Outline

• Concepts for Tier 5 rulemaking
• Potential Tier 5 standards
• Low Load Cycle (LLC) update
• In-use program concepts
• On-board diagnostics (OBD) concepts
Concepts for Tier 5 Rulemaking

• More stringent oxides of nitrogen (NOx) and particulate matter (PM) standards for new engines
• New Off-Road Diesel Carbon Dioxide (CO₂) tailpipe standard
• Off-Road LLC
• Manufacturer-Run Off-Road In-Use Testing Program
• OBD Concepts
• Lengthening Useful Life and Warranty requirements
• Idle Reduction Concept
Potential Tier 5 Exhaust Standards

- Staff is considering (with respect to Tier 4f standards):
  - 75% reduction in NOx and PM for diesel engines < 56 kW
  - 90% / 75% reduction in NOx / PM for engines 56 ≤ kW ≤ 560
  - 5-8.6% reduction in tailpipe CO₂ 56 ≤ kW ≤ 560
  - 50% reduction in NOx and PM for engines > 560 kW
  - No changes for non-methane hydrocarbons and carbon monoxide
LLC Development Update
LLC Background

- Currently, there is no low-load cycle for off-road engines
- Off-road engines frequently operate at low-load up to 50% of the time
- SwRI data show NOx emissions from the proprietary Low-Load Application Cycle (LLAC) are up to 19 times higher than NOx emissions from the Nonroad Transient Cycle used to certify off-road engines
- A representative LLC is critical for controlling real-world emissions
- CARB is the process of developing a LLC
Method for Off-Road LLC Development

• Using National Renewable Energy Laboratory’s methodology from “Heavy-Duty Engine Low-Load Emission control Calibration, Low-Load Test cycle Development, and Evaluation of Engine Broadcast Torque and Fueling Accuracy During Low-Load Operation” as guidance
• Data pre-processing and cleanup
  • Smoothing data
• Conducting initial analysis and window selection
  • Conducting moving micro-trip window analysis
  • Generating a frequency distribution of average loads
• Determining overall distribution and definition of the Low-Load region
• Performing clustering analysis
• Selecting engine profiles and refinement
• Cycle translation and testing
Off-Road In-Use Testing (ORIUT) Concept
Manufacturer In-Use Testing Background

- Manufacturer-run in-use testing programs
  - On-Road Heavy Duty Diesel Engines
    - Heavy-duty diesel engines non-compliance was discovered
    - Settlement/consent decrees
    - 40 CFR 86 Subpart T
  - Large Nonroad Spark Ignition Engines
    - 40 CFR Part 1048
    - Additionally has production line testing and selective enforcement audits
- Currently, manufacturer run in-use program does not exist for:
  - On-road Otto engines
  - Off-road compression ignition engines
    - Selective Enforcement Audits (13 CCR 2427 & 40 CFR 1068 Subpart E)
ORIUT Program Concepts

- Developing a concept for a flexible program, while maintaining accuracy
- Evaluating concepts for an Off-Road Real Emissions Assessment Logging (OR-REAL) program
- Considering annual OR-REAL reporting and screening for high emitters.
- Portable Emission Measurement System (PEMS) testing if high emitter engine families are identified
- In-Use Concepts Tier 5 workgroup meeting: May 2nd
Off-Road OBD Concept
Possible OBD Concepts

- OBD currently not required for off-road engines
- Benefits of an OBD program
  - Provides clear identification of repairs covered by emission warranty
  - Facilitates diagnosis and repair leading to less downtime
  - Leads to durability improvements and lower in-use emissions
  - Facilitates inspections, screening of in-use engines, and in-use compliance testing
- Many OBD features from existing on-road heavy-duty diesel engines could be applied to off-road engines
Possible OBD Requirements

• Possible OBD Requirements:
  • Circuit continuity and out-of-range checks
  • Major component monitoring (e.g. selective catalytic reduction, diesel particulate filter, NOx sensor monitoring)
  • Monitoring of hardware leading to inducement or derate
  • Standardization:
    • Connectors
    • Fault information (fault codes and freeze frame)
    • Data stream parameters
  • NOx and CO₂ tracking: OR-REAL
Wrap-Up

• ORIUT workgroup meeting on May 2
• More workgroups coming in 2022
• Questions?
• Contact us at Tier5@arb.ca.gov