FACT SHEET UNITED STATES

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IN-USE NO_X EMISSIONS FROM HEAVY-DUTY VEHICLES IN THE U.S. AND EU

A new study of on-road, in-use emissions of nitrogen oxides (NO_x) from heavy trucks in the United States and Europe shows that U.S. trucks emit significantly more NO_x overall and especially in urban driving conditions, even though regulatory limits on NO_x in truck exhaust are lower in the U.S. than in the EU.

The difference in performance is likely attributable at least in part to differences in the in-use test protocols under which diesel engines for heavy-duty vehicles are certified to comply with exhaust emissions standards.

High ambient levels of NO_x cause or worsen a number of chronic health issues, including decreased lung function, asthma, and other breathing problems.

Changing the U.S. in-use compliance regulations to include real-world measurements of engine performance at low-load, low-speed conditions typical of urban driving would address this problem. Planned revisions to both the U.S. EPA and California Air Resources Board heavy-duty vehicle emissions regulations offer an immediate opportunity to improve NO_x emissions control.

BACKGROUND

Heavy-duty vehicle emissions regulations in both the U.S. (EPA 2010) and EU (Euro VI) incorporate in-use testing using portable emissions measurement systems (PEMS) to collect second-by-second emissions data. But the test protocols differ.

The U.S. uses the "not to exceed" (NTE) protocol, under which only data collected in a narrow zone of operating conditions defined by engine speed, torque, power, exhaust temperature, and ambient conditions measured at the intake manifold, which must persist for a minimum period of time, can be used for compliance evaluation. By definition, the NTE excludes from evaluation virtually all data collected in operating conditions typical of anything but highway driving.

The EU uses a "moving average window" (MAW) evaluation method in which emissions are calculated for subsets of complete data sets ("windows") defined by the work (or CO_2 emissions) produced by the engine in the window, which must be equal to the work (or CO_2) produced during the engine certification cycle. The MAW method evaluates data collected in a wider range of operating conditions, including some typical of urban driving.

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STUDY METHODOLOGY

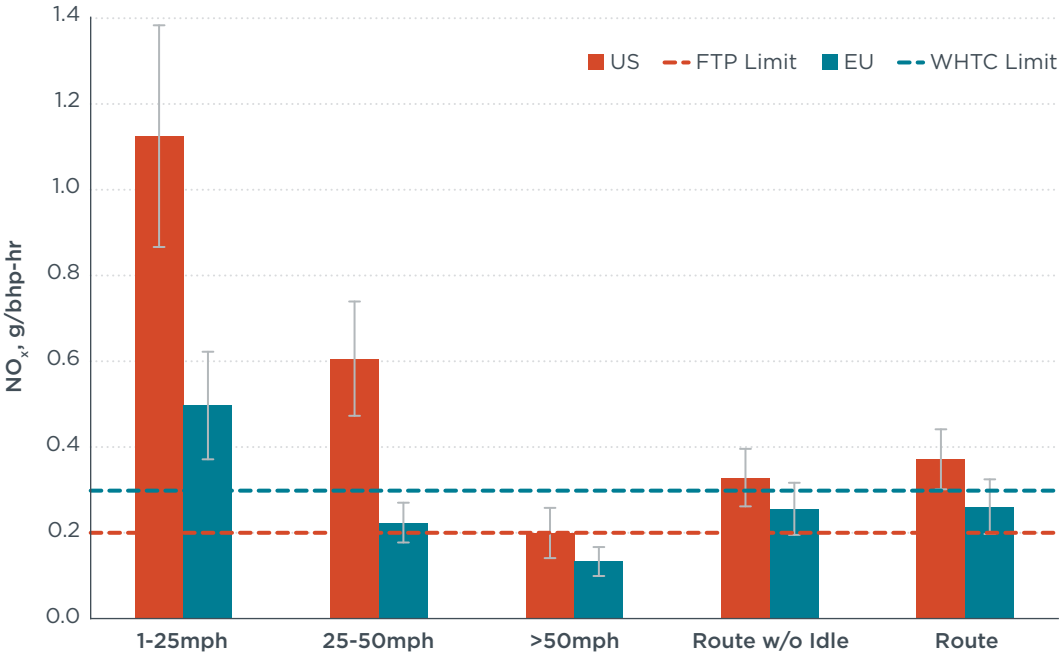
To assess NO_x emissions control performance, second-by-second data were collected by PEMS from 11 HDVs designed to meet the EPA 2010 NO_x standard and compared to emissions from five European trucks designed to the Euro VI NO_x standard. All vehicles belonged to the heaviest class (Class 8 for U.S trucks and N3 for EU trucks), and had similar engine sizes. Data were collected across a wide spectrum of operating conditions—engine and vehicle power, torque, engine rpm, start temperature, exhaust temperature—without constraint by current compliance protocols (NTE or MAW) or data validity restrictions. The study did exclude data collected during DPF regeneration events.

To assess the EPA 2010 and Euro VI protocols for in-use compliance evaluation, the study analyzed PEMS data from five of the tested HDVs (two from Europe and three from the United States) following those protocols but then changing various parameters that determine what data counts as valid and influence emission evaluation.

FINDINGS

The U.S. HDVs emitted on average 1.4 times more NO_x per unit of work than the European vehicles. In urban driving conditions, work-specific NO_x emissions of U.S. HDVs almost quadrupled compared to total route emissions.

NO_x emissions from the European HDVs were more consistent across the full range of speeds. In urban driving, work-specific NO_x emissions from EU trucks were twice the total route emission values.



NO_x emissions by speed bin for European and U.S. heavy-duty vehicles. Dotted lines represent engine emission NO_x limits defined by U.S. (as measured on the Federal Test Procedure) and European (World Harmonized Transient Cycle) HDV emissions regulations.

Excluding data from the regulatory evaluation directly impacts NO_x emission values. High urban NO_x emission values found in U.S certified HDVs potentially can be attributed to the design of the NTE protocol, which evaluates in-use NO_x data obtained only under a narrow band of vehicle operating conditions characteristic only of highway driving.

Reducing or removing the majority of the NTE data validity conditions would not by itself incentivize significant urban NO_x control. Any expansion of the current NTE zone conditions would result in an NTE evaluation value between what is obtained with the current NTE and a total route evaluation (total mass of NO_x divided by total work).

The MAW protocol better captures NO_x emissions at the challenging low-speed and low-power conditions characteristic of urban driving.

Improvements could be made to the MAW protocol to incentivize urban NO_x reductions. These include expanding window validity to all power conditions and evaluating compliance at the 95th percentile.

POLICY CONTEXT

Two relevant regulatory processes are now underway in the U.S.: a revision of the California Air Resources Board Heavy-Duty Low NO_x rule, and the U.S. EPA Cleaner Trucks Initiative. Both agencies currently rely on the NTE protocol for in-use compliance testing of heavy engines. This study suggests that in revising their regulations both should change the in-use compliance evaluation protocol to better address urban NO_x emissions, specifically by replacing the NTE with a more comprehensive data evaluation method, such as an improved MAW protocol.

PUBLICATION DETAILS

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