Air Resources Board

9480 Telstar Avenue, Suite 4
El Monte, California 91731 www.arb.ca.gov

Alan C. Lloyd, Ph.D.
Agency Secretary

Arnold Schwarzenegger
Governor

February 11, 2005

Mail-Out #MSC 05-04

TO: All Interested Parties

SUBJECT: PUBLIC WORKSHOP REGARDING PROPOSED AMENDMENTS TO THE NITROGEN DIOXIDE EMISSION LIMIT IN THE DIESEL EMISSION CONTROL STRATEGY VERIFICATION PROCEDURE

Background: In 1998, the Air Resources Board (ARB or Board) identified diesel particulate matter (PM) emissions from diesel-fueled engines as a toxic air contaminant. The ARB adopted the Diesel Risk Reduction Plan (DRRP or Plan) in 2000 with the goal of significantly reducing public exposure to diesel PM. The Plan identified various control measures including more stringent standards for new diesel-fueled engines and vehicles, the use of diesel emission control systems on in-use engines, and the use of low-sulfur diesel fuel.

To ensure the effectiveness of diesel emission control systems used on in-use engines, ARB staff developed a verification procedure that includes emissions performance, durability, warranty, and in-use compliance requirements (the Procedure). The Board approved the Procedure at the May 16, 2002 public hearing and subsequently approved several amendments at the February 26, 2004 public hearing.

One such amendment was a delay of the effective date of the limit on emissions of nitrogen dioxide (NO_2). The compound NO_2 is classified as a criteria pollutant and has both federal and state ambient air quality standards. The Procedure includes a limit on NO_2 because some diesel emission control systems, while highly effective at reducing emissions of diesel PM, were also found to increase emissions of NO_2. Following the adoption of the Procedure in 2002, a number of concerns arose concerning the limit which are summarized below. To provide time for staff to reevaluate the limit and develop a revised proposal, the Board delayed the effective date of the limit by three years. Before going back to the Board with its recommendations, staff will first hold a public workshop to discuss the draft proposal with interested parties.

Workshop: The following date and time have been scheduled for staff to provide an overview of the draft regulations and for interested parties to give comments.

Date:	Tuesday, March 22, 2005
Time:	1 p.m. to 4 p.m.
Location	Air Resources Board Auditorium, Annex 4 9530 Telstar Avenue El Monte, California 91731

Reevaluation of the NO_2 Limit: The NO_2 limit in the Procedure currently states that post-control NO_2 emissions from an engine using a diesel emission control strategy must not exceed 20 percent of the baseline (pre-control) emissions of all oxides of nitrogen on a mass basis. The Board approved reevaluating this limit because at the time, none of the emission controls manufacturers had been able to develop and verify a compliant system capable of reducing PM by 85 percent or more. In addition, questions arose concerning the assumptions that led to selection of the 20 percent limit, exposure to NO_2 at the micro-scale (i.e., near-source), and the nature of engine-out NO_2 emissions. To provide time for a reevaluation, the Board delayed the effective date of the NO_2 limit from January 1, 2004 to January 1, 2007.

Following the February 26, 2004 public hearing, staff convened an NO_2 working group comprised of representatives from the emissions control system industry, the diesel engine industry, end-user groups, and government. The working group focused on the concern of micro-scale exposure to NO_2, alternatives to the current form of the NO_2 limit, and gathering data on engine-out NO_2 emissions. In October 2004, the working group presented its findings and recommendations at a meeting of the International Diesel Retrofit Advisory Committee (IDRAC).

One of the primary findings of ARB staff in the working group was that the existing 20 percent NO_2 limit determined by regional-scale modeling also appears to be protective in a number of worst-case micro-scale exposure scenarios[1]. This result was found when staff considered the scenarios individually as well as when they occurred simultaneously. At an NO_2 fraction of 50 percent, exposure to NO_2 was greater but still below the ambient standard for each individual scenario. When staff considered the simultaneous occurrence of the scenarios, however, the exposure analysis indicated that the standard could be exceeded for the 50 percent NO_2 case.

---

[1] The October 5, 2004 IDRAC presentation describing this exposure analysis can be found at http://www.arb.ca.gov/diesel/presentations.htm (click on "ARB NO2 Exposure Scenarios").

A key recommendation of the working group was to change the NO_2 limit from one which was inclusive of engine-out NO_2 emissions to a maximum incremental increase above engine-out levels. This is consistent with the position of the Manufacturers of Emission Controls Association (MECA). Limiting the incremental increase in NO_2 helps to resolve issues surrounding the variability of engine-out NO_2 emissions and more directly regulates the effect of the system alone.

Staff's Proposal: Staff proposes that the NO_2 limit be defined as a maximum incremental increase of 20 percent by mass over the baseline NO_2 emission level. For an engine with a typical baseline NO_2 fraction of 5 percent, this corresponds to total NO_2 emissions of 25 percent of the NOx. Both the regional-scale modeling and micro-scale exposure analysis mentioned above indicate that this modest increase over the existing limit is still protective.

While casting the NO_2 limit in terms of a maximum incremental increase helps to isolate the effect of an emission control system on NO_2 emissions, there is still the possibility of obscuring this effect depending on the choice of test engine. If a test engine has unusually high baseline NO_2 emissions, an emission control system may increase the NO_2 fraction by a smaller increment than had the baseline NO_2 level been lower. Staff proposes, therefore, that the test engine's NO_2 emission level serve as one of the criteria by which a given test engine is approved for verification testing.

Another parameter that can influence NO_2 emissions is the amount of PM stored within an emission control system at the time of testing. This concern – raised by a number of working group members – applies to systems like diesel particulate filters that can accumulate and retain PM.

To help ensure that systems are tested on an equal basis, staff proposes that they undergo a pre-conditioning procedure which cleans out stored PM prior to emissions testing. The engine warm-up procedure in the Code of Federal Regulations (CFR) Section 86.1332-90(d)(3)(i) – (iii) appears to be a sound option for engine dynamometer-based testing, and a similar procedure can be conducted on a chassis dynamometer. The procedure consists of running the engine at idle for two to three minutes, 50 percent power at the peak torque speed for five to seven minutes, and finally full power at the rated speed for 25 to 30 minutes. The last mode in particular would generate a hot exhaust stream capable of burning out collected PM within a system. Staff proposes that this last mode be extended until such time as the backpressure stabilizes indicating the PM has burned out. With the system in a clean state, the applicant may conduct a maximum of three test runs of the appropriate test cycle before the actual testing in order to give the system a nominal loading of PM as may be present in actual use.

For the purposes of calculating an NO_2 fraction, staff proposes that the average of the degreened and aged system test results be used, which is consistent with how other emission levels are determined in the Procedure. In the case of chassis dynamometer testing, only the NO_2 results from the heavy-duty Urban Dynamometer Driving Schedule (UDDS) runs should be used for more consistency with engine dynamometer-based testing.

Diesel emission control systems that do not meet the proposed NO_2 limit would not be eligible for verification beginning January 1, 2007. Previously verified systems that do not meet the limit would no longer be verified beginning the same date. Verified systems sold prior to January 1, 2007, which do not meet the limit would continue to be useable after that date.

The draft regulatory language for staff's proposed amendments can be found in the attachment to this workshop notice.

Comments: Staff encourages comments regarding the proposed amendments to the NO2 limit and would appreciate receiving written comments by March 31, 2005. Timely submittal of comments allows staff time to address comments before the proposed regulation order is submitted to the Board for consideration later this year. Please send your comments to Mr. Paul Henderick by email at phenderi@arb.ca.gov and copy Mr. Scott Rowland, Manager, at srowland@arb.ca.gov, or by mail attention Mr. Paul Henderick, ARB, 9528 Telstar Avenue, El Monte, California 91731.

If you have special accommodation or language needs, or have any questions or comments regarding the workshop, please contact Ms. Neidy Pinuelas, Branch Secretary, at npinuela@arb.ca.gov or (626) 350-6454, as soon as possible. TTY/TDD/Speech-to-Speech users may dial 7-1-1 for the California Relay Service.

Sincerely,

Robert H. Cross, Chief
Mobile Source Control Division

Attachment

Attachment 1. Proposed Regulation Order

NOTE: This document is printed in a style to indicate changes from the adopted regulation. All original language is indicated by plain type. The proposed amendments are shown in underline to indicate additions to the original language and ~~strikeout~~ to indicate deletions. The symbol "*****" means that the remainder of the text of the regulation for a specific section is not shown, but has been incorporated by reference, unchanged.

NOTE: Adopt Title 13, California Code of Regulations, Section 2706 to read as follows:

Chapter 14. Verification Procedure, Warranty and In-Use Compliance Requirements for In-Use Strategies to Control Emissions from Diesel Engines

*****

§ 2706. Other Requirements.

(a) Limit and Procedure for Measuring Nitrogen Dioxide (NO_2).

(1) In order for a diesel emission control strategy to be verified, the diesel emission control strategy must not increase emissions of NO_2 by more than an increment equivalent in mass to 20 percent of the baseline NOx emission level. The average of NO_2 emission levels from both the initial and final emissions tests described in Section 2704(g) is used to determine compliance with the NO_2 limit. For chassis dynamometer testing, only the NO_2 emission level over the UDDS cycle is used. ~~The post-control NO_2 emissions must not exceed 20 percent of the total baseline (pre-control) NOx emissions on a mass basis, from the same test cycle(s) for emission testing from section 2703 (e).~~ This limit takes effect beginning on January 1, 2007. Diesel emission control strategies verified and sold ~~installed~~ prior to January 1, 2007 are exempted from this requirement. Those verified prior to January 1, 2007 will no longer be allowed for installation after January 1, 2007 unless they meet the NO_2 emission limit. After January 1, 2007, all diesel emission control strategies verified and sold ~~installed~~ must meet this requirement.

(2) NO_2 emissions are to be quantified by one of the following methods:
(A) Two chemiluminescence analyzers,
(B) A dual-path chemiluminescence analyzer, or
(C) An alternative method approved by the Executive Officer.

(3) Analyzer configuration and determination of NO_2 emission level. For (2)(A) and (2)(B), the analyzers are to be fed from a heated and conditioned sample path. If two chemiluminescence analyzers are employed, they are to be simultaneously fed from a common heated sample path. One instrument (or path) shall be set to NOx mode, while the second shall be set to nitric oxide (NO) mode. The instrument (or path) set to NOx mode receives a sample that has passed through an

NO_2-to-NO converter, and the resultant concentration is designated as total NOx ($NO+NO_2$) in the sample. The instrument (or path) that is set to NO mode receives a sample that has not passed through the converter and quantifies the amount of NO only. The difference between NO and NOx is the amount of NO_2 in the sample. Both NO and NOx signals are recorded by an external data acquisition system at 1 Hertz. Using the average concentrations of NO and NOx over the entire test cycle, the conventional equation for calculating total NOx (Code of Federal Regulations, Title 40, part 86, Subpart N) is then used to generate a gram per mile or g/bhp-hr value for both NO and NOx. The resulting value for NO is then subtracted from that for NOx to determine the gram per mile or g/bhp-hr value for NO_2. The instrument for measuring NO and NOx must be calibrated in accordance with the NOx calibration procedure as described in the Code of Federal Regulations, Title 40, part 86, Subpart N.

(4) Pre-test conditioning. If NO_2 emissions from a diesel emission control system could be affected by the presence of particulate matter (as with a catalyzed diesel particulate filter), the system must be preconditioned according to the following procedure prior to both the initial and final tests described in Section 2704(g):

(A) Conditioning cycle. For engine dynamometer-based testing, follow the engine warm-up procedure in the Code of Federal Regulations, Title 40, Section 86.1332-90(d)(3)(i) – (iii) with the emission control system installed. For chassis dynamometer-based testing, install the emission control system and let the vehicle idle for 2 to 3 minutes. Next, accelerate up to 50 miles per hour and hold that speed for 5 to 7 minutes. Increase the simulated grade from zero to 6 percent and maintain the vehicle speed as close to 50 miles per hour as possible for 25 to 30 minutes.

(B) Monitor and log the exhaust temperature and backpressure at 1 Hertz throughout the conditioning cycle. If by the end of the cycle the backpressure has not yet stabilized, extend the duration of the last mode until stabilization is achieved.

(C) A maximum of three repetitions of the appropriate emissions test cycle may be conducted following the conditioning cycle. No further operation of the engine with the emission control system installed is allowed prior to emissions testing.

(45) Alternative Method to Measure NO_2. The applicant may request the Executive Officer to approve an alternative method in place of the required methods. In reviewing this request, the Executive Officer may consider all relevant information including, but not limited to, the following:

(A) Correlation of the alternative method with the methods stated in 2(A) or 2(B).

(B) Body of existing data generated using the alternative method.