Nonroad SCR Certification

July 26, 2011

Webinar Presentation

Agenda

- Purpose/Background
- SCR Certification Considerations
  - Diesel Exhaust Fluid (DEF) Level Monitoring
  - Inducement for Low Level DEF
  - DEF Quality Monitoring
  - Inducement for Poor Quality DEF
  - Indicators of Tampering
  - Warning and Inducement for Tampering
  - Maintenance Intervals
  - Freeze Protection
  - Unregulated Pollutants
  - Infrastructure
- Next Steps

Purpose

- To provide EPA's current thinking on the certification of SCR-equipped nonroad engines
  - Topics pertain to SCR systems utilizing an aqueous reducing agent (referred to as diesel exhaust fluid or DEF) to reduce NO_X emissions
    - Topics may also be relevant for other types of SCR systems
- To identify different characteristics and concerns regarding nonroad SCR technology and its use in this sector and how EPA's existing regulations may be used to address such issues

Background

- Similar to on-highway heavy-duty engines, nonroad engine manufacturers are interested in applying SCR technology and have raised questions about how certification regulations will be applied
- SCR is unique among emission controls in that it requires on-going operator interaction to ensure proper operation of the system
- EPA has identified several issues for manufacturers to address in developing and applying SCR technology to ensure continuing emission reductions occur
  - Issues largely relate to technology's use of DEF
    - Requires operators to refill DEF on a regular basis
    - DEF refill constitutes maintenance and intervals must be set appropriately
    - Is dependent on broad availability of appropriate quality DEF
    - DEF may be susceptible to freezing in cold temperature conditions
  - Tampering is also a potential issue

Background

- Nonroad equipment operate under different conditions than on-highway trucks and warrant unique consideration
  - Heavy-duty on-highway trucks must maintain reasonable speed to be able to operate
  - Nonroad engines are used in numerous applications
    - Not always moving (e.g., pumps, generators)
    - Average loads vary widely from one application to the next
- EPA has coordinated with the California Air Resources Board to harmonize expectations for nonroad engines
- Manufacturers may present their own unique strategies that are not the same as the examples we are providing, and such strategies will remain subject to EPA review and approval
- EPA plans to issue a Dear Manufacturer Letter in the near future

SCR Certification Considerations

DEF Level Monitoring

- *Issue:* Whether equipment operators are notified in a timely fashion and provided an opportunity to refill DEF tank before it is empty
- *EPA Thinking:* Some indication of DEF level necessary as well as warning of pending inducements
- *Examples:*
  - Constantly visible gauge and warning lights
  - Warning threshold should be adequate to facilitate refill for given application

Inducement for Low Level DEF

- *Issue:* Whether equipment operators are refilling DEF tank if low DEF level warnings are ignored
- *EPA Thinking:* When SCR system is no longer able to dose (i.e., DEF is depleted), equipment should not be able to functionally operate
- *Examples:*
  - Final inducement initiated so that engine is shut down or only idles (no power) when DEF tank is empty
  - Final inducement (shut down or idle only (no power)) to be determined by manufacturer
  - Should provide enough advance warning to avoid unsafe conditions and allow for diagnostics and restart after refill

Inducement for Low Level DEF

- Manufacturers have inquired if it is appropriate to implement other inducements prior to final inducement to get the operator's attention
  - We believe this can be acceptable and manufacturers should do what they think is in the best interest of their customers
  - If DEF is in the tank, we believe significant inducement flexibility exists
  - May include short or limited interruptions of these prior inducements to address safety concerns
    - Operator may need opportunity to raise drill from hole or lower bucket
    - Operator may need time to move equipment off steep grade
  - Manufacturers have also asked about including short or limited interruptions of final inducement to address safety concerns
    - Need for additional interruptions is not readily apparent given time and flexibility to warn operator of impending circumstance through prior inducements and limited interruptions of those inducements
    - Manufacturers may discuss this topic further with the Agency

DEF Quality Monitoring

- *Issue:* Whether equipment operators are using appropriate quality DEF within SCR systems
  - Primary issue is intentional dilution or substitution of DEF with water
  - Secondary issue is attempting to make DEF with agricultural-grade urea and tap water
- *EPA Thinking:* Detection of poor DEF quality should be available as well as operator warning of poor quality and pending inducements
  - Poor DEF quality defined as quality level that causes noncompliance over an applicable test cycle

DEF Quality Monitoring – Continued

- *Examples:*
  - DEF quality sensors will be best reasonable technology
    - Can detect smaller concentration deviations in DEF quality than NO_X sensors, and can do so quicker – becomes increasingly important for determining compliance as Tier 4 standards phase-in
  - Manufacturers would identify poor quality limits over test cycles and continuously monitor quality in-use
  - Should be able to detect non-compliance with applicable regulations within 1 hour of engine restart or change in level of reductant tank
  - For Tier 4 final, we think systems would be able to detect poor quality within 30 minutes

Inducement for Poor Quality DEF

- *Issue:* Whether equipment operators are properly motivated to use appropriate quality DEF
- *EPA Thinking:* When poor quality DEF is used with SCR system, inducements should be present to sufficiently ensure that equipment will not be able to functionally operate
- *Examples:*
  - Final inducement initiated so that engine is shut down or only idles (no power) within 4 hours of detecting poor DEF quality
  - Final inducement (shut down or idle only (no power)) to be determined by manufacturer
  - Should provide enough advance warning to avoid unsafe conditions and allow for diagnostics and restart after replacement of DEF

Inducement for Poor Quality DEF – Continued

- *Examples – Continued:*
  - Believe 4 hours sufficient for all equipment to receive proper maintenance because nonroad equipment can be maintained on-site
  - Electronic monitoring of remote engines expected to assist timely maintenance
  - If other inducements are phased in prior to final inducement, initiate operator warning prior to final inducement
  - If poor quality DEF is detected again within 40 hours:
    - Immediately notify owner
    - Shut down or idle only (no power) within 30 minutes

Indicators of Tampering

- *Issue:* Whether SCR systems are designed to be tamper resistant to sufficiently reduce the likelihood that they will be circumvented
- *EPA Thinking:*
  - Manufacturers should be careful to review any element of SCR design that could be tampered with and prevent proper operation of the system
  - The following actions should be considered at a minimum:
    - Disconnected DEF level sensor
    - Blocked DEF line or dosing valve
    - Disconnected DEF dosing valve
    - Disconnected DEF pump
    - Disconnected SCR wiring harness
    - Disconnected NO_X sensor (that is incorporated with the SCR system)
    - Disconnected DEF quality sensor
    - Disconnected exhaust temperature sensor
    - Disconnected DEF temperature sensor
- *Example:* Would be able to detect tampering within 1 hour of a tampering event

Warning and Inducement for Tampering

- Same as warning and inducement for poor quality DEF

Maintenance Intervals

- *Issue:* Petitions for new maintenance and maintenance intervals shorter than that required by regulations (replacement of the DEF) should be supplied by each manufacturer or by a group documented to represent the manufacturer
- *EPA Thinking:*
  - Each petition must address:
    - The suggested DEF refill interval
    - The rationale and evidence to support the maximum feasible maintenance/refill intervals
    - Demonstration that the refill will be performed at the recommended interval
  - EPA will evaluate petitions and announce approved shorter intervals in the Federal Register

Freeze Protection

- *Issue*: Whether SCR systems are designed to ensure that DEF does not freeze or refreeze during operation
- *EPA Thinking:*
  - Freeze protection systems will be evaluated as Auxiliary Emission Control Devices (AECDs)
  - Engine designs expected to incorporate DEF thawing and freeze prevention technology
  - For engines installed in equipment not intended to operate in cold temperatures, in lieu of a DEF thawing system, manufacturers may demonstrate engine is designed not to operate in freezing conditions
- *Examples:*
  - The following test procedure has been offered as an example of a test procedure that could be used for ensuring that the AECD is used appropriately
    - Prior to Procedure:
      - Temperature: DEF at 20° F (maximum)
    - Soak Conditions:
      - Temperature: 0° F (maximum)
      - Time: 72 hours or solid DEF (whichever occurs first)
    - Test Duty Cycle:
      - Temperature: 0° F (maximum)
      - Time: 70 minutes (maximum)
        - » Start engine and idle with no engine load for 20 minutes
        - » Operate engine at no more than 40% load at rated speed for up to 50 minutes
  - SCR systems that are capable of fully functional dosing at the conclusion of the test procedure may be considered acceptable

Unregulated Pollutants

- *Issue:* No emission control device, system, or element of design may be used if it causes or contributes to an unreasonable risk to public health, welfare or safety in its operation or function
- *EPA Thinking:*
  - Ammonia (NH_3) slip and potential dioxin emissions from copper-zeolite (Cu-Z) catalysts handled like highway
    - NH_3 slip should be below 10 PPM average over the applicable test cycles
    - If Cu-Z catalyst system covered by EPA test program, then dioxin not an issue
    - Combination DPF/Cu-Z SCR catalysts not covered by EPA test program
  - Vanadium SCR catalyst systems must be able to show control measures prevent possible damaging high temperature exposure
    - Default position generally is exhaust temperature controlled to ≤ 550°C
    - Draft test method being evaluated to aid sublimation temperature identification and possible higher temperature control points

Infrastructure

- *Issue:* Whether DEF is widely available and readily accessible to equipment operators to ensure SCR systems are properly maintained
- *EPA Thinking:*
  - Since nonroad equipment can be in many locations, infrastructure needs to account for this
  - Manufacturers should have DEF available at dealerships and provide a back up plan (such as a toll free number) that operators can use if they are unable to obtain it elsewhere
  - Manufacturers should also work with third-parties to ensure that DEF is widely available at appropriate locations, in addition to dealerships
    - For nonroad, third-parties likely to include independent mobile refuelers (jobbers)
    - Pointing to truck stops as third-party availability is not sufficient

Next Steps

- Manufacturers should contact their EPA certification representative with additional questions
- Manufacturers are encouraged to discuss their certification plans with EPA well in advance of submitting applications

Appendix

Regulatory Context

- Maintenance intervals – 40 CFR § 1039.125
  - Refilling of DEF tank may be considered maintenance subject to a prescribed minimum interval
  - Manufacturers may petition for a shorter interval
- Adjustable parameters – 40 CFR § 1039.115(e)
  - DEF tank level and DEF quality may be considered adjustable parameters
  - Elements of design related to adjustable parameters should be protected against tampering
- Auxiliary emission control devices (AECDs) – 40 CFR § § 1039.801 and 1039.115(g)
  - Strategies protecting DEF against freezing should be disclosed and are evaluated as AECDs
- Unregulated pollutants – 40 CFR § 1039.115(f)
  - SCR systems must not result in emissions of a toxic substance engines would otherwise not emit