CALIFORNIA
AIR RESOURCES BOARD

Off-Road In-Use Compliance Program

November 3, 2021

Current In-Use Compliance (IUC) Regulations

Regulation	Details
13 CCR § 2139 (g)	Authority to conduct IUC testing
13 CCR § 2423 (b)(1)(B)	Regulation guide to specific compliance & test procedures
13 CCR § 2421 (a)(4)(B)	Regulation definition on MY2011 and Later Test Procedures
California Exhaust Emission Standards and Test Procedures for New 2011 and Later Tier 4 Off-Road Compression-Ignition Engines **Part I-D**	Test procedure: modifies 40 CFR Part **1039**
California Exhaust Emission Standards and Test Procedures for New 2011 and Later Tier 4 Off-Road Compression-Ignition Engines **Part I-E**	Test procedure: modifies 40 CFR Part **1065**
California Exhaust Emission Standards and Test Procedures for New 2011 and Later Tier 4 Off-Road Compression-Ignition Engines **Part I-F**	Test procedure: modifies 40 CFR Part **1068**

CARB's Off-Road In-Use Compliance Pilot

- Staff has been developing an Off-Road In-Use Compliance program based on current regulations to ensure:
  - Manufactured vehicle/equipment meets CARB's certification requirements
  - Manufactured vehicle/equipment maintains emission compliance throughout useful life
- For screening purposes, CARB may conduct additional testing as deemed necessary including Auxiliary Emission Control Device (AECD) screening and Selective Catalytic Reduction (SCR) inducement testing
- **Valuable findings from initial work are described in the following slides**

Off-Road IUC Pilot Program – Status

- Staff is working with 5 different manufacturers
- Data logged over 25 different equipment
  - Including wheel loaders, excavators, graders, dozers
  - Engine displacements of 3.4L to 15L
- Portable Emissions Measurement Systems (PEMS) - tested 3 pieces of equipment
- Completed inducement testing on 2 pieces of equipment
- Conducting ongoing data logging, PEMS testing, inducement testing, and AECD evaluations

Off-Road IUC Pilot – Test Findings

- Lack of On-Board Diagnostic (OBD)/Controller Area Network (CAN) standardization port connections and communication
  - Data logging requires the use of proprietary tools and/or an intrusive break-out box
- Different inducement behavior was found within the same engine family
- Some equipment does not operate within the Not-to-Exceed (NTE) window during normal operation
- Some equipment is not reaching aftertreatment system temperatures above 250 degrees Celsius during a normal workday
- Lack of appropriate emission label placement

Other Off-Road IUC Test Findings

- CARB's testing has shown that the NTE protocol is not adequate for off-road engines
  - NTE protocol does not capture all types of operations including idle and low load
  - Has aftertreatment temperature exclusions
  - Engine must be in NTE area for at least 30 seconds continuously for the event to be valid
    - Results in very minimal NTE valid events making it difficult to assess engine compliance

Possible OBD and Communication Standardization Considerations

- In order to facilitate PEMS and IUC testing, possible concepts include:
  - Standardized parameters diagnostic port
  - Standardized CAN protocol
  - Defined parameters and information required to support PEMS testing should be publicly broadcasted
  - Functional and threshold monitors

SCR Inducement Findings

- As part of the Off-Road IUC program, CARB tested two pieces of equipment with the same engine family and same engine power rating
  - Resulted in completely different inducement behavior
- A low-Diesel Exhaust Fluid (DEF) quality inducement study resulted in:
  - Equipment 1 induced as described in the certification documents
  - Equipment 2 did not induce after extensive operation

Staff is considering concepts and requests feedback on how to ensure all equipment comply with the appropriate inducement strategies for low-DEF, DEF quality, and tampering.

Manufacturer-Run In-Use Testing Program

- Currently not required for off-road
- NTE evaluation method not adequate
- A manufacturer-run in-use testing program could help ensure compliance:
  - PEMS or engine dyno based
  - Telematics could be an option
- Possible concepts include some type of modified moving average window (MAW) or binning method

Conclusion

- Pilot Off-Road IUC program indicates the need for:
  - OBD/CAN communication standardization
  - A more robust protocol than NTE that more adequately captures low load operations
  - SCR inducement standardization
- Next steps:
  - Continue development of the Off-Road IUC program critical for controlling real-world emissions
  - Evaluate NTE versus MAW post-processing for in-use compliance