



# **EMA Workshop: Tier 5 Concepts Update**

**April 20, 2022**

# 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 (NO<sub>x</sub>) and particulate matter (PM) standards for new engines
- New Off-Road Diesel Carbon Dioxide (CO<sub>2</sub>) 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 NO<sub>x</sub> and PM for diesel engines < 56 kW
  - 90% / 75% reduction in NO<sub>x</sub> / PM for engines  $56 \leq \text{kW} \leq 560$
  - 5-8.6% reduction in tailpipe CO<sub>2</sub>  $56 \leq \text{kW} \leq 560$
  - 50% reduction in NO<sub>x</sub> 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 NO<sub>x</sub> emissions from the proprietary Low-Load Application Cycle (LLAC) are up to 19 times higher than NO<sub>x</sub> 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 CO<sub>2</sub> tracking: OR-REAL

# Wrap-Up

- ORIUT workgroup meeting on May 2
- More workgroups coming in 2022
- Questions?
- Contact us at [Tier5@arb.ca.gov](mailto:Tier5@arb.ca.gov)