



# Transportation Synthesis Report

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## Achieving Compliance with the Diesel Reflash Program

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*Transportation Synthesis Reports (TSRs) are brief summaries of currently available information on topics of interest to WisDOT technical staff. Online and print sources include NCHRP and other TRB programs, AASHTO, the research and practices of other state DOTs, and related academic and industry research. Internet hyperlinks in TSRs are active at the time of publication, but changes on the host server can make them obsolete.*

### **Request for Report**

In the mid-1990s, the United States Department of Justice, the Environmental Protection Agency and the California Air Resources Board discovered that the seven major engine manufacturers had designed their 1993 through 1998 model heavy-duty diesel engines – approximately 1.3 million units – to operate with advanced electronic controls that cause the engines to switch to a more fuel-efficient driving mode during “off-cycle” steady highway cruising, but also cause the engines to emit excessive levels of nitrogen oxides (NO<sub>x</sub>), a harmful pollutant. In October 1998 a court settlement was reached between the agencies and the manufacturers over the issue, that requires the manufacturers to provide their dealers with modified software (“Low-NO<sub>x</sub> Rebuild Kit” or “chip reflash”) that reduces the excess emission, and to install the kits free of charge at the time of engine rebuild or upon owner/operator request. WisDOT’s Bureau of Equity and Environmental Services asked us to gather information on actions other states are taking to get manufacturers and owners involved in the program. If reflash can be accelerated in Wisconsin, NO<sub>x</sub> emissions from diesel engines can be reduced, helping the state to achieve its air quality goals.

### **Summary**

We present our research results in two sections.

#### **Reflash Programs:**

A number of states have taken action to mandate compliance by manufacturers. California launched a mandatory reflash program in 2004, and while no other state or local jurisdiction currently requires it, the Northeast States for Coordinated Air Use Management (NESCAUM) recently developed a model chip reflash rule for a mandatory program. The State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Officials have urged EPA to take swift action to implement an enforceable nationwide program to reflash all diesel engines eligible for NO<sub>x</sub> reflash under the settlement. Eric Skelton, Senior Policy Analyst for NESCAUM, talked with us about the group’s conceptual discussions regarding voluntary manufacturer compliance programs and incentives for owners/operators. Anne Wick, Diesel Engine Consent Decree Coordinator for EPA, shared some ideas with us on ways that states could incentivize reflash participation by owners/operators.

#### **Quantifying Emission Reductions:**

Using EPA’s MOBILE6.2 vehicle emission modeling software, it is possible for a state to quantify the level of NO<sub>x</sub> emission reduction it could achieve through a reflash program. Gary Dolce, Environmental Scientist with EPA’s National Vehicle and Fuel Emissions Laboratory, provided us with an introduction to the method. In a study prepared for the Ontario Ministry of the Environment, Eastern Research Group Inc. uses MOBILE modeling to predict emission reductions from reflashing heavy-duty diesel vehicles.

The following Web site also provides pertinent information:

Heavy Duty Diesel Engine Settlement Information

<http://www.epa.gov/compliance/resources/cases/civil/caa/diesel/>.

This EPA site is a gateway to a variety of practical information materials concerning the settlement that include the Lox NOx Rebuild FAQ (<http://www.epa.gov/compliance/resources/cases/civil/caa/diesel/faq.pdf>), the Low NOx Progress Report (<http://www.epa.gov/compliance/resources/cases/civil/caa/diesel/progress.pdf>), and postings of consent decree public meetings (<http://www.epa.gov/compliance/resources/cases/civil/caa/diesel/meetings.html>). The next consent decree public meeting is scheduled to be held Sept. 13, 2006 at 9 a.m. Central Time by teleconference – details are available at the Web site.

## **Reflash Programs**

### **California: mandatory reflash program**

#### **Diesel Retrofit Technology and Program Experience- Final Draft**

U.S. Environmental Protection Agency, July 29, 2005

<http://epa.gov/cleandiesel/documents/retrofit-tech-prog-exp.07-2005.pdf>.

From: Section 2.8 (page 59) – Engine Control Module Reflash:

In December 2004, the California Air Resources Board (CARB) recommended and passed a mandatory reflash program. Since the Detroit Diesel Corporation was able to approach CARB’s initial target of a 35% reflash installation rate it was allowed to continue on the original voluntary compliance program. For the remaining engine manufacturers, the compliance schedule shown in Table 2-6 was used, 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:

*Table 2-6, CARB Mandatory Compliance Schedule*

Model Year/Application	Compliance Date
1993-1994 model year engines (all)	By April 30, 2005
1995-1996 model year engines (all)	By August 31, 2005
1997-1998 model year engines (all)	By December 31, 2005 (except MHDDE)
1997-1998 model year MHDDE	By December 31, 2006

Engines with the reflash are required to meet NOx emission standards based on the two options shown in Table 2-7:

*Table 2-7, Reflash Engine Certification Options*

Option A			Option B		
Model Year/ Test Cycle	Application/ Emission Standard		Model Year/ Test Cycle	Application/ Emission Standard	
1994-98	MHDDE	HHDDE	1993-98	MHDDE	HHDDE
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

Installation of the reflashes would be verified by CARB through its existing Heavy Duty Vehicle Inspection Program (HDVIP) and the Periodic Smoke Inspection Program. CARB already inspects vehicles as part of the HDVIP at California Highway Patrol weigh inspection stations, which are randomly located along roadsides and at fleet facilities. Penalties for failing to install the reflash would be \$300 if the software was not installed within 45 days of any citation issuance. There is an additional \$500 penalty if the software is not installed after 45 days of the citation issuance. The fines apply to both California-registered and out-of-state registered vehicles and are in addition to any fines incurred as part of the HDVIP.

The regulation is currently under litigation in the California courts and a decision on the case was expected before the end of 2006. Helpful insights related to the California program were obtained from Anne Wick, Diesel Engine Consent Decree Coordinator- EPA (phone: 202-564-2063, email: [wick.anne@epa.gov](mailto:wick.anne@epa.gov)). “There are a number of states interested in adopting a mandatory program like California’s,” Anne said. “NESCAUM is looking into it. I guess the linchpin to all of this is that the Consent Decrees say that the manufacturers have to provide the low NOx calibration free of charge to anyone who asks for it. And the manufacturers are saying you’re taking that language out of context: it meant whenever anyone asks for it during a rebuild. That’s really what the court case is going to be about.

“States could also look at ways to try to incentivize reflashing,” Anne said. “What comes to mind are reductions in state taxes (maybe registration fees) for low NOx trucks. Or maybe any trucks used in state contracts must be low NOx.”

### **NESCAUM: Model Chip Reflash Rule**

Contact: Eric Skelton, Senior Policy Analyst- Mobile Source Team, phone: 617-259-2028, email: [eskelton@nescaum.org](mailto:eskelton@nescaum.org).

Northeast States for Coordinated Air Use Management (NESCAUM) is a nonprofit association of air quality agencies in the Northeast. The group’s Board of Directors is comprised of the air directors of the six New England states (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont), New Jersey and New York, and staff provide scientific, technical, analytical and policy support to the air quality programs of the eight Northeast states. Eric provided us with helpful information concerning NESCAUM’s new model chip reflash rule, and early discussions concerning voluntary reflash programming and incentives.

“NESCAUM has developed a model chip reflash rule for a mandatory program,” Eric said. “We finished that in late February (2006), and essentially just provided it to the eight NESCAUM states for their consideration for adoption. Then the Ozone Transport Commission (<http://www.otcair.org/>) became interested in it as well. Their Board of Directors essentially endorsed it at their June meeting. So it’s really in the hands of the states that are part of NESCAUM and/or part of the OTC whether or not they want to move forward with adopting a mandatory rule.

“Going back to May,” Eric said, “a group of us representing the OTC states met with an attorney who represents the Engine Manufacturers Association and we talked about our efforts to develop a model rule and mandatory programs. We also had some conceptual discussions about voluntary programs. The individual from the Engine Manufacturers Association said on behalf of his members they might be interested in helping to do something voluntarily to get chip reflash completed. We haven’t had any follow-up discussions with them. However, I anticipate that we are going to in the near future. One of the provisions in the OTC resolution endorsing the rule also indicated that the OTC states would be receptive to voluntary efforts if they could accomplish the same thing according to the same time frame. What I anticipate is that the OTC state representatives and myself are going to put our heads together again in the near future and just talk about a conceptual voluntary program. Then, probably following that, we will re-approach the Engine Manufacturers Association to see to what extent they might be interested in essentially taking the ball and running with it on getting a voluntary program up and running and getting these vehicles reflashed, kind of parallel to the process of states moving forward with their various rule-making processes to adopt a mandatory program.

“We haven’t really talked too much about reflash incentives,” Eric said. “During the meeting in May where we talked just a little bit about what a voluntary program might entail, there was a realization that chip reflash is a fairly simple thing to accomplish. It’s a matter of downloading electronic software to the engine control module, and that it could be done in conjunction with other routine maintenance activities. So when somebody brings their truck in for an oil change or something like that, perhaps chip reflash could be done at the same time. And maybe as a way to attract truck owners to bring their vehicles in they could be offered discounted or free routine maintenance-type services as an inducement to get them to come in. But of course, somebody would have to come up with the funds to pay for things like that, and there has been no further discussion really as far as who would pay for those kinds of incentives.”

### **Connecticut: Special Act No. 05-7 -- Connecticut Clean Diesel Plan**

January 2006

<http://dep.state.ct.us/air2/diesel/docs/ctcleandieselplanfinal.pdf>.

From: II- On-Road Fleets Report / A- State-wide baseline / Heavy Duty Diesel Engine – Chip Reflash Program (page 174):

All of the northeast states are concerned that chip reflash has not occurred at the projected rate and are now considering a mandatory program, modeled after the California program. The following table illustrates the potential NOx emissions (tons per day) that could be reduced in the Northeast if the states adopt a reflash program –

**Table 3**

State	NO <sub>x</sub> Reductions tons per day (TPD) from in-state registered vehicles
Connecticut	3.5
Maine	1.4
Massachusetts	6.7
New Hampshire	2.0
New Jersey	9.7
New York	16.1
Rhode Island	0.8
Vermont	0.9
Northeast Total	41.1

NESCAUM is in the process of developing a model “reflash” rule. DEP (Connecticut Department of Environmental Protection) will continue to evaluate this as a potential reduction strategy. If DEP were to adopt a regulatory chip reflash rule, program development costs for a regulation could range from \$75,000 to \$150,000 plus associated administrative costs (2 FTEs).

- From: Comments Received concerning the draft Clean Diesel Plan / Engine Manufacturers Association / Heavy-duty Diesel Engine-Chip Reflash Program (Appendix: PDF page 284):  
Regardless of the outcome of the California case, there would be significant legal issues surrounding any efforts by Connecticut to adopt a mandatory reflash program involving engines associated with consent decree agreements. In addition, this issue affects engines (manufactured) in the 1990s that are becoming a smaller and smaller proportion of the existing fleet. Any anticipated NO<sub>x</sub> benefits of a mandatory reflash program would be minimal.

### **STAPPA/ALAPCO: request for a mandatory, nationwide reflash program**

December 2004

<http://www.4cleanair.org/ReflashLetter-Dec2004-lthd.pdf>

The State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Officials are the two national associations representing air pollution control agencies in 53 states and territories and more than 165 major metropolitan areas across the United States. STAPPA/ALAPCO urged EPA to take swift action to implement an enforceable nationwide program to reflash all diesel engines eligible for NO<sub>x</sub> reflash under the consent decrees. From the written communication to EPA:

“If such action is not taken at the federal level, states and localities must seriously consider action of their own, following the lead of California. To date, only about 10% of the affected engines have been reflashed, either at the time of engine rebuild or through nationwide incentive programs. States and localities across the nation continue to grapple with an array of serious air pollution problems in which NO<sub>x</sub> emissions play a central role, and face major challenges implementing measures sufficient to effectively address the eight-hour ozone and PM<sub>2.5</sub> standards. It is of particular concern to our memberships that diesel trucks equipped with devices that circumvent environmental standards continue to operate at unmitigated NO<sub>x</sub> levels.”

### **Quantifying Emission Reductions**

#### **MOBILE6.2 Vehicle Emission Modeling Software**

<http://www.epa.gov/otaq/m6.htm>

Gary Dolce works as an environmental scientist with EPA’s National Vehicle and Fuel Emissions Laboratory in Ann Arbor, Michigan. We asked Gary whether EPA or other organizations had performed research to quantify the effect of reflash on NO<sub>x</sub> emissions. “As a generalization, it would be very difficult to quantify,” Gary said, “there are local environmental conditions and vehicle activity issues and many other factors.” But there is a method that states could use to perform this type of analysis using EPA’s MOBILE6.2 Vehicle Emission Modeling Software.

“The benefit from reflash is basically a benefit that primarily occurs in vehicle classes 22 and 23,” Gary said, “and it occurs in them when they’re driving in a certain kind of driving cycle, basically a high speed, cruise type cycle. The model basically can take all of that into account when it’s developing the emission factors. The model also has an input in it that allows you to set the rate of reflashes. And so, typically what a state would do if they wanted to do a reflash program, is figure out what the rate of reflash vehicles was before they did their program in the area, estimate the rate of reflashes that would occur as the result of their program, and then run the model with both of those inputs. The difference between those two – the values, the results you would get – would be the benefit of that reflash program. The inputs and so forth for this are documented in the MOBILE6.2 User Guide and the MOBILE6.2 Technical Guidance.

“If Wisconsin actually wants to do this, what they should do is describe the rebuild program that they would want to put into place, describe how they would get the data for that, and then work with the EPA Region 5 office to get some confirmation as to whether we think you’re on the right track.” Gary suggested contacting Michael Leslie at the Region 5 office for further information – phone: 312-353-6680, email [leslie.michael@epa.gov](mailto:leslie.michael@epa.gov).

**Ontario: assessment of establishing a chip reflash program**

**Evaluation of Ontario Drive Clean Program**

Ontario Ministry of the Environment, July 18, 2005

[http://www.driveclean.com/downloads/ERG-FINAL\\_REPORT.pdf](http://www.driveclean.com/downloads/ERG-FINAL_REPORT.pdf).

The purpose of the Drive Clean program is to test vehicle emissions in order to identify high-emitting vehicles with missing, broken or malfunctioning emission controls. Once these vehicles are identified, the program strives to ensure that effective and durable repairs are performed on them, with the ultimate goal of reducing on-road emissions. The Drive Clean Office of the Ontario Ministry of the Environment has conducted several evaluations of the Drive Clean program.

From: Section 6.3- HDV Options Assessment (page 6-60)- this section focuses on options for the heavy-duty portion of the Drive Clean fleet; Subsection 6.3.1- Establish a Chip Reflash Program (page 6-64):

Table 6-22 presents emissions reductions resulting from “reflashing” the computers of heavy-duty diesel vehicles (HDDVs). (Only class HDD7, HDD8A, and HDD8B trucks can be reflashed.) Eastern Research Group Inc. used the MOBILE model to vary the percent of vehicles reflashed using the Rebuild Effects command. (Unlike the estimates for HDV PM benefits, MOBILE modeling of NOx emissions from these vehicles has relatively low uncertainty.) A value of 7% was used for the base case program, corresponding to the current reflash rate in the U.S.\* ERG then used the default reflash rate in MOBILE to model the implemented option, corresponding to 90% of the estimated percent of Class 6-8b trucks registered in the area and therefore subject to the program. Note that the emission benefits achieved will be distributed well outside the Drive Clean area, as a large fraction of these trucks regularly travel outside of the Province as well as the country.\*\*

**Table 6-22. Emissions Reductions for Heavy-Duty Diesel Reflash (tonnes/yr)**

Calendar Year	2005	2010	2015
NOx	5,729	1,273	736
VOC	0	0	0
CO	0	0	0
NOx + VOC	5,729	1,273	736

Note that emissions benefits are assumed to drop off precipitously in future years, due to the MOBILE model’s assumption regarding engine turnover.

\* Low NOx Rebuild Program Summary as of June 2004, from Anne Wick, U.S. EPA OTAQ, May, 2005.

\*\* The precise amount of regional VKMT attributable to locally registered trucks is unknown, so just as with the base case PM reduction program, local NOx reductions cannot be determined.