



# **Diesel On-Board Diagnostic (OBD) Demonstration Engine Aging**

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# Diesel OBD Demonstration Testing Background

- OBD regulation requires OBD system demonstration testing for annual certification
  - 1-3 engine demonstrations per manufacturer per model year
  - Malfunctioning parts implanted one at a time on engine/aftertreatment system
  - Emissions testing conducted to show OBD system detects implanted malfunctions before the emission-based OBD malfunction criteria are exceeded
- Testing conducted on engine/aftertreatment system rapidly aged to represent full useful life (FUL) aging to ensure:
  - OBD system calibration accounts for real-world aging
  - Real-world malfunctions are detected before emissions exceed applicable malfunction criteria in the regulation

# Diesel OBD Demonstration Engine Aging

- OBD regulation specifies minimum aging requirements on complete engine/aftertreatment system
  - Minimum system (engine, engine emission controls, aftertreatment) accelerated aging process aging hours:
    - Heavy heavy-duty engines: 2,500 hours
    - Medium heavy-duty engines: 1,063 hours
    - Light heavy-duty engines: 632 hours
  - Operation at rated horsepower
  - Operation at load levels greater than 80% of the rated torque, with sustained intervals at 100% of the rated torque
  - Operation over transient conditions (e.g., Mode 2 of Federal Test Procedure cycle)
  - Calculated number of regeneration events experienced over FUL
  - Thermal cycling events (i.e., system shut down with a subsequent cold start)

# Diesel OBD Demonstration Engine Aging Validation

- Accelerated aging process required to be validated against actual FUL in-use engines to ensure it is representative
- Validation must include:
  - Following metrics over FUL: fuel burn rate, total fuel, and reductant used by system
  - Correlation between a representative actual FUL system(s) and the test engine of all adaptation/learning parameters used to maintain emission control performance to the applicable emission certification standard over the life of the system.

# U.S. Environmental Protection Agency Aging for Deterioration Factors

- U.S. Environmental Protection Agency (U.S. EPA) diesel aftertreatment rapid aging protocol (Title 40, Code of Federal Regulations §1036.245) has different primary purpose
  - Deterioration factors (DF) used to show engines will meet emission standards throughout the useful life
- U.S. EPA aging protocol differences include:
  - Fewer hours of aging on the complete system (engine + aftertreatment) for heavy heavy-duty engines
  - Accelerated bench aging of aftertreatment devices including accelerated chemical exposure (lube oil, sulfur)

# Diesel OBD Demonstration Engine Aging

- CARB wants to explore opportunities to preserve representative OBD demonstrations and harmonize between OBD aging and DF aging
- Seeking feedback on:
  - How the engine and emission controller adaptation parameter values compare for the U.S. EPA aging protocol versus CARB OBD protocol
    - e.g., amount of available authority used up, adaptation
  - Impacts of aging protocol differences on OBD system performance
  - Parts of the protocols that can be harmonized without compromising OBD performance