UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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OFFICE OF
AIR AND RADIATION

December 30, 2009

CISD-09-04 REVISED (HDDE)

SUBJECT: Revised Guidance for Certification of Heavy-Duty Diesel Engines Using Selective Catalyst Reduction (SCR) Technologies

Dear Manufacturer:

On February 18, 2009, EPA issued a SCR guidance document that provided guidance to manufacturers regarding the certification of heavy-duty engines using SCR systems (CISD-09-04). The document was designed to address certain issues relevant to the certification of heavy-duty diesel engines using SCR, the control technology that many manufacturers have selected to meet stringent requirements for NOx emissions. We intended that document to supplement previous guidance regarding engines using SCR (CISD-07-07, issued on March 27, 2007) and provide further guidance regarding specific areas of concern.

An engine manufacturer has filed a petition for review, in the United States Court of Appeals, DC Circuit, to review, among other things, EPA's CISD-09-04 Guidance. Because some prescriptive language in CISD-09-04 may have led to confusion regarding our intent that the document be used as guidance, rather than setting forth binding requirements, I believe it is appropriate to provide a new document providing revised guidance regarding certification of heavy-duty diesel engines using SCR. This document supersedes the previously issued CISD-09-04, which is no longer in effect. Manufacturers wishing to certify engines using SCR technology should consult this document and the general guidance provided in CISD 07-07, and in turn work with their certification representatives to provide EPA descriptions of the strategies incorporated in their SCR systems in order to demonstrate compliance with EPA's certification requirements as set forth in its regulations. EPA issues all certificates of conformity, to date and in the future, based solely on requirements of the Clean Air Act and EPA's regulations. The authority for issuance of such certificates is not based on this or any other guidance.

If you have any questions about this letter, please contact your certification representative or Khesha Reed of my staff at reed.khesha@epa.gov.

Sincerely,

Karl J. Simon, Director
Compliance and Innovative Strategies Division
Office of Transportation and Air Quality

BACKGROUND

On March 27, 2007, EPA issued a guidance document regarding the certification of motor vehicles and motor vehicle engines using SCR systems (CISD-07-07). That document was designed to address the control technology that many manufacturers had selected to meet stringent requirements for NOx emissions. At the time, we recognized that SCR technology was evolving and reserved the right to make changes to our approach. This document is intended to supplement CISD-07-07 and provide additional guidance regarding specific areas of concern, in particular for heavy-duty diesel engines. The statements in this document are intended solely as guidance. This guidance is not intended to provide any final decision or bind the Agency regarding any of the topics discussed in this document or the Agency's future actions regarding certification of heavy-duty engines using SCR technology.

As noted in CISD-07-07, there are several regulatory requirements that can impact the certification of engines using SCR technology to meet the NOx standards for heavy-duty diesel engines. In particular, 40 CFR § 86.004-25 and 40 CFR § 86.094-25, relevant to allowable maintenance, 40 CFR § 86.094-22, relevant to adjustable parameters, and 40 CFR § 86.004-2, 40 CFR § 86.094-25 and 40 CFR § 86.004-16, which address Auxiliary Emission Control Devices (AECDs), are the regulatory provisions that are relevant to this guidance.

REGULATORY REQUIREMENTS

ALLOWABLE MAINTENANCE

Under 40 CFR §86.1834-01(b)(7)(ii) and §86.094-25(b)(7)(ii), a manufacturer must submit a request for approval for any new scheduled maintenance it wishes to recommend to purchasers and perform during durability testing. "New scheduled maintenance" is that maintenance which did not exist prior to the 1980 model year, including that which is a direct result of the implementation of new technology not found in production prior to the 1980 model year. On the basis of the manufacturer submission and other data, EPA will determine whether to designate the scheduled maintenance as new and to establish technologically necessary maintenance intervals for the new maintenance. The agency received requests for new scheduled maintenance of the SCR system, in particular replenishment of reducing agent (also known as Diesel Exhaust Fluid, or DEF). EPA has approved the maintenance intervals associated with the DEF tank sizes below. A federal register notice has been published to announce this decision 74 Fed. Reg. 57671 (November 9, 2009). This approval does not preclude manufacturers from requesting alternative new scheduled maintenance under this provision.

DEF Tank Size

For vocational applications (*e.g.*, garbage truck, dump truck, concrete mixer, beverage truck, fire truck, airport refueler), EPA approved a minimum DEF tank size that provides no less than:

Equal the range (in miles or hours) of the vehicle's fuel capacity (*i.e.*, 1:1)

These applications are generally refueled daily from a central location and conducive to refilling DEF in the same manner.

For all other vehicle applications, EPA approved a minimum DEF tank size that provides no less than:

Twice the range (in miles or hours) of vehicle's fuel capacity (*i.e.*, 2:1); or,

Three times the range (in miles or hours) of the vehicle's fuel capacity (*i.e.*, 3:1), if there is no constant DEF level indicator.

For further information regarding this approval, please see 74 Federal Register 57671, November 9, 2009.

Reasonable Likelihood of Maintenance Occurring In Use

As noted in the November 9, 2009 Federal register notice, EPA considers SCR systems to be critical emission-related components. As such, according to §86.094-25(b)(6)(ii), manufacturers must show that there is a reasonable likelihood of scheduled maintenance being performed in-use. Manufacturers may make such a showing by satisfying at least one of the conditions listed in §86.094-25(b)(6)(ii)(A-F). Among other methods, the regulation establishes two methods for showing a reasonable likelihood of maintenance occurring, which are: (A) presenting information establishing a connection between emissions and vehicle performance such that as emissions increase due to lack of maintenance that vehicle performance will deteriorate to a point unacceptable for typical driving; and (C) installing a clearly displayed visible signal system approved by EPA to alert the driver that maintenance is due. The discussion below provides some guidance on possible approaches to showing a reasonable likelihood that DEF in a vehicle's tank will be maintained at acceptable levels. EPA is not requiring that the methods discussed below be used, nor is the Agency stating that engine and vehicle designs that use these methods will be acceptable for certification, as that decision must be made based on the design of particular engines or vehicles.

Driver Warning

Examples of clearly displayed visible signal systems that could be approvable include a DEF level indicator, messages in the instrument cluster, a DEF indicator, engine shutdown lamp, or audible warnings to warn the driver that maintenance is due (DEF refill in needed). One method of enhancing the likelihood of maintenance can be to include some level of warning escalation. The Agency has discussed with engine

manufacturers the use of a particular symbol to indicate the need to refill the DEF tank. While no final action requires the use of any particular symbol, the Agency, after discussions with manufacturers and manufacturer groups, understands the following symbol is generally accepted and believes that it would likely be appropriate:

Driver Inducement

Another method of showing that scheduled maintenance of critical emission-related equipment is reasonably likely is establishing a connection between emissions and vehicle performance such that as emissions increase due to lack of maintenance vehicle performance will simultaneously deteriorate to a point unacceptable for typical driving. Possible strategies include those set forth in the EPA's March 27, 2007, guidance letter or a performance degradation strategy that is sufficiently onerous to discourage operation without DEF. In determining strategies that are sufficiently onerous to cause the driver to replenish the DEF tank and minimize any adverse emission impact, manufacturers can consider strategies that begin to degrade performance prior to the DEF tank being empty and that progressively become more onerous as the DEF tank becomes empty. It would also be useful to communicate to the driver why the disabling performance degradation has occurred, e.g. through a flashing DEF indicator or a similar message. Possible approaches for the manufacturer to degrade performance include a derate of the engine's maximum available engine torque of a sufficient magnitude for the operator to notice decreased operation (a derate of at least 25% is likely to be needed for such an effect) and progressing to further degradation that could include operation of the engine being disabled or severely restricted, implemented in a manner designed to prevent operation without DEF. EPA recognizes that there may be safety concerns regarding a complete disablement of the engine or severe degradation occurring while the vehicle is moving, and therefore believes that such degradation would best be initiated at the time of refueling, parking or restart.

These are possible general approaches to meeting the requirement that the maintenance is reasonably likely to occur in use, but EPA will evaluate all approaches taken by manufacturers at the time of certification, and such evaluation will be based on the requirements in the regulations.

ADJUSTABLE PARAMETERS

Under section 86.094-22(e), EPA is to determine vehicle or engine parameters that are subject to adjustment for testing purposes. In guidance document CISD-07-07, the Agency notified manufacturers that SCR systems utilizing a reducing agent that needs to be periodically replenished could be considered an adjustable parameter. In particular, the level and quality of DEF are parameters that are potentially subject to adjustment under 86.094-22(e)(1)(i). These parameters can physically be adjusted, may significantly affect emissions and have not been present on previous model year engines in the same form or function. Pursuant to section 86.094-22(e), the Agency will determine the

adequacy of the limits, stops, seals or other means used to inhibit adjustment. For any parameter that has not been determined to be adequately limited, 86.094-22(e) authorizes the Administrator to adjust the parameter to any setting within the physical limits or stops during certification and other testing. In determining the parameters subject to adjustment, EPA will consider the likelihood that settings other than the manufacturer's recommended setting will occur in-use, considering such factors as, but not limited to, the difficulty and cost of getting access to make an adjustment; damage to the vehicle if an attempt is made; and the effect of settings other than the manufacturer's recommended settings on engine performance.

EPA believes that the use of certain engine design features by manufacturers using SCR technology will be particularly beneficial in determining the likelihood, or lack thereof, that settings other than the manufacturer's recommended setting (in particular, operation without appropriate reducing agent) will occur in-use. SCR systems that incorporate such design features as driver warnings, inducements that affect engine performance, and design features that make the engine resistant to misadjustment, tampering, or operation outside the manufacturer's recommended settings are less likely to be considered subject to adjustment than SCR systems without such design features.

Empty DEF Tank

As noted above, EPA considers the level of DEF in the DEF tank to be a potentially adjustable parameter under the regulations. In accordance with 86.094-22(e), the Agency will determine at the time of certification whether a manufacturer design has adequately limited adjustment of the parameter. EPA expects that its analysis of the likelihood that settings other than the manufacturer's recommended setting will occur in-use (i.e. whether the engine is designed to prevent operation without DEF) will be similar to the analysis discussed above regarding the likelihood that maintenance of the DEF level will occur in use. Please refer to that discussion.

Identification of Incorrect Reducing Agent

SCR systems require the use of a reducing agent containing a certain concentration of urea to ensure NOx is effectively converted. Many SCR systems identify incorrect reducing agent by using NOx sensors to determine catalyst efficiency. Urea quality sensors may provide more robust detection capability in the near future. Under either of these systems, once the system detects a DEF quality problem, the driver is alerted. In order to reduce the likelihood that there will be significant operation using incorrect reducing agent, the manufacturer could use strategies similar to the strategies discussed above for alerting the operator to the problem and then use a gradually more onerous inducement strategy to correct the poor quality DEF and discourage its repeated use. For example, a manufacturer might use the following sequence:

1. **DEF Warning.** Once the SCR system detects poor quality DEF that inhibits the SCR system from functioning, a warning lamp illuminates or message appears in the instrument cluster.

2. **Engine Derate.** If the driver fails to remedy the problem within a reasonably short amount of time or mileage after detection, the maximum available engine torque would be reduced by a level that would limit performance in a manner that would be noticeable to the operator and induce the driver to remedy the problem. While EPA understands that a certain amount of time or mileage may be needed after detection to provide the driver enough time to have the vehicle serviced and incorrect DEF removed, EPA is not determining in this guidance what specific amount of time or mileage, or the level of derate, that would be needed if the manufacturer uses this approach to reduce the likelihood of operation outside of manufacturer recommended settings.

3. **Severe Inducement.** If the driver fails to remedy the problem within a longer, but still relatively short period of time or mileage after initial detection, performance could be further degraded using a severe reduction in the capability of the engine. For example, the manufacturer could program the engine to be disabled after refueling, after parking, or after restart. EPA understands that certain additional time may be appropriate after the initial driver inducement to provide enough time to service the vehicle prior to the severe inducement. EPA is not determining in the guidance, what specific amount of time or mileage would be necessary or sufficient to ensure that significant operation outside of manufacturer recommended setting is unlikely, should a manufacturer use this approach.

Tamper Resistant Design

SCR systems may be designed to be tamper resistant to reduce the likelihood that the SCR system will not be circumvented, as provided under 86.094-22(e). In order to reduce the likelihood that the parameters will be circumvented in use, EPA will review during certification the tamper resistance of the SCR system. In particular, manufacturers should be careful to review the tamper resistance of the system regarding the following actions:

1. Disconnected DEF tank level sensor

2. Blocked DEF line or dosing valve

3. Disconnected DEF dosing valve

4. Disconnected DEF pump

5. Disconnected SCR wiring harness

6. Disconnected NOx sensor (that is incorporated with the SCR system)

7. Disconnected DEF quality sensor

In developing a strategy for reducing the likelihood that these actions will occur in-use, manufacturers, in addition to designing their systems to make these components physically difficult to access, can also use the three-layered strategy discussed above (warning, inducement, and severe inducement) including strategies for reducing the likelihood of repeated occurrences. The Agency believes that combining the difficulty in accessing the components with inducements will decrease the likelihood that the SCR system will be circumvented, which will increase the likelihood that EPA will not consider such parameters adjustable. Other methods to inhibit the adjustment of SCR parameters may also be considered.

AUXILLIARY EMISSION CONTROL DEVICE - FREEZE PROTECTION

The EPA understands that under extreme temperatures conditions DEF may freeze and not immediately flow to the SCR system. There are, however, systems and devices that can be utilized to ensure the flow of DEF. These systems will be evaluated as AECDs (see 86.082-2). As outlined in 86.004-2 and 86.004-16 manufacturer must describe this AECD and show that the engine design does not incorporate strategies that reduce emission control effectiveness compared to strategies used during the applicable Federal emissions test procedures. EPA will examine systems for ensuring proper dosing during extreme conditions during certification. The following test procedure has been offered as an example of a test procedure that could be used for ensuring that the AECD is not inappropriately used beyond the requirements of engine starting. Under this example, SCR systems that are capable of fully functional dosing at the conclusion of the test procedure might be considered acceptable.

Test Procedure for Performance of DEF Dosing Freeze Protection Systems:

1. Prior to Procedure:
    - Temperature: DEF at 20° F (maximum)
2. Soak Conditions:
    - Temperature: 0° F (maximum)
    - Time: 72 hours or solid DEF (whichever occurs first)
3. Test Duty Cycle:
    - Temperature: 0° F (maximum)
    - Time: 70 minutes (maximum)
        a. Start engine and idle with no engine load for 20 minutes
        b. Operate engine at no more than 40% load at rated speed for up to 50 minutes

EPA is not determining that compliance with this procedure is either necessary or sufficient to showing that any AECD associated with freeze protection is appropriate. EPA will determine the compliance of each strategy during certification. However, EPA believes that strategies that follow this test procedure would be helpful for manufacturers in showing that any AECD for freeze protection is appropriate.