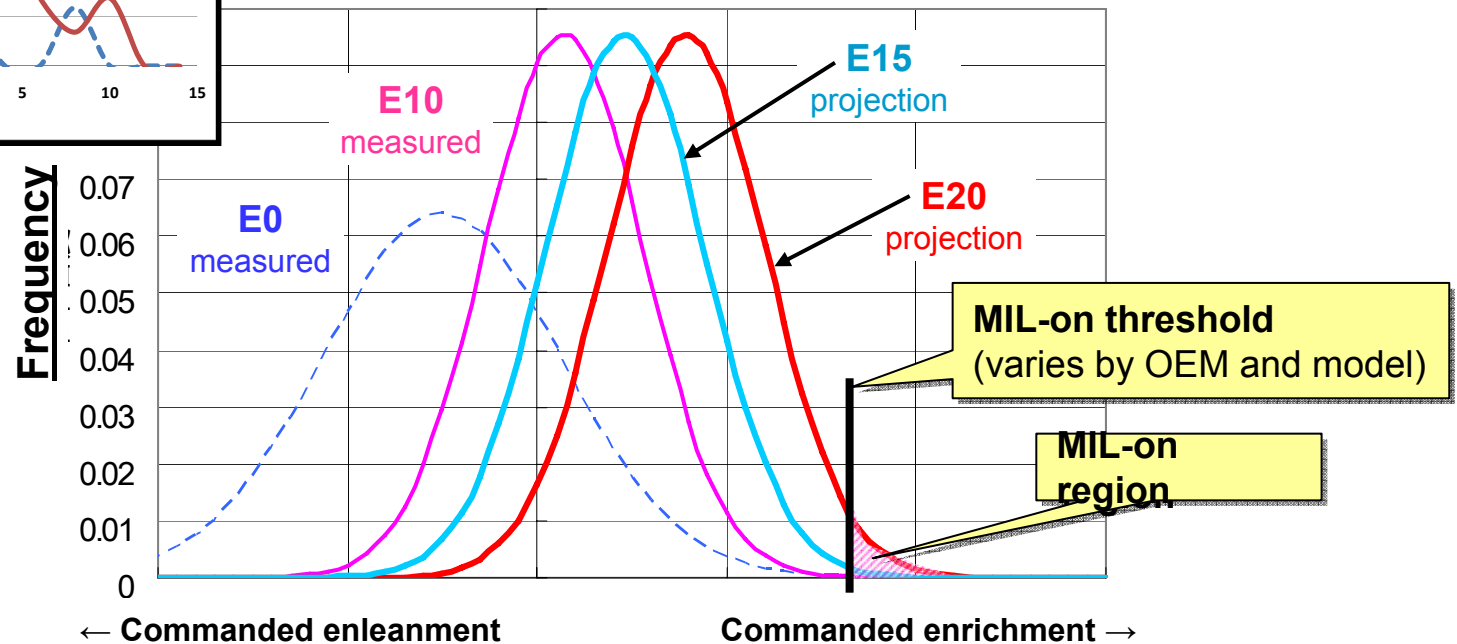
Approach 2 (based on distribution curves)

Raw vehicle data (OEM-5)



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

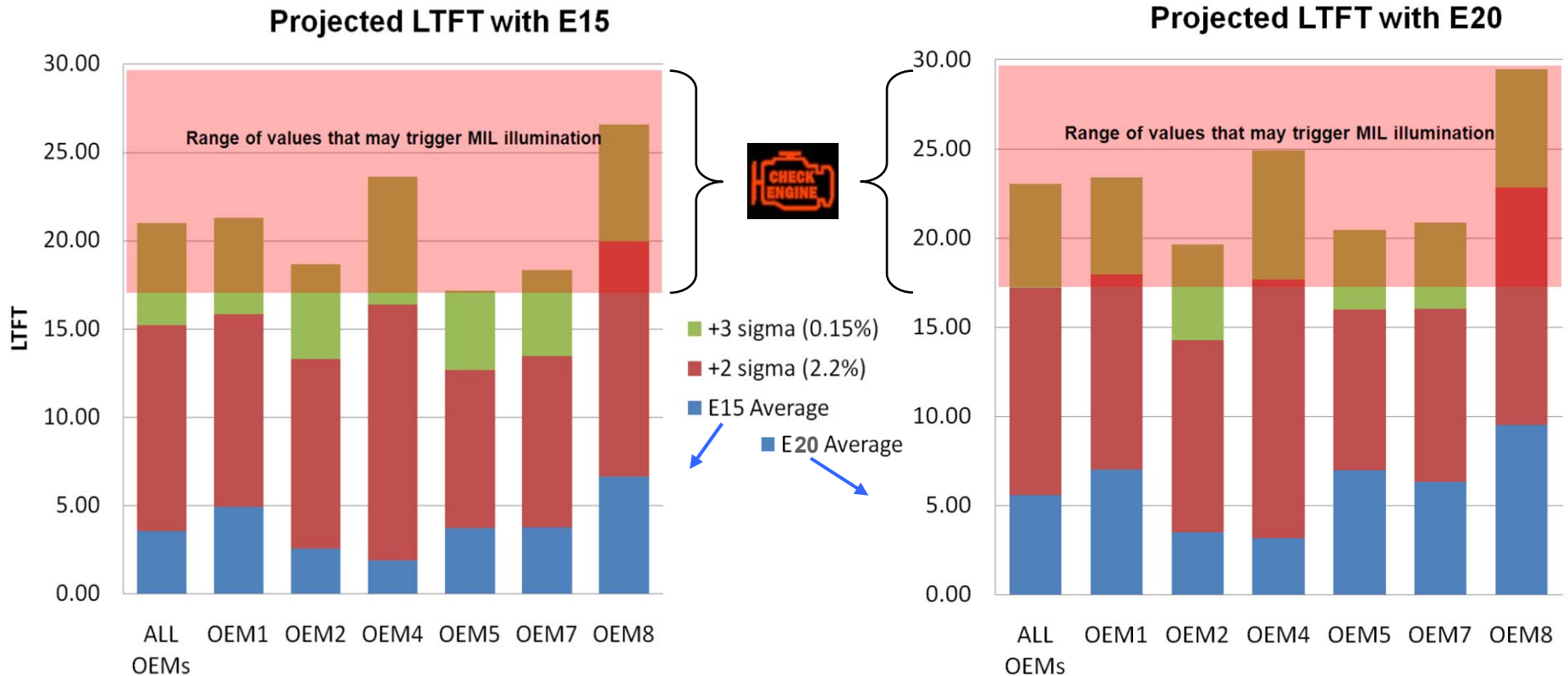
LTFT Max* distribution



- 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: 4th quarter 2010.*