



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
NATIONAL VEHICLE AND FUEL EMISSIONS LABORATORY  
2565 PLYMOUTH ROAD  
ANN ARBOR, MICHIGAN 48105-2498

OFFICE OF  
AIR AND RADIATION

February 18, 2009

CISD-09-04 (HDDE)

Dear Manufacturer:

**SUBJECT: Certification Requirements for Heavy-Duty Diesel Engines Using Selective Catalyst Reduction (SCR) Technologies**

**BACKGROUND**

On March 27, 2007, EPA issued a SCR guidance document that delineated our intended approach for the certification of vehicles and engines using SCR systems (CISD-07-07). This document was designed to address the control technology that many manufacturers selected to meet stringent requirements for NO<sub>x</sub> emissions. At the time we recognized that SCR technology was evolving and reserved the right to make changes to our approach. Today's guidance is intended to supplement the previous document and provides additional details regarding specific areas of concern. Again the Agency reserves the right to issue additional guidance or make necessary changes to our approach for SCR certification.

We want to highlight one specific area in this supplemental guidance. In the section that addresses tamper resistant design, we outline inducement requirements for specific SCR system conditions. As a general rule, certification is based on tamper resistant designs. Due to the unique aspects of SCR systems, we believe that additional action minimizing the potential adverse environmental risks associated with tampering of SCR technology (through the use of warnings and inducements) is justified if such systems are not designed to be tamper resistant. The following unique characteristics are associated with SCR systems: (i) reduced scheduled maintenance; (ii) the reduced maintenance requires replenishing a reductant; (iii) the user has a financial incentive to avoid replenishing the reductant; and (iv) the tampering does not require special tools or expertise.

## **REGULATORY REQUIREMENTS**

### **DEF TANK SIZE**

For specific vocational applications, a smaller DEF tank size is appropriate (*e.g.*, garbage truck, dump truck, concrete mixer, beverage truck, fire truck, airport refueler). These applications are generally refueled daily from a central location and conducive to refilling DEF in the same manner. The minimum DEF tank size must provide no less than:

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

For all other vehicle applications, the minimum DEF tank size must provide 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.

### **VEHICLE COMPLIANCE**

#### **Driver Warning**

Since the driver inducements described below are so severe that they will disable the commercial mission of a vehicle, the marketplace requires prior driver warning strategies that minimize the likelihood that the inducements deploy. Manufacturers must include a warning that provides adequate time to re-fill the DEF. They may use a DEF level indicator, messages in the instrument cluster, a DEF indicator, engine shutdown lamp, or audible warnings to warn the driver of low DEF levels. Manufacturers must include some level of warning escalation. The DEF indicator will contain the following symbol:



#### **Driver Inducement**

If indicators and warnings are not successful in causing the driver to replenish the DEF tank, a stronger inducement strategy must be initiated. Acceptable strategies include those specifically set forth in the EPA's March 27, 2007, guidance letter or a performance degradation strategy that is sufficiently onerous. Each of the following strategies is sufficiently onerous to cause the driver to replenish the DEF tank and minimize any adverse emission impact. Each strategy (i) must be preceded by a period of lower-level inducement (which can last until the DEF tank is empty) or (ii) must begin before the DEF level is less than 2.5% tank capacity (collectively, "DEF Trigger") or (iii) for vehicles with 1:1 DEF tank size, must begin when the DEF tank is empty with derate, applied between peak torque engine speed and governor break point (see Figure 1), ramped in at 1% per minute up to at least a 40% derate. To communicate to the driver

why the disabling performance degradation has occurred, the DEF indicator will flash or a similar message will appear in the instrument cluster (hereinafter, collectively, “*inducement notification.*”)

1. **Disable after Fueling.** Once the DEF Trigger is achieved, *after the primary or secondary fuel tank level rise a measurable amount*, the vehicle will be limited to 5 mph with inducement notification.
2. **Disable after Parking.** Once the DEF Trigger is achieved, *after the vehicle has been stationary for more than one hour*, the vehicle will be limited to 5 mph with inducement notification. If the vehicle is not stationary for more than one hour after 24 hours of operation, the vehicle will be disabled *after the vehicle has been stationary for a limited period of time (to be defined, e.g., 10 - 20 minutes)*.
3. **Disable after Restart.** Once the DEF Trigger is achieved, *after the engine has been shut down*, the vehicle will be limited to 5 mph with inducement notification.

### **Identification of Incorrect Reducing Agent**

The following stepped inducement strategy for poor quality DEF provides the driver enough time to have the vehicle serviced and minimizes any potential adverse emission impact:

1. **DEF Warning.** Once the SCR system detects poor quality DEF that inhibits the SCR system from functioning, a warning lamp will illuminate or message will appear in the instrument cluster.
2. **Engine Derate.** If the driver fails to remedy the problem within 500 miles or 10 hours after detection, the maximum available engine torque will be reduced 25% between peak torque engine speed and governor break point across the engine speed range. However, at engine speeds below the peak torque engine speed, the maximum available engine torque may be limited to a value not exceeding 75% of the peak torque. In addition, at engine speeds higher than the governor break point, the maximum available engine torque may be limited to a value not exceeding 75% of the maximum torque at the governor break-point engine speed (see Figure 2). If, at the time of certification, a manufacturer can demonstrate a strategy capable of determining that poor quality DEF was not the result of tampering, only step 2 will deploy. Alternatively, one of the severe driver inducement strategies specifically set forth in the guidance letter (or step 3) may be initiated in lieu of steps 2 and 3.
3. **Severe Inducement.** If the driver fails to remedy the problem within 1000 miles or 20 hours after initial detection, performance is further degraded with one of the three severe inducement strategies:

- **Disable after Fueling.** *After the primary or secondary fuel tank level rise a measurable amount, the vehicle will be limited to 5 mph.*
- **Disable after Parking.** *After the vehicle has been stationary for more than one hour, the vehicle will be limited to 5 mph. If the vehicle is not stationary for more than one hour after 24 hours of operation, the vehicle will be disabled after the vehicle has been stationary for a limited period of time (to be defined, e.g., 10 - 20 minutes)*
- **Disable after Restart.** *After the engine has been shut down, the vehicle will be limited to 5 mph.*

### **Tamper Resistant Design**

SCR systems may be designed to be tamper resistant consistent with the EPA's March 27, 2007 guidance letter. For all other engines, the actions listed below will trigger illumination of a warning lamp, followed by, at a minimum, a mild inducement or severe inducement (described below):

- Disconnected DEF tank level sensor
  - Blocked DEF line or dosing valve
  - Disconnected DEF dosing valve
  - Disconnected DEF pump
  - Disconnected SCR wiring harness
  - Disconnected NOx sensor (that is incorporated with the SCR system)
  - Disconnected DEF quality sensor
1. **Engine Derate.** If the driver fails to remedy the problem within 500 miles or 10 hours after detection, the maximum available engine torque will be reduced 25% between peak torque engine speed and governor break point across the engine speed range. However, at engine speeds below the peak torque engine speed, the maximum available engine torque may be limited to a value not exceeding 75% of the peak torque. In addition, at engine speeds higher than the governor break point, the maximum available engine torque may be limited to a value not exceeding 75% of the maximum torque at the governor break-point engine speed (see Figure 2).
  2. **Severe Inducement.** If the driver fails to remedy the problem within 2000 miles or 40 hours after initial detection, performance is further degraded with one of the three severe inducement strategies:

- **Disable after Fueling.** After the primary or secondary fuel tank level rise a measurable amount, the vehicle will be limited to 5 mph.
- **Disable after Parking.** After the vehicle has been stationary for more than one hour, the vehicle will be limited to 5 mph. If the vehicle is not stationary for more than one hour after 24 hours of operation, the vehicle will be disabled after the vehicle has been stationary for a limited period of time (to be defined, e.g., 10 - 20 minutes)
- **Disable after Restart.** After the engine has been shut down, the vehicle will be limited to 5 mph.

If, at the time of certification, a manufacturer can demonstrate a strategy capable of determining that the failure was not the result of tampering, only the warning lamp will deploy after 500 miles or 10 hours after initial detection.

### **FREEZE PROTECTION**

SCR systems must pass the following 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 up to 20 minutes
    - b. Operate engine at no more than 40% load at rated speed for up to 50 minutes
4. **DEF must be capable of fully functional dosing at the conclusion of the Test Duty Cycle.**

Figure 1

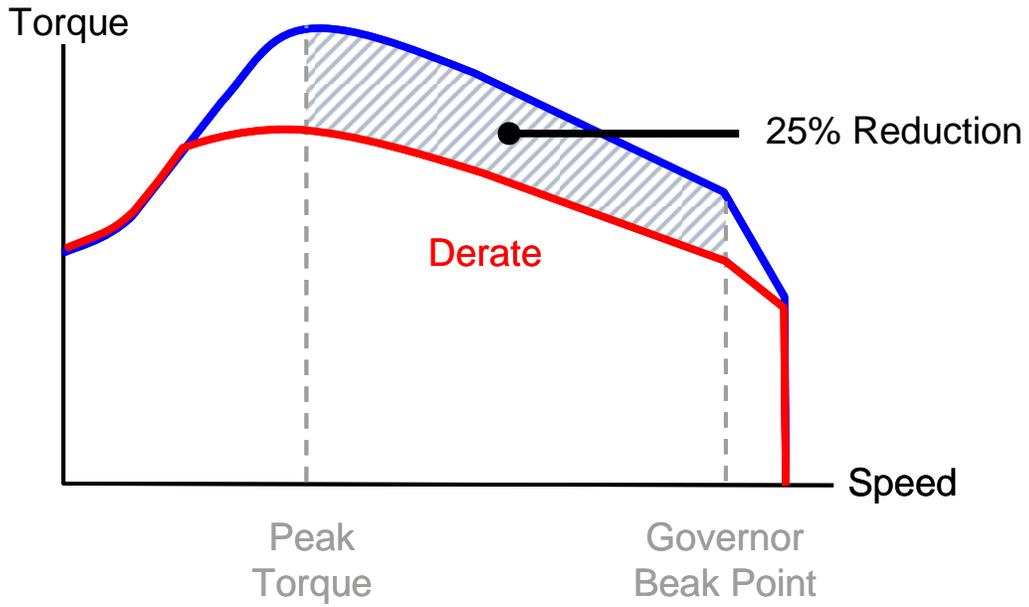
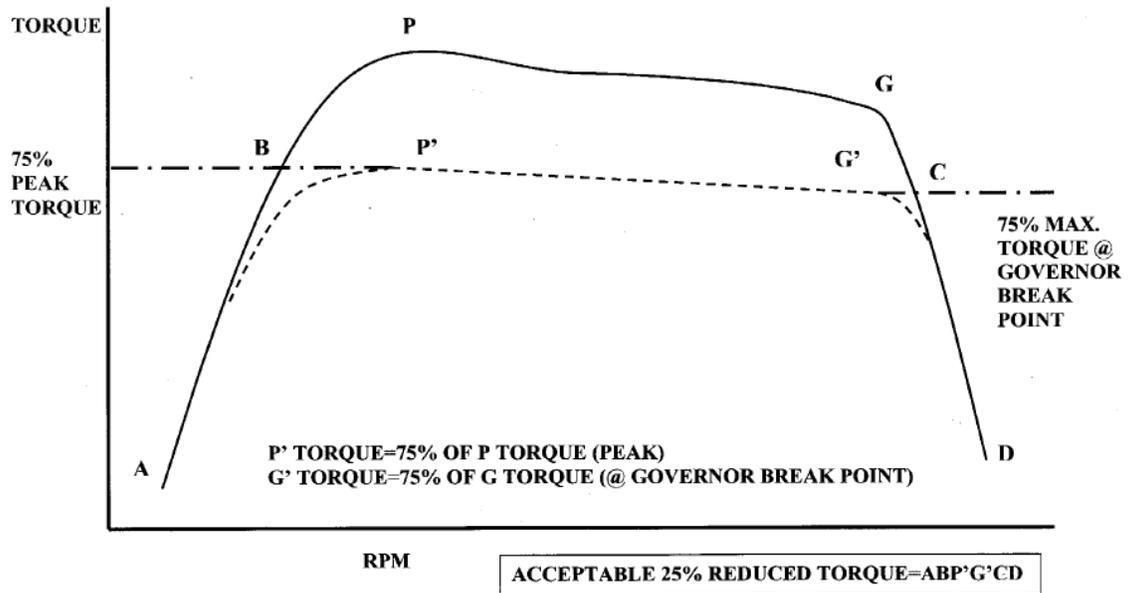


Figure 2



If you have any questions, please contact your certification representative.

Sincerely,

A handwritten signature in black ink, appearing to read "Karl J. Simon". The signature is fluid and cursive, with a long horizontal flourish extending to the right.

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