

IX. ENGINE ELECTRONIC CONTROL MODULE (ECM) REPROGRAM

A. Technology Overview and Description

In October 1998, a court settlement was reached between the EPA, Department of Justice, CARB and engine manufacturers (Caterpillar, Inc., Cummins Engine Company, Detroit Diesel Corporation, Volvo, Mack Trucks/Renault and Navistar/International) over the issue of high NO_x emissions from heavy-duty diesel engines during certain driving modes. Since the early 1990s, the manufacturers used software in the electronic engine control module (ECM) that caused engines to switch to a more fuel-efficient (but higher NO_x) driving mode during “off-cycle” steady highway cruising. These engines were built between 1993 and 1998 in a way that allowed the engines to pass EPA emission certification tests but increased emissions while the vehicle was being operated under conditions not included in the Federal Test Procedure (FTP) emission testing cycle used to establish compliance with EPA heavy duty engine emission standards. It is estimated that 1.3 million engines contain the “off-cycle” ECM software.

The court settlement required the companies to introduce cleaner engines (including development of engines meeting the 2004 emission standards by October 2002, 15 months ahead of time), rebuild or reprogram older engines to cleaner levels, recall pickup trucks that have the so-called “defeat devices” and conduct new emissions testing. As part of the manufacturers’ requirements to rebuild or reprogram older engines (1993-1998) to cleaner levels, companies developed a heavy-duty diesel engine software upgrade (known as an ECM “reprogram”, “reflash” or “low NO_x” software) that modifies the fuel control strategy in the engine’s ECM to reduce the excess NO_x emissions



Courtesy of Detroit Diesel Corporation

B. Emission Reduction

On road engines with low NO_x software are required to meet NO_x emission standards based on the two options shown in Table 9-1, where Medium Heavy-Duty Diesel Engines (MHDDE) are used in vehicles with Gross Vehicle Weight Restrictions (GVWRs) of 14,001 to 33,000 pounds and Heavy Heavy-Duty Diesel Engines (HHDDE) are used in vehicles with GVWRs greater than 33,000 pounds.

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Table 9-1, Low NO_x Engine Software Certification Options

Option A			Option B		
Model Year/ Test Cycle	Application/ Emission Standard		Model Year/ Test Cycle	Application/ Emission Standard	
1994-98	MHDDE	HHDE	1993-98	MHDDE	HHDE
SET	6.0 g/bhp-hr	7.0 g/bhp-hr	SET	6.5 g/bhp-hr	7.5 g/bhp-hr
NTE	7.5 g/bhp-hr	8.75 g/bhp-hr	NTE	8.1 g/bhp-hr	9.38 g/bhp-hr

Current Federal regulations do not require that complete heavy-duty diesel vehicles be emission-certified using a chassis dynamometer (as is used for light-duty vehicle emission testing), instead requiring that a manufacturer’s engines be certified using an engine dynamometer.

Consequently, the basic emission standards are expressed in g/bhp-hr (grams per brake horsepower-hour) and require heavy-duty diesel engine emission testing over the Transient FTP engine dynamometer cycle. For comparison, the EPA FTP NO_x emission standard for 1993-97 heavy duty diesel truck engines was 5.0 g/bhp-hr and was 4.0 g/bhp-hr for 1998 heavy duty diesel truck engines. The NO_x level for an older offroad diesel engine that was not required to meet any emission standards is typically over 10 g/bhp-hr.

Low NO_x software was developed by the engine manufacturers to achieve compliance with existing emission standards (for the specific year of manufacture). Thus, the software, in and of itself, as developed for satisfaction of the 1998 consent decree requirement does not constitute a means to reduce emissions below the emission standards that were in place for the specific year of manufacture, in the classic sense of diesel emission reduction retrofit products. Catalytic exhaust aftertreatment retrofit products (typically a DOC or DPF) have been combined with (legally required) ECM reprograms for at least two engine manufacturers (International and Cummins) to create retrofit systems that reduce NO_x, PM, HC and CO emissions below the emission standards that were in place for the year of engine manufacture. The system for Cummins 1994 through 1998 M11 engines has been verified by CARB as providing emissions reductions of 85% for PM and 25% for NO_x. The International system is claimed to meet the U.S. EPA 2007 heavy-duty diesel engine emissions standards for PM and HC, and to be allowed by CARB as being qualified to share in California funding of new school bus purchases under the DRRP.

C. Status and Availability

To date, over 60,000 heavy-duty vehicles have received ECM reprogramming. CARB has now required ECM reprogramming to be done on all applicable vehicles (estimated at between 300,000 and 400,000). The number of offroad engines receiving ECM reprogramming is not known.

ECM reprogram installations are available in California and throughout the U.S. at engine dealers and distributors. Low NO_x software can be arranged to be installed at the local engine dealer/distributor or in instances where a large fleet operator is involved, the software can be installed on-site.

D. Selection and Use Criteria

An ECM reprogram can be accomplished on only certain on-road and offroad engines. Obviously, an ECM reprogram can be accomplished on only engines equipped with electronic engine controls. Many offroad engines are not electronically controlled, and so cannot benefit for ECM reprogram technology.

E. Installation and Vehicle Modifications

The average ECM reprogram requires approximately 15 to 30 minutes for installation. One potential concern is for the engine's ECM to fail after a low-NO_x software install. Based on limited information provided to CARB, failure rate of the engine's ECM is less than 1% as a result of the reprogram installation

F. Fuel Requirements

Since low NO_x software only entails reprogramming the engine's ECM, there are no fuel requirements for an ECM reprogram. However, manufactures have reported negligible impacts on fuel economy. Several fleets had the software installed prior to engine rebuilds and have reported no noticeable differences in their fuel use. CARB has recognized that there may be an average fuel economy penalty and expects it to be less than 1%. In addition, there have been no complaints regarding vehicle performance as a result of ECM reprogram installations.

G. Maintenance

There are no maintenance requirements for low NO_x software.

H. Costs

The engine manufactures agreed, as part of their consent decrees, to voluntarily provide low NO_x software upgrades free of charge to on-road vehicle owners and operators at the time of engine rebuild or upon request. However, some engine manufacturers are not installing the ECM reprogram free of charge unless it is installed in conjunction with an engine rebuild. Consequently, dealer/distributors are passing on 30 minutes to one hour of labor charges to vehicle owners that choose to have the ECM reprogram installed without an engine rebuild. CARB has been in contact with the engine manufactures to rectify the problem so that the only cost to the owner/operator is the out-of-service time for the vehicle. The cost of having an ECM reprogram performed for an offroad engine that can benefit from it is not known, however, there is likely to be some cost associated with the process since the consent decrees did not apply to offroad engines.

The ECM reprogram retrofit systems that include an exhaust aftertreatment retrofit product typically involve an additional cost beyond that of the exhaust aftertreatment product.