Compliance Management Program for Heavy-Duty On-Highway Engines in the U.S.

The 4th SINO-US Workshop on Motor Vehicle Pollution Prevention and Control

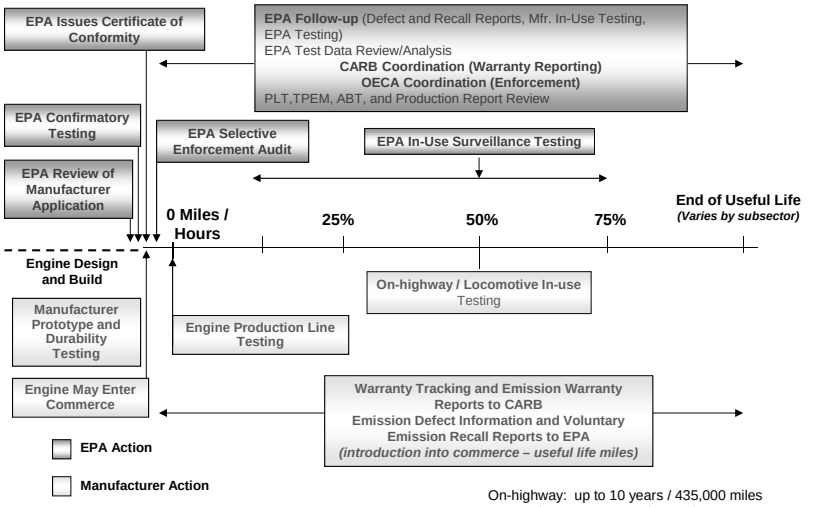
U.S. Environmental Protection Agency
Office of Transportation and Air Quality

How OTAQ Ensures Compliance

OTAQ makes use of multiple compliance tools within our regulatory framework

- Prior to engine production
  - Detailed review of manufacturers' application for certification
    - Ensure pollution prevention through proper emission control design
  - Confirmatory testing
    - Ensure test results for certification engines are accurate
  - Review of reporting results and compliance testing performance from previous model years
- At time of engine production
  - Selective enforcement audits (SEAs) of manufacturers' engine production lines
    - Ensure conformity of production engines to certification engine/application
    - Includes audit of manufacturers' labs to ensure compliance with testing requirements
- After engine introduced into commerce
  - Manufacturer-run in-use testing programs with data submission to EPA
  - EPA-run in-use testing (engine dynamometer and in-situ PEMS)
    - Ensure engines comply with standards in real-world operating conditions (field testing)
  - Emission-related defect and recall reporting
    - Ensures emission defects identified and corrected as needed
    - Provides poor quality deterrent and encourages future improvements

Diesel Engine Compliance Program



Full Useful Life:

On-highway: up to 10 years / 435,000 miles
Nonroad: up to 10 years / 8,000 hours
Marine: up to 10 years / 20,000 hours
Locomotive: up to 10 years / 32,000 MW-hours

Pre-Production Certification Process

- Review information requirements
  - Emissions data collected over appropriate test cycles
    - Federal Test Procedure (FTP) – transient test (cold/hot starts)
    - Supplemental Emissions Test (SET) or Ramped Modal Cycle (RMC) – steady-state test (hot start only)
  - Not-to-Exceed (NTE) testing
    - Engine speed/load conditions not represented above
    - Expanded ambient conditions
  - Infrequent regeneration adjustment factors
  - Deterioration factors
    - Service accumulation over portion of regulatory useful life
    - In-use representative durability cycle
  - Emission control strategies (Auxiliary Emission Control Devices or AECDs)
    - For strategies that reduce effectiveness of emission controls, manufacturers must justify why they are approvable (i.e., not a defeat device)
      - Substantially included in a test cycle
      - Limited to engine starting only
      - Necessary for engine/equipment protection (for operation outside the NTE zone)

Pre-Production Certification Process (cont.)

- Adjustable parameters
  - Ensure against tampering outside of compliant settings
- Maintenance intervals
- On-board diagnostics (OBD)
  - Monitoring and detection of malfunctions in emission-related engine systems and components
- Collect application fees
  - EPA collects fees for each certificate issued
  - Allows EPA to recover reasonable costs associated with certification and compliance
- Issue certificate of conformity

OBD Approvals

- Part of the pre-production certification process
- CARB is currently conducting comprehensive review of heavy-duty OBD applications
- HD regulations allow EPA to accept an engine meeting California OBD requirements as compliant with federal OBD requirements
  - Manufacturer needs to notify EPA of any concerns raised or deficiencies granted by CARB staff and plans for resolving
- Avoids duplicity
- Manufacturers have single point of contact

Confirmatory Testing

- Manufacturers do bulk of emission certification testing at their labs
- EPA audits (or confirmatory tests) a subset of those engines at NVFEL, contract labs, or manufacturers labs
  - Provides manufacturers incentive to perform accurate tests
- Tests conducted
  - Federal Test Procedure (FTP) – transient test (cold/hot starts)
  - Supplemental Emissions Test (SET) or Ramped Modal Cycle (RMC) – steady-state test (cold/hot starts)
  - Not-to-Exceed (NTE) testing
- If manufacturer fails confirmatory test, certificate of conformity is withheld until manufacturer addresses root cause of noncompliance

Selective Enforcement Audits (SEAs)

- EPA selects engines off the manufacturers production line for emission testing
  - Typically requires testing of 5-6 engines minimum to come to pass/fail decision
  - Ensures that production engines comply with emission standards and conform to the engine design indicated in the certification process
  - Provides a measure of production variability
  - Allows for audits of manufacturers test labs
  - If manufacturer fails SEA, certificate of conformity can be suspended until manufacturer addresses root cause of noncompliance
- Note: Certificates are conditioned upon manufacturers granting EPA access to production facilities to conduct audits

Production Line Testing (PLT)

- Manufacturer-run version of SEAs
  - Not applicable for on-highway industry
- Manufacturer selects engines off their production line for emission testing throughout the year
  - Sample size is typically small percentage (e.g., 1%) of U.S.-directed production
  - Ensures that production engines comply with emission standards and conform to the engine design indicated in the certification process
  - Provides a measure of production variability
  - If manufacturer fails PLT, certificate of conformity can be suspended until manufacturer addresses root cause of noncompliance

In-Use Testing

- EPA's evaluation of engine compliance extends beyond the pre-production certification process to ensure engines comply with emission standards during their full useful life
- Manufacturer-run in-use
  - Under the program, manufacturers test fleet or customer-owned in-use trucks
  - Fully enforceable program beginning in the 2007 model year for gaseous emissions and 2008 model year for PM emissions (pilot programs prior to then)
  - Monitors in-use emissions of diesel vehicles with portable emission measurement systems. Pollutants to be measured: Hydrocarbons (HC), Carbon Monoxide (CO), NOx and PM
  - Testing will be conducted on in-use vehicles, under real-world driving conditions, within the engine's useful life to monitor for NTE compliance and to help ensure overall compliance with the emission standards
  - Measurement "accuracy" margins established to account for the emissions measurement variability associated with these units in the field
- EPA-run in-use
  - EPA procures and tests commercial trucks
  - Includes in-situ testing (PEMS) and/or pulling engines for lab testing
- If manufacturer fails any testing, EPA can order recall of engines introduced into commerce

Emissions Warranty and Defects

- Emissions Warranty
  - Manufacturers must warrant the following to purchasers regarding engine and all parts of its emission-control system:
    - It is designed, built, and equipped so it conforms at the time of sale to applicable regulations
    - It is free from defects in materials and workmanship that may keep it from meeting applicable regulations
  - Warranty period: up to 5 years / 100,000 miles
- Emission-related defects
  - Manufacturers must investigate any indication that engines introduced into commerce have incorrect, improperly installed, or otherwise defective emission-related component
    - Includes defects in design, materials or workmanship
    - Must file reports for defects affecting typically 20 or more engines
  - Can lead to EPA ordering recalls by manufacturer if determined that a substantial number of properly maintained and used engines do not conform to regulations during their useful life
    - Manufacturer required to submit plan to remedy nonconformity
    - Manufacturer encouraged to conduct voluntary recalls

Compliance Reporting

- Manufacturers are required to report certain information to EPA on a periodic basis
- Examples:
  - Engine Production Volume Reports (Annual)
  - Emissions Averaging, Banking, and Trading Reports (Annual)
  - Defect / Voluntary Recall Reports
- EPA audits information to ensure conformance to regulatory requirements
  - Delinquent reporting can result in denial of certification in future model years

Interacting with Regulated Manufacturers

- Providing compliance assistance to industry is critical to ensuring that products comply throughout their useful life
- Recommendations:
  - Annual certification preview meetings with manufacturers
  - Regular interactions throughout the year
    - Conference calls
    - Exchanges of information by e-mail
  - Issuance of guidance documents
    - See http://www.epa.gov/otaq/cert/dearmfr/dearmfr.htm for examples
  - Intermittent workshops or web-conferences

Strategy to Address Growth in Size and Complexity of Program

- Prioritize work using risk-based approach
- Establish agile strategy that periodically shifts focus among sectors and compliance activities
- Target compliance activity on emerging as well as traditional priorities
- Use technology to automate and streamline certification and record-keeping processes
- Work early and collaboratively with stakeholders to establish guidance and policy, and to provide technical assistance
- Use tracking and reporting to inform public about compliance results

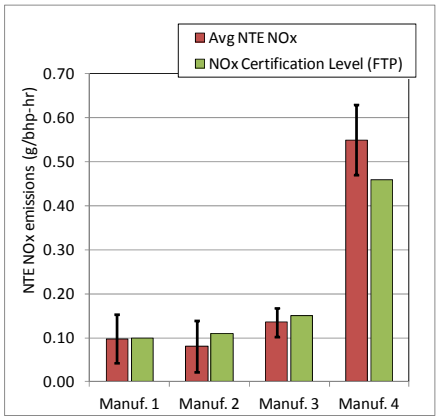
Appendix

Recent Compliance Issues

- In-use testing of HD on-highway trucks
  - Important for assessing compliance with NTE limits under real-world operating conditions
  - Provides feedback for certification process on associated emission impacts of complex AECDs
  - Provides insight into engine production variability and durability of emission controls
- Results from recent testing indicate that one manufacturer may be designing engine to have significantly different emission characteristics in-use than in the test cell

Recent Compliance Issues

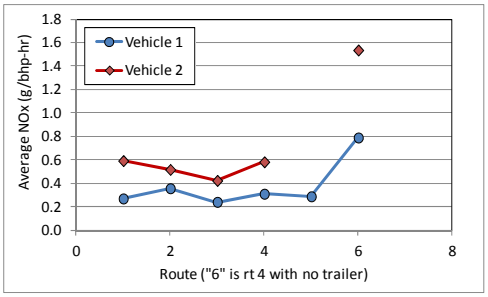
- EPA testing found average NTE NOx emissions for one manufacturer to be significantly higher than certification levels
  - Would expect NTE event NOx emission to largely be in-line with certification levels
- NTE testing provisions provide additional compliance margin so all were found to be in compliance
  - However, these data provide basis for further discussions with manufacturer on improving emission control strategy performance
- Difficult to make this type of assessment based on data submitted in manufacturer's cert application alone
- Ensures level playing field among manufacturers



Comparison of real-world measured NOx emissions and certification data submitted by manufacturers. In this example, "Manufacturer 4" real-world emission levels are significantly higher than certification levels

Recent Compliance Issues

- Results from recent testing of another manufacturer indicate possible production line variability issues
- Can be a problem for manufacturers to translate compliant emissions design from prototype engines to mass-produced engines
- Data provide basis for targeting SEAs to ensure production variability doesn't compromise emissions compliance
- Difficult to make this type of assessment based on data submitted in manufacturer's cert application alone
- Ensures level playing field among manufacturers



NOx emissions from two vehicles with the same model engine over different driving conditions highlighting the significant variation from engine-to-engine

SCR-Related Issues

- EPA has developed guidance regarding proper maintenance and adjustment of SCR systems
  - Diesel Exhaust Fluid (DEF) level monitoring and low level inducements
    - Warn operators of low DEF level and provide inducements (e.g., vehicle speed limitation, engine shutdown) to ensure DEF tanks are refilled
  - DEF quality monitoring and poor quality inducements
    - Warn operators of poor quality DEF and provide inducements (e.g., vehicle speed limitation, engine shutdown) to ensure appropriate specification DEF is utilized
  - SCR component tampering and inducements
    - Alert operators of SCR component tampering (e.g., disconnected dosing module) and provide inducements (e.g., vehicle speed limitation, engine shutdown) to problems are fixed

SCR-Related Issues

- DEF Infrastructure
  - Addressed with manufacturer at time of certification
  - Ensure reducing agent available at dealerships and truck-stops or non-road distributors
  - Have a back-up plan, such as a toll-free phone number, if customers are unable to obtain DEF
  - Education and outreach for potential owners and service industry
- DEF Quality
  - Manufacturers adopted ISO 22241-1 quality standard for DEF
  - API DEF Quality Licensing Program widely utilized
    - Includes audit and enforcement functions
    - www.apidef.org