



SAE 2009 **On-Board Diagnostics** Symposium

Update on Light and Heavy Duty Vehicle

September 22-24, 2009 • Indianapolis Marriott Downtown • Indianapolis, IN



Diagnostics and the EPA Driver Warning System for SCR Technology

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Overview

Background

Requirements and Options

Concerns

DEF = Diesel Exhaust Fluid

= Reducing Agent

= 32.5% urea by volume



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Background

- On March 27, 2007, EPA issued a final SCR guidance document, designed to address certification requirements for SCR technology. Revised guidance was provided on February 19, 2009.
- Documents provided control system acceptance criteria, designed to assure that diesel vehicles or engines using SCR technology achieve the agency goal of always meeting emission standards in-use.
- Acceptance criteria provided details surrounding:
 - ✓ DEF tank size
 - ✓ **Vehicle compliance**
 - ✓ Reducing agent availability and accessibility
 - ✓ Freeze protection



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Vehicle Compliance Requirements

- Driver warning system and inducement for the following conditions:
 1. Reducing agent low level
 2. Identification of incorrect reducing agent
 3. Vehicle tampering
- Durable design

OBD Monitoring Requirements

- Detection and MIL illumination of the following conditions:
 1. Reducing agent low level
 2. Identification of incorrect reducing agent
 3. Vehicle tampering



Driver Warning System

- Inform the operator that a condition has occurred which compromises their emission control system
- Visual and possibly audible alarms
- Escalate in intensity as the operator continues to ignore warnings without correcting the issue
- Designed such that it cannot be defeated, ignored, or disabled without correcting the concern





Driver Inducement

- Must be robust and onerous enough to ensure that users will not continue to operate the vehicle without correcting the concern
- Should minimize emission impact while operating in inducement
- Details are ultimately up to the manufacturer and should not create undue safety concerns
- Should employ a two stage process - beginning with engine de-rate and ending with a severe inducement such as no engine restart, forced idle or maximum vehicle speed of 5 MPH
- Severe inducement strategies may begin after a restart countdown, refueling, parking, or some other approved alternate condition



Reducing Agent Low Level

Warning System

- Inform the operator more reducing agent is needed before it runs out
- Should begin at
 - ✓ 1000 miles to empty,
 - ✓ The mileage of two diesel fuel tank fills, or
 - ✓ a reasonable alternative suggested by the manufacturer.

Inducement

- Engine derate should begin at or before the DEF level is at 2.5% tank capacity and can last until the DEF tank is empty
- Vehicles with a 1:1 DEF to diesel fuel tank size, inducement begins derate when DEF tank is empty.



Reducing Agent Low Level

OBD

- Detect a malfunction when there is no longer sufficient reductant available (e.g., the reductant tank is empty)
- May request EO approval to delay illumination of the MIL if the vehicle is equipped with an alternative indicator for notifying the vehicle operator of the malfunction



Incorrect Reducing Agent

Warning System

- Inform the operator of high NO_x emissions associated with filling the storage tank with the wrong or excessively diluted reducing agent
- Need not identify slight differences in reducing agent quality

Inducement

- Engine derate if driver does not remedy within 500 miles / 10 hours of operation.
- Invoke severe inducement within 1000 miles / 20 hours of operation after initial detection.



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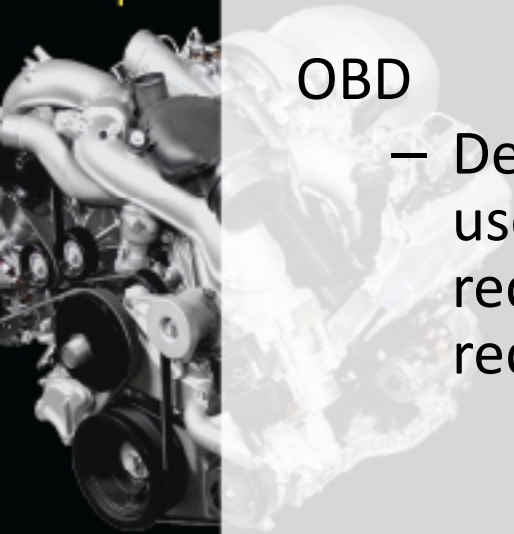
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Incorrect Reducing Agent

OBD

- Detect a malfunction when improper reductant is used in the reductant reservoir/tank (e.g., the reductant tank is filled with something other than the reductant).





Tamper Resistant Design

Warning System

- SCR systems may be designed to be tamper resistant. For all other engines, the following conditions will trigger the warning system and inducement: Disconnected DEF tank level sensor, DEF dosing valve, DEF pump, SCR wiring harness, Nox sensor, DEF quality sensor, or block DEF line or dosing valve

Inducement

- Engine derate if driver does not remedy within 500 miles / 10 hours of operation.
- Invoke severe inducement within 2000 miles / 20 hours of operation after initial detection.



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Tamper Resistant Design

OBD Requirement

- Must detect disconnected components under Comprehensive Component Monitor.
- Must detect blocked DEF line / dosing valve under reductant delivery performance monitoring at emission threshold.





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Concerns

- Devising severe inducement to protect the operator from getting stranded in a location where they cannot get help.
- Healing the fault while in severe inducement due to DEF quality concerns.
- Lack of continuous level sensing technology - discrete level sensing makes accurate range usage difficult.
- Estimated DEF range will change based upon operating condition and may confuse the customer.
- Customer education is needed for how to avoid the warning strategy, what to do once they are in it, what to do if their actions are not corrective.
- DEF has a finite shelf life.
- Challenges in packaging sufficient reducing agent volume.
- Warning strategy and OBD implementation details must be reviewed with as many as four agencies and conflicting feedback can occur.