Air Resources Board

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MANUFACTURERS ADVISORY CORRESPONDENCE (MAC) 2003-02

TO: ALL HEAVY-DUTY DIESEL ENGINE AND VEHICLE MANUFACTURERS
ALL MEDIUM-DUTY ENGINE AND VEHICLE MANUFACTURERS
ALL OTHER INTERESTED PARTIES

SUBJECT: Guidance to Certification and Compliance with California's Supplemental Test Procedures, Including, and Specific to, Not-To-Exceed (NTE) Emission Testing Caps for 2005 and 2006 Model-Year (MY) Heavy-Duty and Medium-Duty Diesel Engines (HDDEs and MDDEs)

On December 8, 2000, the Air Resources Board (ARB or Board) amended the emission standards and test procedures (STP) applicable to MY2005 and later (MY2005+) HDDEs, and MDDEs certified using the HDDE test procedure. (Hence forth, HDDE as used in this document also refers to MDDE unless specifically differentiated) These amendments created the new NTE test requirements that limit vehicle emissions during a broad range of engine operating conditions outside of those encountered during the Federal Test Procedure (FTP). In October 2001, the Board adopted more stringent emission requirements for MY2007 and later (MY2007+) HDDEs and modified the NTE requirements to harmonize with similar federal requirements for MY2007+ HDDEs. As a result, MY2005-2006 HDDEs certified for California will be subject to NTE requirements that are not directly enforceable federally and that are different in certain respects from the federal/California MY2007+ NTE requirements.

Although the United States Environmental Protection Agency (U. S. EPA or EPA) regulations do not require compliance with NTE testing caps for MY2005-2006 HDDEs, the EPA Advisory Circular (AC) 24-3 does provide that EPA will use the NTE as a screening tool during certification of these engines. In consultation with ARB and the Engine Manufacturers Association (EMA), the EPA has developed a questions-and-answers (Q&A) document explaining how it intends to apply the NTE for this purpose. The Q&A also provide guidance on how the EPA will implement aspects of the NTE requirements included in the MY2007 emission regulations. The EMA has emphasized the importance of consistency between the certification framework reflected in the Q&A and the ARB's implementation of the California MY2005-2006 and the federal/California MY2007+ NTE requirements. In response to EMA's concern, this Manufacturers Advisory Correspondence (MAC) clarifies the criteria the ARB staff will use in applying the NTE requirements during the certification process for MY2005-2006 HDDEs. As described in this MAC, the ARB intends to harmonize its certification decisions for these HDDEs with the certification decisions of EPA as fully as possible.

If you have any questions regarding this MAC, please contact Mr. Tom Chang, Staff Air Pollution Specialist, at (626) 575-6809 or by e-mail at ychang@arb.ca.gov.

Sincerely,

/s/

Allen Lyons, Chief
Mobile Source Operations Division

Attachment

State of California
AIR RESOURCES BOARD

MANUFACTURERS ADVISORY CORRESPONDENCE (MAC) 2003-02

SUBJECT: Guidance to Certification and Compliance with California's Supplemental Test Procedures, Including, and Specific to, Not-To-Exceed (**NTE**) Emission Testing Caps for 2005 and 2006 Model-Year (**MY**) Heavy-Duty and Medium-Duty Diesel Engines (**HDDEs** and **MDDEs**)

APPLICABILITY: MY2005-2006 HDDEs, and MDDEs Certified Using the HDDE Test Procedures

REFERENCES:

1. California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Year Heavy-Duty Diesel Engines and Vehicles, amended December 8, 2000. (**STP2005**)

2. California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Year Heavy-Duty Diesel Engines and Vehicles, adopted November 14, 2002. (**STP2007**)

3. United States Environmental Protection Agency (**U.S. EPA** or **EPA**) Advisory Circular (**AC**) 24-3.

BACKGROUND AND DISCUSSION:

In December 2000, the Air Resources Board (**ARB** or **Board**) amended the emission standards and test procedures (**STP**) applicable to MY2005 and later (**MY2005+**) HDDEs, and MDDEs certified using the HDDE test procedure [STP2005; Reference 1]. These amendments created the new supplemental and NTE test requirements that measure vehicle emissions during a broad range of engine operating conditions outside of those encountered during the Federal Test Procedure (**FTP**). (Hence forth, HDDE as used in this document also refers to MDDE unless specifically differentiated) Subsequent to this December 2000 California action, the **EPA** promulgated its STP for MY2007 and later (**MY2007+**) HDDEs that also include new supplemental and NTE test requirements. In November 2001, the ARB amended its STP applicable to MY2007+ HDDEs [STP2007; Reference 2]. This later action achieves parity with the EPA's Code of Federal Regulations, Title 40, Subparts A, I and N, and substantially aligns California STP2007 with the federal STP2007 for on-road HDDEs. It also commits ARB to conform as closely as possible its certification decisions for MY2005-2006 HDDEs in conjunction with EPA guidance for applying the NTE as a screening tool to those certified engine families.

Although similar, the ARB's MY2005+ NTE requirements are not identical to California or federal MY2007+ requirements. The Engine Manufacturers Association (**EMA**) has raised concerns that the STP2005 may be more restrictive than the STP2007 under certain NTE engine operating conditions. Also, the STP2007 provides additional flexibility that is not found in the STP2005. As provided in this MAC, the ARB intends to align the NTE provisions of these two sets of regulations as fully as possible. The ARB also intends to conform its application of NTE requirements during certification of MY2005-2006 HDDEs to the certification framework outlined in EPA AC 24-3 and the accompanying questions-and-answers (**Q&A**) document developed by the EPA, the ARB and the EMA. The specific consistency issues are discussed below.

A) SUBMITTED INFORMATION IN APPLICATIONS FOR CERTIFICATION

Under California's STP2005, and ARB's and EPA's STP2007s, engine manufacturers are required to include in their certification applications exhaust emission data demonstrating compliance with the FTP emission standards and the supplemental emission caps under the European steady-state test cycle (**ESC**) and the NTE protocols. In addition, at the time of submitting the certification application, the engine manufacturer must provide a compliance statement stating that all engine models within the engine family seeking Executive Order approval will meet the NTE emission testing caps under defined in-use operating conditions.

The EMA requests that the ARB's on-road HDDE certification procedure align with the federal certification procedure for MY2005-2006 as it pertains to the submittal of ESC and NTE emission data, and the NTE compliance statement. Federally, the EPA encourages manufacturers to voluntarily include an in-use NTE compliance statement in the certification applications for MY2005-2006 HDDEs. The EPA does not call for the submission of supporting data at the time of certification but provide that manufacturers should have a reasonable basis for their NTE compliance statements and submit this information to EPA upon request. For California, ESC and NTE emission testing caps and in-use compliance apply to all HDDEs starting from MY2005. In the interest of permitting manufacturers to submit the same certification applications to EPA and ARB during MY2005-2006, the ARB will not require the inclusion of ESC and NTE compliance data in the certification applications. However, the ARB would nonetheless welcome voluntary submission of the data for review during the certification process. In any event, manufacturers are still required to include a compliance statement in the cover letter that is submitted together with the application to ARB. As an example, the following statement is acceptable to ARB; other statements will also be considered.

> Sample compliance statement to be included in the certification application:
> *"ABC (manufacturer name) hereby states that on the basis of test data, engineering evaluation and/or other evidence gathered, developed and maintained by the manufacturer at the time the application for certification is submitted to ARB, this engine family for which an Executive Order is being sought will comply with all applicable ESC and NTE emission testing caps under all conditions which can*

reasonably be expected to be encountered in normal vehicle operation and use for the useful life of these engines. Upon request, ABC (manufacturer name) agrees to furnish these test data, engineering evaluation and/or other evidence to ARB within 30 days after receipt of such request and in the format to be mutually specified by ARB and EPA."

There is a variety of information that a manufacturer could use as a reasonable basis for a statement that engines are expected to meet NTE testing caps. For example, a reasonable basis could include FTP data, ESC data, a robust engine emissions map derived from laboratory testing (e.g., an emissions map of similar resolution to the engine's base fuel injection timing map) and technical analyses relying on good engineering judgment which are sufficient, in combination, to project emission levels under NTE conditions reasonably expected to be encountered in normal vehicle operation and use. Manufacturers may assemble this combination of information on a single engine model and project it to other engine models within a family where there is a reasonable basis to do so. Data generated from on-highway testing to determine emission levels should also be part of this combination. However, a reasonable basis for the manufacturer's compliance statement does not require on-highway emissions test data. This statement could reasonably be based solely on laboratory test data, analysis, and other information reasonably sufficient to support a conclusion that the engine will meet the NTE testing caps under conditions reasonably expected to be encountered in normal vehicle operation and use. If the manufacturer has relevant on-highway emissions test data, it should be taken into consideration by the manufacturer in developing the basis for its statement.

B) NTE COMPLIANCE GUIDANCE

California's and EPA's STP2007s provide additional flexibility for NTE compliance in the following situations: (1) specified operating points that identified petroleum-fueled engine/vehicle combinations are incapable of operating at; (2) specified operating points that an alternative-fueled engine is not expected to operate at in normal vehicle operation and use; (3) restricted testing in a 5.0% zone[1]; (4) cold temperature operating exclusion for engines equipped with exhaust gas recirculation (**EGR**); and (5) deficiencies[2].

[1] Under this provision, a manufacturer may request to limit NTE testing of petroleum-fueled HDDEs in a single defined region of speeds and loads. Such a defined region must generally be of elliptical or rectangular shape, and must share some portion of its boundary with the outside limits of the NTE zone. Under this provision, testing would not be allowed with sampling periods in which operation within that region constitutes more than 5.0 percent of the time-weighted operation within the sampling period. Approval of this limit by the ARB is contingent on the manufacturer satisfactorily demonstrating that operation at the speeds and loads within that region accounts for less than 5.0 percent of all in-use operation (weighted by vehicle-miles-traveled or other ARB-approved weightings) for the in-use engines of that configuration (or sufficiently similar engines).

[2] A deficiency occurs when specific requirements are not fully met by an HDDE that otherwise complies with the NTE requirements. Upon application by the manufacturer, a deficiency will be granted only if compliance would be infeasible or unreasonable considering such factors as, but not limited to: technical feasibility of the given hardware and lead time and production cycles including phase-in or phase-out of engines or vehicle designs and programmed upgrades of computers. Deficiencies will be approved on an engine model and/or horsepower rating basis within an engine family, and each approval is applicable for a single model year. A manufacturer's application must include a description of the auxiliary emission control device(s) which will be used to maintain emissions to the lowest practical level, considering the deficiency being requested, if applicable. An application for a deficiency must be made during the certification process; no deficiency will be granted to retroactively cover engines already certified.

[Reference 2, Sections 86.1370-2007 (b)(6)(i), (b)(6)(ii), (b)(7), (f) and (i), respectively] However, "deficiencies" are the only flexibility available in ARB's STP2005. In the interest of furthering consistency between ARB and EPA certification procedures, the ARB agrees that MY2005-2006 engines should be provided with the same NTE flexibility as provided to MY2007+ engines. Additionally, the EMA requests that the ARB accept EPA-approved auxiliary emission control devices (**AECD**s) for California certification of MY2005-2006 HDDEs.

For MY2005-2006 HDDEs, in addition to the above NTE deficiency flexibility, the ARB will also consider requests for other NTE compliance flexibility, namely items (1) through (4) listed above, under the NTE deficiency provision. This approval is subject to the following clarifications and conditions.

As provided in this MAC, the additional flexibility under criteria (1) through (4) above granted for MY2005-2006 HDDEs under the NTE deficiency provision is not subject to the carry-over restriction that is generally applicable to approved NTE deficiencies. Furthermore, requests for the additional flexibility (1) through (4) above are not subject to the infeasibility or unreasonableness test that is generally required for a request under the NTE deficiency provision.

Manufacturers requesting approval of a 5.0% zone should provide analyses of typical engine operation that reflects known or reasonably anticipated engine use patterns. These analyses should be based on in-use data from testing of representative vehicle/engine configurations, valid engineering calculations corresponding to operational data from in-use vehicles, or a combination of the two. As an example of engineering calculations that would support a 5.0% region, some manufacturers have developed methodologies which predict speed/torque operations for certain engine/vehicle configurations based on inputs such as vehicle weight, axle, torque and expected driving cycle and vehicle use. Where the manufacturer can reasonably demonstrate that these methodologies correlate with actual on-road operation and use realistic input data, it would provide an adequate basis for defining 5.0% regions under this provision. Other types of engineering analyses might also support determination of a 5.0% region if their validity can likewise be demonstrated.

The regulations state that the manufacturer's "demonstration must include operational data from representative in-use vehicles." This requirement can be satisfied by operational data from representative in-use vehicles used to demonstrate the validity of a methodology for predicting speed/torque operations for certain vehicle/engine combinations. For example, the manufacturer might measure speed/torque levels during

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Unmet requirements should not be carried over from the previous model year except where unreasonable hardware or software modifications would be necessary to correct the deficiency, and the manufacturer has demonstrated an acceptable level of efforts toward compliance as determined by the Executive Officer. The NTE deficiency should only be seen as an allowance for minor deviations from the NTE requirements. The NTE deficiency provisions allow a manufacturer to apply for relief from the NTE requirements under limited conditions. ARB expects that manufacturers should have the necessary functioning emission control hardware in place to comply with the NTE requirements. In appropriate cases, ARB may convey its intent to approve a deficiency for an additional model year barring a major change in circumstance; this may occur, for example, where the manufacturer shows that for an additional model year the hardware, software or changes in the engine design necessary to correct the deficiency would be infeasible or unreasonable.

in-use operation and correlate predicted levels with these measured values. Alternatively, the manufacturer might develop in-use data confirming that the driving conditions assumed in applying the methodology are in fact typical of on-road operation of the vehicles in question. These kinds of operational data would be part of the demonstration, which the manufacturer submits to support recognition of a 5.0% zone.

ARB expects that separate 5.0% demonstrations would be needed for each engine family and for significantly different engine/vehicle combinations within those families. However, it is not necessary to perform separate analyses for each possible configuration of engines and vehicles and for each possible set of operating conditions under which these engine/vehicle configurations might be used. Rather, a manufacturer can submit a 5.0% demonstration for a representative engine/vehicle use configuration that is generally reflective of similar configurations within that engine family.

The regulations state that the 5.0% region must "generally" be of elliptical or rectangular shape. This does not preclude the ARB from approving a 5.0% region that is some other single shape so long as it shares some portions of its boundary with the outside limits of the NTE zone, and so long as the shape does not create a discontiguity or division in the remainder of the NTE zone. However, the ARB does not expect that the portion of the region's boundary that it shares with the outside limits of the NTE zone will be a single point.

In any assessment to determine compliance with NTE testing caps, operation within the 5.0% region may be included in a valid NTE sampling period, but only if it does not represent more than 5.0% of the sampling period on a time-weighted basis. This would mean, for example, that where an engine operated for 30 seconds in the 5.0% region, a valid NTE sampling period could not be shorter than 10 minutes. Should in-use testing be performed on an engine for which a 5.0% region has been established, speed/load points within that region would need to represent 5.0% or less of the sampling period or the sampling period would be invalid. The time that an engine operates within a 5.0% region would be determined after taking into account the accuracy of the underlying speed and torque measurements, both in assessing the manufacturer's designation of the 5.0% region, and in any subsequent assessments or testing.

Based on EMA's request that the ARB accept EPA-approved AECDs for MY2005-2006 HDDEs, the ARB will continue to accept AECDs that are approved by EPA within the scope of FTP engine operation. The ARB will also accept AECDs for MY2005-2006 HDDEs that are approved by EPA. In consultation with EPA, the ARB will separately evaluate whether these approved AECDs meet the ARB's criteria for granting an NTE deficiency request. Under the regulations, deficiencies will be granted where compliance with NTE requirements would be "infeasible or unreasonable considering such factors as, but not limited to: technical feasibility of the given hardware and lead time and production cycles including phase-in or phase-out of engines or vehicle designs and programmed upgrades of computers." These criteria would likely be met for certain engine strategies that had previously been approved as AECDs. For example, where a request for a deficiency is based on the need to protect the engine or vehicle from damage, the ARB's

analysis may demonstrate that NTE compliance during AECD operations is "unreasonable" or "infeasible." Other operations where AECDs have been approved for current technology engines may also be suitable for NTE deficiencies; these could include, for example, engine starting operations or modulation of the emission control system under extreme altitude or temperature conditions.

ARB wishes to reiterate that an approved AECD is not considered a defeat device. On the other hand, an unapproved AECD will be likely considered a defeat device unless it is only used for engine starting, engine protection, or engine diagnostics.

A manufacturer requesting NTE compliance flexibility is responsible for providing all data, information, and analyses necessary for an evaluation of such requests by the ARB. The request, complete with all support information, should be submitted at least 60 days before the Executive Order for the engine family is requested.

Examples of the needed support information are given here for illustration purposes only. Manufacturers should use good engineering judgment in providing relevant data and information based on specific engine designs and vehicle applications. For example, a request for flexibility under (1) or (2) above must, at a minimum, identify the engine-vehicle combinations (e.g., engine model/code, vehicle make/model, transmission code) and/or operating points (e.g., engine speed/load, vehicle speed/weight, transmission gear) that a petroleum-fueled HDDE is incapable of operating at, or an alternative-fueled HDDE is not expected to operate at in normal vehicle operation and use, and provide an explanation of the basis for this determination. A request for flexibility under (3) above must, at a minimum, include a functional or graphical description of the 5.0% zone in terms of both engine and vehicle operating conditions, and the applicable data and analysis used for this determination. A request for flexibility under (4) above must, at a minimum, identify where changes in the engine and/or fueling calibration strategy occur for purposes of engine protection due to problems associated with EGR operation at cold temperature, and show that the specified criteria for intake manifold temperature and absolute pressure and engine coolant temperature are met at these changes. A request for flexibility under (5) above for an NTE deficiency, referenced in footnote 2 of this MAC, must, at a minimum, include the information specified in STP2005, section 86.007-21(p)(2) [Reference 1.].

Recognizing that engine design and certification review take time, the ARB encourages manufacturers to consult with ARB staff on the AECD review process early in the development of a certification package, and provides the same encouragement for early consultation on proposed NTE deficiencies. Assuming that a manufacturer has submitted adequate engine design information, the ARB will make every effort to communicate its views on the likely outcome of the deficiency request as soon as practicable. To that end, engine manufacturers may begin a request for NTE deficiency determination as early as two years prior to the certification deadline for a given engine family model year. The ARB will make every effort to review these requests within 60 days of submission of a full and complete description of the NTE deficiency, and provide the manufacturer with the ARB's feedback, verbally or in written format. If the ARB is unable to approve the deficiency at

that time, it will advise the manufacturer of its reasons and will specify the steps the ARB expects the manufacturer to take to either eliminate the need for the NTE deficiency or document the justification for the requested NTE deficiency. In any such case, the ARB will make every effort to render a final determination on the allowance of a particular deficiency at least six months prior to production, recognizing that manufacturers must, at some point, freeze a design to allow engine production. The ARB's denial of a preliminary deficiency determination request will not preclude a subsequent additional request by the manufacturer.

POLICY:

For California certification of MY2005-2006 HDDEs, manufacturers are allowed to request NTE compliance flexibility in the following situations in addition to the flexibility provided under the NTE deficiency provision.

1. For petroleum-fueled HDDEs, a manufacturer may identify particular engine-vehicle combinations and may petition the Executive Officer to exclude specific operating points from the NTE control area if the manufacturer can demonstrate that the engine is not capable of operating at such points when used in the specified engine-vehicle combination(s).

2. For alternative-fueled HDDEs, a manufacturer may petition the Executive Officer to exclude specific operating points from the NTE control area if the manufacturer can demonstrate that the engine is not expected to operate at such points in normal vehicle operation and use.

3. For petroleum-fueled HDDEs, a manufacturer may petition the Executive Officer to limit NTE testing in a single defined region of speeds and loads. The defined region must be contiguous, and must share some portion of its boundary with the outside limits of the NTE zone, and be of a reasonable geometric shape that is typically, but not necessarily, elliptical or rectangular. Under this provision, testing would not be used for NTE compliance activities when it involves sampling periods in which operation within that region constitutes more than 5.0 percent of the time-weighted operation within the sampling period. Approval of the defined region is contingent on the manufacturer satisfactorily demonstrating that operation at the speeds and loads within that region accounts for less than 5.0 percent of all in-use operation (weighted by vehicle-miles-traveled or other ARB-approved weightings) for the in-use engines of that configuration (or sufficiently similar engines).

4. For petroleum-fueled HDDEs, a manufacturer may petition the Executive Officer to exclude, under cold operating conditions, EGR operation for EGR-equipped HDDEs whose operation is within the NTE control area. Upon approval, the engine family would not be subject to NTE emission testing caps during cold operating conditions defined in 86.1370-2007, A. of Reference 2.

5. A manufacturer requesting any NTE compliance flexibility, including the flexibility under an NTE deficiency as provided in Section 86.1370(i) of Reference 1., is responsible for providing all data, information, and analyses necessary for an evaluation of such requests by the ARB. For guidance on examples of the support information needed, see the BACKGROUND AND DISCUSSION section in this MAC. The request, complete with all support information, should be submitted at least 60 days before the Executive Order for the engine family is requested.

6. The ARB will accept AECDs that are approved by EPA within the scope of FTP engine operation. The ARB will also accept AECDs for MY2005-2006 HDDEs that are approved by EPA. In consultation with EPA, ARB will separately evaluate whether these approved AECDs meet the ARB's criteria for granting an NTE deficiency request. An AECD approved during certification is not considered a defeat device. On the other hand, an unapproved AECD may be considered as a defeat device unless it is used only for engine starting, engine protection, or engine diagnostics.

7. Submittal of data and analyses supporting ESC and NTE compliance as part of the certification application is voluntary for MY2005-2006 HDDEs. However, a compliance statement must be submitted as part of an application for certification. The following is an example of an acceptable compliance statement; other statements will also be considered.

   "ABC (manufacturer name) hereby states that on the basis of test data, engineering evaluation and/or other evidence gathered, developed and maintained by the manufacturer at the time the application for certification is submitted to ARB, this engine family for which an Executive Order is being sought will comply with all applicable ESC and NTE emission testing caps under all conditions which can reasonably be expected to be encountered in normal vehicle operation and use for the useful life of these engines. Upon request, ABC (manufacturer name) agrees to furnish these test data, engineering evaluation and/or other evidence to ARB within 30 days after receipt of such request and in the format to be mutually specified by ARB and EPA."

   It is expected that the manufacturers have available development, in-house and/or field tests or other evaluations to support this compliance statement. If requested by the ARB, these data and information must be provided to the Executive Officer within 30 days. A manufacturer requesting certification pursuant to voluntary submittal of certification emission data is still fully responsible and liable under all applicable regulations for the in-use compliance of the certified engines with the applicable ESC and NTE emission testing caps during the applicable useful life of these engines.