**Draft Off-Cycle Emissions GTR**
**January 6, 2005**

## A. Statement of Technical Rationale and Justification

### 1. Technical and Economic Feasibility

The objective of this Global Technical Regulation (GTR) is to establish a process which ensures emissions requirements for heavy-duty vehicles are met over a broad range of conditions encountered during normal in-use operation .

The proposed GTR adopts new harmonized emissions standards and test procedures which cover a broad range of normal driving conditions that are otherwise not subject to traditional emissions testing. This GTR also updates the prohibition against defeat devices (strategies) through a set of harmonized definitions to account for the new emissions standards and test procedures.

Heavy-duty vehicles are driven over a wide variety of operating conditions, including starts, stops, accelerations, decelerations, steady cruises, and under varying loads and ambient conditions (e.g., variations in temperature, humidity and barometric pressure). Over many years of engineering study and development, manufacturers have developed sophisticated electronic and mechanical systems that control the performance of heavy-duty engines over this wide variety of driving conditions. A central aspect of this sophisticated engineering is the constant monitoring of a wide range of engine operating parameters, including engine rotational speed, vehicle ground speed, and intake manifold pressure and temperature. Based on the monitored data, the engine computer is typically programmed to control the operation of the engine, by, for example, adjusting the timing and rate of fuel injection or the amount of air from a turbocharger

The growing sophistication of engine technology has greatly increased the potential that emission control system will be modified under conditions not included or underrepresented on the laboratory test procedures, which may result in substantially higher emission levels under actual driving conditions.

Over the last several years it has become clear that in-use emissions control might be inappropriately reduced as compared to the control demonstrated over the certification/type approval test. In some cases ,this resulted in significantly higher in-use (i.e., off-cycle) emissions than anticipated when the emissions standards were developed and finalized.

For many years, the basic regulatory approach for heavy-duty diesel engine exhaust standards for NOx and PM relied on a standardized test to demonstrate compliance at the time of certification /type approval and on defeat device provisions to ensure

appropriate control during off-cycle operation . The tests in various countries including the United States, Japan and the European Union are highly regimented laboratory test procedures. The engine is installed in a test cell and operated over the designated test cycles. The test cycles are intended to simulate a representative driving regime, but a substantial portion of the wide variety of real world driving conditions are not incorporated into specific tests. [1]

Regulating entities have traditionally relied exclusively on the defeat device provisions to ensure appropriate off-cycle emissions control over real world driving conditions not well represented by the certification/type approval tests. The defeat device prohibition, however, does not provide a quantified numerical emissions limit and associated test procedure for conditions not encountered on the laboratory tests, resulting in case-by-case decision making regarding whether a particular element of design constitutes a defeat device. The design-based reviews associated with the defeat device prohibition become increasingly burdensome as emission control technologies grow more complex.

The approach proposed in the GTR reduces the reliance on time consuming case-by-case design reviews and provides a more efficient and objective performance-based means for evaluating traditional off-cycle emissions behavior. For this reason, the proposed GTR is an important step forward to ensure emission control technologies are actually effective and that emissions requirements are met under a wide range of normal in-use operating conditions.

The proposed GTR requires adherence to a Not-to-Exceed (NTE) standard and test procedure for certification/type-approval. The NTE requirements, in combination with the defeat device prohibition, will better ensure an appropriate control of emissions under a broad range of in-use operating conditions. .

The technical and economic feasibility of the NTE has been demonstrated by virtue of its implementation in the United States. Since 1998, certain engine manufacturers have been required to comply with NTE provisions under the terms of a settlement agreement with the United States. Over that same period, other companies have been using the NTE as a means to voluntarily demonstrate compliance with the United States' defeat devise prohibition as provided for under guidance issued by the U.S. Environmental Protection Agency. The NTE is designed so it does not present additional costs for engines which employ appropriate off-cycle emission control strategies.

***[How the OCE GTR interacts with the work of the harmonized WHTC and WHSC and OBD efforts will need to be added– here or at A.2. or B.1.}***

[1] For example, all certification/type approval test cycles apply only at a specific temperature range and only at the specific speed and torque points and in the order specified over the specified test cycles. This means that an engine might comply with the certification/type approval test in the laboratory, but not achieve the demonstrated emission control and reductions during real world driving.

## 2. Anticipated Benefits

The addition of NTE requirements to the certification testing regime and harmonized defeat device prohibition will better ensure that an appropriate control of emissions is achieved in-use, under a wide range of operating conditions. As a result, it can be expected that the application of this GTR for emissions legislation within the Contracting Parties will result in an improved level of control of in-use emissions due to the coverage of expected in-use driving ranges of vehicles world-wide.

Additionally, heavy commercial vehicles and their engines are increasingly produced for the world market. It is economically more efficient for manufacturers to prepare models that can meet the emission objectives using shared testing and measuring methods. This in turn will allow manufacturers to develop new models more effectively and with in a shorter time frame. A common performance-based approach for evaluating traditional off-cycle emissions will conserve both manufacturer and certification/type approval authority resources. .

This GTR facilitates on-road testing which is more cost effective than traditional lab-based testing. It also promotes continued product refinement and standardization within the portable emissions measurement equipment industry.

## 3. Potential cost effectiveness

RESERVED. LOOK AT OTHER GTRS FOR A MODEL. MAKE SURE LANGUAGE CONSISTENT WITH OTHER GTRS. DISCUSS WITH OTHER (OBD AND WHTC) CHAIRS.

The GTR does not increase the stringency of traditional emissions requirements or introduce additional costs for engines which do not employ defeat devices. The NTE is designed to account for emissions increases that occur naturally during operation considered more challenging for emission control relative to the certification/type approval tests.

# B. Text of Regulations

## 1. Scope and Purpose

This regulation establishes emissions standards and a test procedure for heavy-duty engines to better ensure appropriate control of in-use emissions under a broad range of operating conditions.

## 2. Application

**LANGUAGE RESERVED FOR FURTHER DISCUSSIONS AMONG CHAIRPERSONS OF THE OTHER WORKING GROUPS. RECOMMEND REVIEWING APPROPRIATENESS OF VEHICLE CLASSIFICATION LANGUAGE FROM SPECIAL RESOLUTION 1 ADOPTED JUNE 2004 AT WP 29.**

**FYI THE FOLLOWING IS LANGUAGE FROM GTR-WHDC [REDLINE TEXT ADDED]:**

"This regulation applies to the emission of gaseous and particulate pollutants from compression-ignition engines, natural gas engines and positive-ignition engines fuelled with LPG, used for propelling on-road (?), heavy duty motor (?) vehicles.

NOTES:

CONFIRM THAT GTR APPLIES TO DIESEL AND DIESEL-DERRIVED ENGINES.

NEED TO ADD ANNEX FOR DEFINITION OF HEAVY-DUTY VEHICLES AND ENGINES.

EDITORIAL COMMITTEE AGREED TO LET GROUP CHAIRS DECIDE ON APPROPRIATE VEHICLE CLASSIFICATIONS AND DEFINITIONS. ONCE THAT HAPPENS, EDITORIAL COMMITTEE WILL REVIEW IN CONTEXT OF NTE GTR TO IDENTIFY ANY POSSIBLE CONFLICTS.

ECE DEFINITION USES SIMILAR CLASSIFICATIONS BUT MAY CHANGE VIA THE WWHD PROCESS.

**3. Definitions**

WILL ADD TEXT AT A LATER DATE AS WE DISCUSSED IN PREVIOUS OCE MEETINGS. BELOW ARE LISTED THE POTENTIAL DEFINITIONS WE HAVE DISCUSSED THUS FAR.

[ADD TABLE OF THE 3 WORKING DEFINITIONS FOR DD AND AECDS?]

Element of Design
Emission Control Strategy
Basic Emission Control Strategy
Auxiliary Emission Control Strategy
Defeat Strategy
Beer-Lambert relationship
Engine starting
Engine Family
Engine rating/configuration
Heavy-duty engine
Passive regeneration
Active regeneration
Diesel derived engines

**4. General Requirements**

The components liable to affect the emission of gaseous and particulate pollutants shall be so designed, constructed and assembled as to enable the vehicle in normal use, despite vibration to which it may be subject, to comply with the provisions of this Regulation

FROM WHDC SECTION 4. IS THIS LANGUAGE A NECESSARY REQUIREMENT TO BE ACCEPTABLE TO THE E.U. COUNTRIES? IF SO, DOES THE LANGUAGE NEED TO BE REVISED TO ACCOUNT FOR OTHER CONDITIONS SUCH A TEMPERATRUE AND HUMIDITY? ALTERNATIVELY CAN THE REFERNCE TO VIBRATION BE DELETED?

**4.1** Prohibition of Defeat Strategies
No new heavy duty engine shall be equipped with a defeat device/strategy

**4.2** NTE Requirement.
The purpose of this test procedure is to measure emissions of heavy-duty engines while operating within a broad range of speed and load points (the Not-To-Exceed Control Area). Using the NTE test procedures, emissions are evaluated under conditions which can reasonably be expected to be encountered in normal vehicle operation and use.

The NTE emissions standards must be met when engine operation is within the load and speed range specified by Section 7.1; ambient operating conditions [within the ranges specified <<<< REPLACE WITH THE WORD "DESCRIBED"?] in Section 6.0; and testing is conducted using the procedures described in Section 7.0 and Annex XX [EQUIVALENT TO EPA'S 1065 TESTING REGULATIONS], unless otherwise provided for under the provisions of Sections 8.0, 9.0, and 10.0.

Emission results from this test procedure are to be compared to the Not-To-Exceed Limits specified in Section 5.0. When operated within the Not-To-Exceed Control Area defined in Section 7.1, emissions from heavy-duty engine measured and averaged over a minimum sampling period shall not exceed the applicable Not-To-Exceed Limits specified in Section 5.0. The Not-To-Exceed Limits do not apply during engine starting conditions.

**4.3** Labeling requirements [MOVE TO CERT SECTION?]

**5. Performance Requirements**

RESERVED- overall HDE limits.

**[ADD SUMMARY TABLE]**

**5.1** For engines certified to a NOX standard or FEL of less than 1.50 g/bhp-hr [DO WE WANT A SEPARATE THRESHOLD FOR NMHC], the brake-specific exhaust NMHC or NOx emissions in g/bhp-hr, as determined under Section 7.0 pertaining to the not-to-exceed test procedures, shall not exceed 1.5 times the applicable NMHC or NOX emission standards or *FELs* specified in the *[reference to participating country's standard setting regulation cite]*, during engine and vehicle operation specified in Section 6.0 of this section except as noted in Sections 8 through 10[2].

[2] FEL is the abbreviation for Family Emissions Limit. An FEL is used in conjunction with Averaging, Banking and Trading (ABT) programs. In general, ABT programs allow a manufacturer to certify a portion of its production with an emission level or FEL above the applicable standards (credit users) so long as there are a sufficient number of engines produced with an FEL far enough below the applicable standards (credit generators) to establish a net zero or positive emissions balance. Unless otherwise

**5.2** For engines certified to a NOX standard or FEL greater than or equal to 1.50 g/bhp-hr, the NOX and NMHC exhaust emissions in g/bhp-hr, as determined under Section 7.0 pertaining to the not-to-exceed test procedures, shall not exceed 1.25 times the applicable emission standards or FELs specified in *[reference to participating country's standard setting regulation cite]*, during engine and vehicle operation specified in Section 6.0 except as noted in Sections 8 through 10.

**5.3** For engines having a PM standard or FEL less than 0.05 g/bhp-hr, the exhaust PM emissions in g/bhp-hr, as determined under Section 7.0 pertaining to the not-to-exceed test procedures, shall not exceed 1.5 times the applicable PM emission standards or FEL (for FELs above the standard only) specified in *[reference to participating country's standard setting regulation cite]*, during engine and vehicle operation specified in Section 6.0 except as noted in Sections 8 through 10.

**5.4** For engines having a PM standard or FEL greater than or equal to 0.05 g/bhp-hr, the exhaust PM emissions in g/bhp-hr, as determined under Section 7.0 pertaining to the not-to-exceed test procedures, shall not exceed 1.25 times the applicable emission standards or FELs specified in *[reference to participating country's standard setting regulation cite]*, during engine and vehicle operation specified in Section 6.0 except as noted in Sections 8 through 10.

**5.5** The exhaust CO emissions in g/bhp-hr, as determined under Section 7.0 pertaining to the not-to-exceed test procedures, shall not exceed 1.25 times the applicable CO emission standards or FEL specified in *[reference to participating country's standard setting regulation cite]*, during engine and vehicle operation specified in Section 6.0 except as noted in Sections 8 through 10.

**5.6** Smoke emissions requirements. Operation within the NTE zone (defined in Section 7.1) must comply with:

[NOTES: 1) QUESTION RAISED ABOUT NEED FOR NTE SMOKE STANDARDS GIVEN LOW PM LEVELS. EDITORIAL COMMITTEE DECIDED TO KEEP SMOKE LIMITS AT LEAST UNTIL PORTBALE PM MEASUREMENT DEVICES BECOME COMMERCIALLY AVALABLE. WE COULD ADD LANGUAGE THAT SETS A PM THRESHOLD BELOW WHICH SMOKE MEASUREMENT WOULD NOT BE REQUIRED AS LONG AS PORTABLE PM MEASUREMENT SYSTEMS ARE AVAILABLE. 2) CAUTION RAISED OVER POSSIBILITY OF INCREASED NO2 LEVELS FROM OXIDIZING AFTERTREAMENT DEVICES BEING DETECTED BY SMOKE OPACITY METERS. NO2 SHOULD NOT BE CONSIDERED SMOKE AS SMOKE IS ONLY CARBON BASED. 3) COMMENT MADE THAT SMOKE STANDARDS SEEM TOO LENIENT COMPARED TO EU AND JAPAN. 4) DECIDE WHETHER A DEFINITION IS NEEDED FOR TRANSIENT AND STEADY-STATE]

**5.6.1** A filter smoke number of 1.0 under steady-state operation, or the following alternate opacity limits:

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permitted, that emissions balance must be achieved for each model year. The FEL serves as the emissions standard for engines participating in ABT programs.

**5.6.1.1** A 30 second transient test average opacity limit of 4% for a 5 inch path; and

**5.6.1.2** A 10 second steady state test average opacity limit of 4% for a 5 inch path.

**5.6.2** The standards set forth in Section 5.6.1 of this section refer to exhaust smoke emissions generated under the conditions set forth in Section 7.1 through 7.3 and calculated in accordance with the procedures set forth in Section 7.4.

## 6.0 Applicable Operating Conditions

**6.1** Ambient operating regions. The not-to-exceed emission limits must apply during one of the following two ambient operating regions:

**6.1.1** Option (A) The not-to-exceed limits apply for all altitudes less than or equal to 5,500 feet above sea-level, during all ambient conditions (temperature and humidity). Temperature and humidity ranges for which correction factors are allowed are specified in Section 7.3; or

EDITORIAL COMMITTEE HAS IDENTIFIED THE ALTITUDE CUT POINT AS AN ISSUE TO BE FURTHER DISCUSSED BY PLENARY GROUP

**6.1.2** Option (B) The not-to-exceed emission limits apply at all altitudes less than or equal to 5,500 feet above sea-level, for temperatures less than or equal to the temperature determined by the following equation at the specified altitude:

$$T = -0.00254 \times A + 100$$

Where:

T = ambient air temperature in degrees Fahrenheit.

A = altitude in feet above sea-level (A is negative for altitudes below sea-level).

[ISSUES/CONCERNS/FOLLOW-UP:
1) DESIRE NOT TO DESIGN FOR ALTITUDES ABOVE 1000 METERS FOR COUNTRIES WHERE LESS THAN 2% VMT (VEHICLE MILES TRAVELED) IS SPENT AT SUCH ALTITUDE (ARGUMENT IS THAT HIGH ALTITUDE REQUIREMENTS DRIVE ENGINE DESIGN, BOTH HARDWARE AND SOFTWARE, WHICH ULTIMATELY APPLIES TO LOW ALTITUDE OPERATION AS WELL). NOT CLEAR THAT IS THE CASE.

2) ALTITUDE REQUIREMENTS DRIVE DESIGN REQUIREMENTS IN TERMS OF COOLING CAPACITY, CAB DIMENSIONS

3) SPECIAL CONSIDERATION HAS TO BE GIVEN TO COUNTRIES AT ALTITUDES GREATER THAN 1680 METERS

4) PLENARY GROUP TO PROVIDE SUGGESTION WHETHER TO SPLIT OUT ALTITUDE RANGES AND HOW TO ADDRESS COST BENEFIT DISCUSSION

5) NEED TO UNDERTAND SPECIFIC DESIGN ISSUES AND THE POTENTIAL FOR AN ALTITUDE ENGINE CONTROL STRATEGY TO SOLVE THE RESOLVE THE STATED CONCERNS.

6) NEED TO CONSIDER THE LOST BENEFIT OF HARMONIZATION

7) CONSIDER ENGINE LABELING ISSUE FOR REGIONAL ENGINES

8) NEED TO CONSIDER AFTERMARKET SALES/CROSS BOARDER MIGRATION

9) ALTITUDE TIERS THAT COULD BE CONSIDERED: 1000 METERS AND BELOW, 1000 TO <1680 METER, AND GREATER THAN 1680

10) OICA WILL PREPARE MATERIALS FOR THE NEXT PLENARY MEETING: DISCUSSION OF AMBIENT CONDITION DISTRIBUTION AMONG VARIOUS COUNTRIES, DISCUSSION OF THE ASSOCIATED COST WITH DESIGNING TO THE MOST STRINGENT CONDITIONS, SUGGESTED AMBIENT CONDITION TIERING FOR GROUP DISCUSSION. US EPA/EMA WILL PROVIDE SIMILAR US DOCUMENT.]

**6.2** Temperature and humidity correction factors.
Ranges for which correction factors are allowed are specified in Section 7.3.

**6.3** Emissions Control Technology Considerations

**6.3.1** Exhaust gas recirculation.
For engines equipped with exhaust gas recirculation, the not-to-exceed emission limits specified in Section 5.0 do not apply to engine or vehicle operation during cold operating conditions as specified in Section 10.1.

**6.3.2** NMHC and NOx aftertreatment
For engines equipped with NMHC and NOx aftertreatment, the not-to-exceed emission limits specified in Section 5.0 do not apply to engine or vehicle operation during the engine warm-up conditions specified in Section 10.2.

## 7.0 NTE Test Procedures

**7.1** Not-to-exceed control area for diesel heavy-duty engines (see Figure 1). The Not-To-Exceed Control Area for heavy-duty engines consists of the following engine speed and load points:

**7.1.1** Engine speed range. All operating speeds greater than the speed calculated using the following formula:

nlo+0.15 x (nhi-nlo)

where nhi and nlo are determined according to the provisions in *[EPA Sec. 86.1360(c)/reference to participating country's Euro Steady-State test regulation cite Preference is to refer to WHDC GTR (confirm WHDC and current Euro steady-state provisions are the same)]*:

**7.1.2** Engine load range. All engine load points greater than or equal to 30% or more of the maximum torque value produced by the engine.

**7.1.3** Particulate matter engine speed and load carve-out. For engines certified to a PM standard or FEL greater than 0.05 g/bhp-hr, speed and load points determined by using the applicable method described below shall be excluded from the Not-To-Exceed Control Area.

**7.1.3.1** NTE C speed below 2400 rpm (see Figure 1). Exclude engine speed and load points to the right of or below the line formed by connecting the two points defined by 7.1.3.1.1 and 7.1.3.1.2:

**7.1.3.1.1** 30% of maximum torque or 30% of maximum power, whichever is greater, at the B speed; and
**7.1.3.1.2** 70% of maximum power at 100% speed (nhi)

**7.1.3.2** NTE C speed is above 2400 rpm (see figure 2). Exclude engine speed and load points to the right of the line formed by connecting following the two points in Section 7.1.3.2.1 and 7.1.3.2.2 and below the line formed by connecting the two points in Section **7.1.3.2.2** and **7.1.3.2.3**:

**7.1.3.2.1** 30% of maximum torque or 30% of maximum power, whichever is greater, at the B speed;
**7.1.3.2.2** 50% of maximum power at 2400 rpm;
**7.1.3.2.3** 70% of maximum power at 100% speed (nhi).

**7.1.3.3** Determining NTE B and C engine speeds. B and C engine speeds shall be determined according to the provisions in *[EPA Sec. 86.1360(c)/reference to participating country's Euro Steady-State test regulation cite Preference is to refer to WHDC GTR (confirm WHDC and current Euro steady-state provisions are the same)]*:

**Figure 1. Not-To-Exceed Control Area When NTE C Speed < 2,400 rpm**

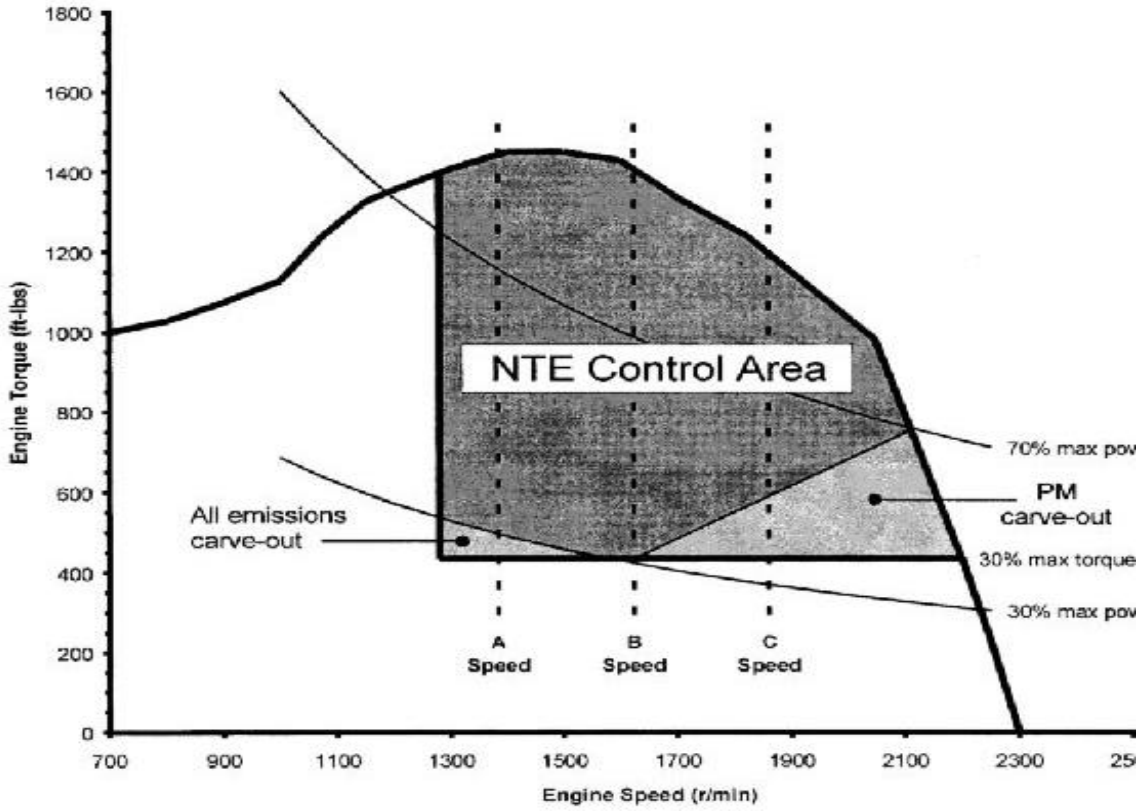
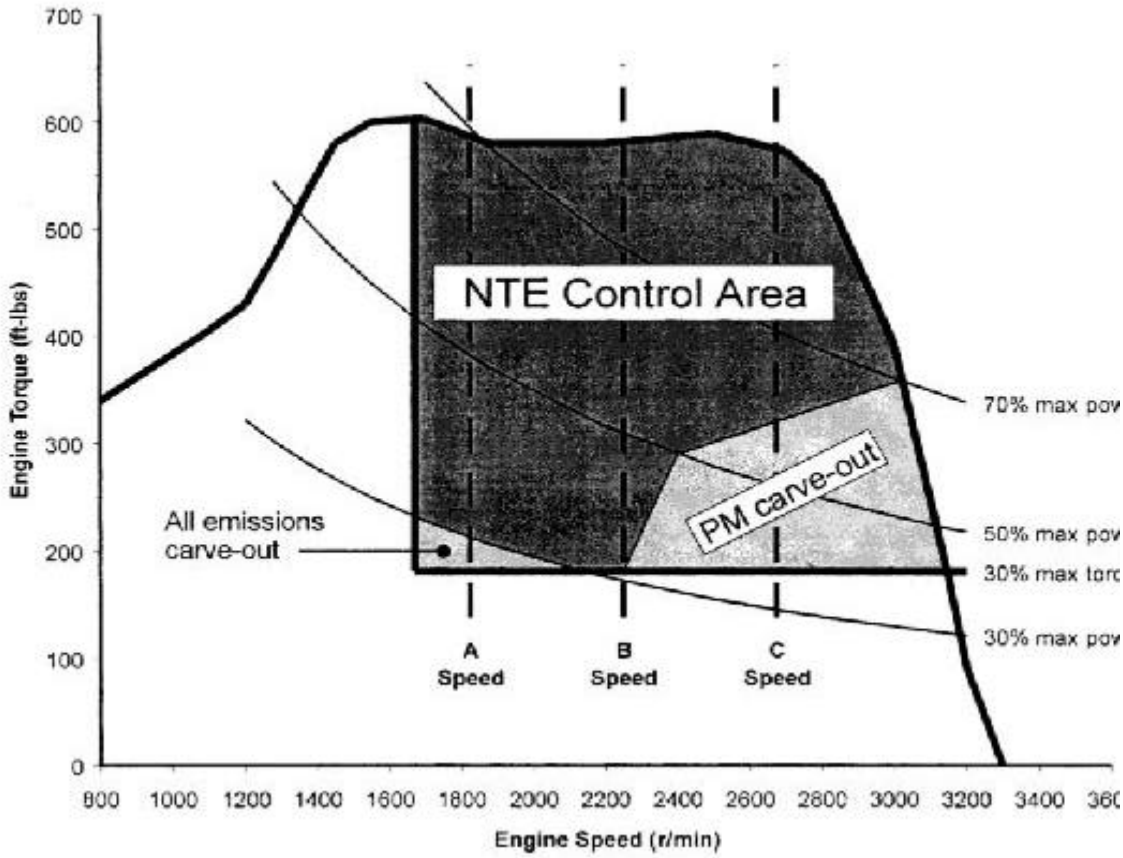



**Figure 2. Not-To-Exceed Control Area When NTE C Speed > 2,400 rpm**




**7.1.4** Engine power range. Notwithstanding the provisions of Sections 10.1.1 and 10.1.2, speed and load points below 30% of the maximum power value produced by the engine shall be excluded from the Not-To-Exceed Control Area for all emissions.

**7.1.5** Minimum BSFC requirement. Notwithstanding the provisions of Sections 7.1.1 and 7.1.2 of this section, all operating speed and load points with brake specific fuel consumption (BSFC) values within 5% of the minimum BSFC value of the engine.

**7.1.5.1** For the purposes of this requirement, BFSC must be calculated under the general test cell conditions specified in *[EPA Sec. 86.1330//reference to participating country's applicable test regulation cite ASTM XXX and ISO XXX Methods ] .*

**7.1.5.2** The manufacturer may petition the Certification or Type Approval Authority at certification to exclude such points if the manufacturer can demonstrate that the engine is not expected to operate at such points in normal vehicle operation and use. Engines equipped with drivelines with multi-speed manual transmissions or automatic transmissions with a finite number of gears are not subject to the requirements of this Section (10.1.3) **[DESIGNED TO COVER CONTINUOUSLY VARIABLE TRANSMISSIONS.]**.

NOTE: JAPAN EXPRESSED CONCERN WHETHER NTE WOULD CAPTURE SUFFICIENT TRANSIENT OPERATION WHICH IS A PREDOMINATE OPERATING MODE IN CITIES. JAPAN SUGGESTED NTE ZONE MIGHT NEED TO BE MADE LARGER OR AVERAGING TIME SHORTER. EDITORIAL COMMITTEE DISCUSSED HOW SHORTER AVERGING PERIOD MAY CAPTURE INFREQUENT EMISSIONS PEAKS AND COULD CHALLENGE PEMS ACCURACY CAPABILITY. OVERALL AFFECT COULD DRIVE A HIGHER NTE LIMIT AND REDUCE OVERALL ENVIRONMENTAL BENEFIT OF THE NTE.

U.S. MENTIONED IT IS NOT CONSIDERING CHANGING NTE ANYTIME SOON. A LONGER SAMPLING PERIOD AND WIDER NTE ZONE COULD BE A FUTURE CONSIDERATION. IN THAT CASE, THE NTE MULTIPLIER WOULD LIKELY MOVE TOWARDS 1X. IN THAT CASE, WOULD NEED TO CONSIDER NTE MULTIPLIER FOR ENGINES THAT SPENT MOST TIME AT IDLE OR VERY LOW LOAD.

JAPAN PLANS TO DEVELOP DATA TO CONFIRM WHETHER ZONE NEEDS TO BE CHANGED TO MEET ITS NEEDS. VOLVO BELIEVES CURRENT NTE ZONE IS APPROPRIATE FOR HEAVY-HEAVY ENGINES. VOLVO ASSUMES SIMILAR OPERATING BEHAVIOR FOR US AND EUROPE HEAVY-HEAVY TRUCKS. NOT SURE ABOUT MEDIUM AND LIGHT-HEAVY APPLICATIONS. NOT AWARE OF A STATISTICAL EVALUATION FOR WORLD WIDE OPERATION. DATA HAS BEEN LOGGED IN U.S., AND EUROPE. JAPAN PLANS TO LOG VEHICLE ACTIVITY DATA.

**7.2** NTE minimum sampling period. When determining compliance with the emissions standards specified Section 5.0, an engine shall operate within the Not-To-Exceed Control Area defined in Section 7.1 and its emissions shall be measured and averaged over any period of time greater than or equal to continuous 30 seconds, except where a longer averaging period is required by Section 7.2.1.

INTRODUCE VIA AN ANNEX AN ALTERNATIVE NTE SAMPLING EVENT CONSISTENT WITH CONCEPT OF “NTE EVENT” USED FOR EPA MANUFACTURER IN-USE TESTING PROGRAM?

**7.2.1** Engines equipped with emission controls that include discrete regeneration events. If a regeneration event occurs during the NTE test, then the averaging period must be at least as long as the time between the events multiplied by the number of full regeneration events within the sampling period. The requirement in this Section only applies for engines that send an electronic signal indicating the start of the regeneration event. [INSERT RELEVANT TEXT FROM REGENERATION Q&A GUIDANCE, OR CREATE AN ANNEX WHICH CONTAINS THE BODY OF THE GUIDANCE.]

NOTES: COMMENTS MADE THAT PROCEDURE NOT CLEAR. FOR EXAMPLE, NEED TO DESCRIBE HOW TO HANDLE ONLY ONE

REGENERATION EVENT. NEED TO EXPLAIN HOW TO HANDLE SPONTANEOUS, PASSIVE REGENERATION. DETERMINE WHETHER NEED TO DEFINE SPONTANEOUS REGENERATION.

JAPAN AND EU HAVE TO REVIEW THEIR NATIONAL REGULATIONS AND COMPARE THE REQUIREMENTS WITH WHAT IS OUTLINED IN THIS DRAFT GTR. JAPAN AND EUROPE WILL SHARE THOSE PROCEDURES WITH THE OCE WORKGROUP.

QUESTION WAS RAISE HOW TO ADDRESS IN-USE COMPLIANCE AFTER TYPE APPROVAL IS GRANTED. A POSSIBLE SOLUTION IS TO ISSUE Q&A GUIDANCE FOR DATA SUBMITTAL AT CERTIFICATION/TYPE APPROVAL THAT ACCOUNTS FOR REGEN VIA AN ADJUSTMENT FACTOR LIKE WITH SUCH AS WITH THE US FTP. REGENERATION WOULD BE TREATED AS A TEST CYCLE ISSUE. DEFER IN-USE TESTING ISSUE VIA A SEPARATE GTR.

NEED A DEFINITION OF PASSIVE AND ACTIVE REGENERATION

**7.3** Ambient emissions corrections. For operation within the conditions specified in Sections 6.1 and 6.2, the measured data shall be corrected based on the ambient conditions under which it was taken, as specified in this section.

**7.3.1** For engines operating within the ambient conditions specified in Section 6.1.1:

**7.3.1.1** NOX emissions shall be corrected for ambient air humidity to a standard humidity level of 50 grains (7.14 g/kg) if the humidity of the intake air was below 50 grains, or to 75 grains (10.71 g/kg) if above 75 grains.
**7.3.1.2** NOX and PM emissions shall be corrected for ambient air temperature to a temperature of 55 degrees F (12.8 degrees C) for ambient air temperatures below 55 degrees F or to 95 degrees F (35.0 degrees C) if the ambient air temperature is above 95 degrees F.
**7.3.1.3** No ambient air temperature or humidity correction factors shall be used within the ranges of 50-75 grains or 55-95 degrees F.

**7.3.2** For engines operating within the ambient conditions specified in Section 6.1.2:

**7.5.3.1** NOX emissions shall be corrected for ambient air humidity to a standard humidity level of 50 grains (7.14 g/kg) if the humidity of the intake air was below 50 grains, or to 75 grains (10.71 g/kg) if above 75 grains.
**7.3.2.2** NOX and PM emissions shall be corrected for ambient air temperature to a temperature of 55 degrees F (12.8 degrees C) for ambient air temperatures below 55 degrees F.
**7.3.2.3** No ambient air temperature or humidity correction factors shall be used within the ranges of 50-75 grains or for temperatures greater than or equal to 55 degrees F.

NOTES: SUGGESTION MADE TO DESCRIBE HOW TO APPLY THE CORECTION FACTORS VIA A REFERENCE OR DIRECT DISCUSSION IN THE GTR.

SUGGESTION MADE TO ADD CO AND HC CORRECTION VALUES (OICA WILL PROVIDE DATA) (CONVERT VALUES TO METRIC).

**7.3.3** Where test conditions require such correction factors, the manufacturer must use good engineering judgement and generally accepted engineering practice to determine the appropriate correction factors, subject to EPA review.

NOTES: CORRECTION FACTORS FOR NOX EXIST FROM CONSENT DECREES. NEED FACTORS FOR PM AND OTHER POLLUTANTS.

AGREED THAT BEST APPROACH IS FOR THIS GTR TO REFER TO ACCEPTED CORRECTION FACTORS.

NEED TO DETERMINE WHAT REFERENCE TO USE. POSSIBLY AN ISO OR EMA PROCEDURE COULD BE CONSIDERED.

**7.4** Measuring smoke emissions within the NTE zone. This section contains the measurement techniques to be used for determining compliance with the filter smoke limit or opacity limits in
Section 5.6.

JAPAN ASKED FOR EXPLANATION OF TRANSIENT AND STEADY-STATE SMOKE REQUIREMENTS FOR NTE TESTING. POSSIBLE THAT REFERS TO TRANSIENT OR STEADY-STATE OPERATION THAT OCCURS DURING OPERATION WITHIN THE NTE ZONE. NEED TO DEFINE TRANSIENT AND STEADY-STATE.

THE NTE FIELD TESTING PROCEDURES AND EQUIMENT REEQUIREMNTS WILL BE REFERENCED TO AN ANNEX OR GTR BASED EPA 1065. EDITORIAL COMMITTEE WILL KEEP AN EYE ON EUROPEAN JOINT RESEARCH COMMITTEE WORK.

**7.4.1** For steady-state or transient smoke testing using full-flow opacimeters. 10.7.1.1 Equipment meeting the requirements of *subpart I of this part or ISO/DIS-11614 ``Reciprocating internal combustion compression-ignition engines--Apparatus for measurement of the opacity and for determination of the light absorption coefficient of exhaust gas*" is required. This document is incorporated by reference *(see Sec. 86.1 /reference to participating country's applicable test regulation cite)*.

PERHAPS NEED TO REFER TO A SMOKE ABSORPTION COEFFECIENT. REFER TO ECE R-24? HAVE TO SEE IF THIS WILL IMPACT ISO REFERENCE (OICA WILL PRESENT A PROPOSAL)

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**7.4.1.1** All full-flow opacimeter measurements shall be reported as the equivalent percent opacity for a five inch effective optical path length using the Beer-Lambert relationship.

CONCERN RAISED THAT CORRECTING TO 5 IN OPTICAL PATH WILL PENALIZE SMALLER ENGINES THAT ARE TYPICALLY USED WITH VEHICLES HAVING SMALLER TAIL PIPES.

**7.4.1.2** Zero and full-scale (100 percent opacity) span shall be adjusted prior to testing.

**7.4.1.3** Post test zero and full scale span checks shall be performed. For valid tests, zero and span drift between the pre-test and post-test checks shall be less than two percent of full-scale.

CONCERN RAISED THAT 2% OF FULL SCALE DRIFT IS 50% OF ALLOWABLE LIMIT FOR SMOKE. DRIFT LIMITS NEED TO BE SUBSTANTIALLY REDUCED.

**7.4.1.4** Opacimeter calibration and linearity checks shall be performed using manufacturer's recommendations or good engineering practice.

**7.4.2** For steady-state testing using a filter-type smokemeter. Equipment meeting the requirements of *ISO/FDIS-10054 ``Internal combustion compression-ignition engines--Measurement apparatus for smoke from engines operating under steady-state conditions--Filter-type smokemeter''* is recommended. Other equipment may be used provided it is approved in advance by the Certification or Type Approval Authority.

**7.4.2.1** All filter-type smokemeter results shall be reported as a filter smoke number (FSN) that is similar to the Bosch smoke number (BSN) scale.

**7.4.2.2** Filter-type smokemeters shall be calibrated every 90 days using manufacturer's recommended practices or good engineering practice.

**7.4.3** For steady-state testing using a partial-flow opacimeter. Equipment meeting the requirements of *ISO-8178-3 and ISO/DIS-11614* is recommended. Other equipment may be used provided it is approved in advance by the Certification or Type Approval Authority.

SEE PREVIOUS ADSORBTION COEFFICIENT COMMENT IN SECTION 7.4.1.

**7.4.3.1** All partial-flow opacimeter measurements shall be reported as the equivalent percent opacity for a five inch effective optical path length using the Beer-Lambert relationship.

**7.4.3.2** Zero and full scale (100 percent opacity) span shall be adjusted prior to testing.

**7.4.3.3** Post-test zero and full scale span checks shall be performed. For valid tests, zero and span drift between the pre-test and post-test checks shall be less than two percent of full scale.

**7.4.3.4** Opacimeter calibration and linearity checks shall be performed using manufacturer's recommendations or good engineering practice.

**7.4.4** Replicate smoke tests. Replicate tests may be run to improve confidence in a single test or stabilization. If replicate tests are run, three additional tests which confirm to this section shall be run, and the final reported test results must be the average of all the valid tests.

**7.4.5** A minimum of thirty seconds sampling time shall be used for average transient smoke measurements. The opacity values used for this averaging must be collected at a minimum rate of 1 data point per second, and all data points used in the averaging must be equally spaced in time.

**7.5** Calculating NTE emissions.

REFER TO AN ANNEX, ANOTHER GTR, OR INSERT LANGUAGE DIRECTLY INTO THIS GTR. CONSIDER USING CALCULATIONS IN EPA 40 CFR 1065 OR FUTURE HEAVY-DUTY IN-USE TESTING REGULATION.

**7.6** Rounding. NTE emissions determined under Section 7.0 shall be rounded to the same number of significant figures as the applicable cycle-based standards using the conventions described in Annex XX. [Annex XX would incorporate ASTM E29-93a and ISO XXX by reference].

**8.0 Compliance exclusion from certain NTE operating points.**
NTE compliance is not required under the following conditions:

**8.1** For petroleum-fueled diesel cycle engines [DEFINE.IN TERMS THAT ARE GLOBALLY CONSISTENT. FOR EXAMPLE, EITHER SPARK OR COMPRESSION IGNITION], the manufacturer may identify particular engine-vehicle combinations and may petition the Certification or Type Approval Authority during certification or type approval to exclude operating points from the Not-to-Exceed Control Area defined in Section 7.1 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).

QUESTION RAISED WHY IS A PROVISION EVEN NEEDED IF ENGINE IS NOT CAPABLE OF OPERATING OVER CERTAIN NTE POINTS. INITIAL THOUGHT IS THAT WHILE THE VEHICLE MAY NOT BE CAPABLE OF OPERATING AT SOME POINTS WITHIN THE NTE ZONE, AN ENGINE IN THE LAB MIGHT. THE INTENT IS NOT CONDUCT LAB-BASED ENGINE DYNAMOMETER TESTING IN AN AREA OF THE NTE WHERE THE VEHICLE IS NOT CAPABLE OF OPERATING ON THE ROAD. IF THIS IS TRUE, "THE SPECIFIED" ABOVE SHOULD BE CHANGE TO "ANY".

**8.2** For diesel cycle engines that are not petroleum-fueled [SEE COMMENT IN SECTION 8.1], the manufacturer may petition the Certification or Type Approval Authority during certification or type approval to exclude operating points from the Not-to-Exceed Control Area defined in Section 7.1 if the manufacturer can demonstrate that the engine is not expected to operate at such points in normal vehicle operation and use.

**[CONSIDER COMBINING SECTIONS 8.1 AND 8.2]**

**9.0 NTE deficiencies**

MORE SPECIFITY ON THE REQUIREMENTS REQUESTED.

**9.1** General.
For the first three model years after a new emissions standard takes effect, upon application by the manufacturer, the Certification or Type Approval Authority may accept a HDDE as compliant with the NTE standards even though specific requirements are not fully met.

**9.2** Evaluation criteria.
Deficiencies, 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 [MORE SPECIFICITY NEEDED].

**9.3** Approval process.
Deficiencies will be approved on a engine model and/or horsepower rating basis within an engine family, and each approval is applicable for a single model year. An application for a deficiency must be made during the certification/type approval process; no deficiency will be granted to retroactively cover engines already certified.

**9.4** Limitations.
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 effort toward compliance as determined by the Certification or Type Approval Authority. 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 emission requirements under limited conditions, such as extreme ambient temperatures and/or severe operation where vehicles do not accumulate significant mileage. The Certification or Type Approval Authority expects that manufacturers should have the necessary functioning emission control hardware in place to comply with the NTE.

SUGGESTION MADE TO CONSIDER COMBINE SECTIONS 9.2 AND 9.4

EXPLICILY STATE GENERAL CRITERIA SUCH AS WHY THE DEFICIENCY IS NEEDED, WHY THE PROBLEM CAN NOT BE SOLVED WITHOUT A DEFICIENCY, HOW MUCH ABOVE THE NTE DOES THE DEFECIENCY

CAUSE EMISSIONS TO INCREASE, HOW FREQUENTLY THE DEFICIENCY WILL ACTIVATE IN TERMS OF VEHICLE MILES TRAVELED AND/OR % OF OPERATION, ETC.

ADD LANGUAGE THAT STATES DEFECIECIES WHICH RESULT IN NONCOMPLIANCE OVER THE ENTIRE NTE WILL NOT BE GRANTED.

**9.5** Number of deficiencies.
[U.S. EPA ALLOWS AN UNLIMITED NUMBER OF DEFICIENCIES PER ENGINE FAMILY FOR MODEL YEARS 2007 THROUGH 2009 (PHASE 1 STANDARDS); ONLY THREE PER MODEL YEAR UNLESS OTHERWISE APPROVED BETWEEN 2010 AND 2013 (PHASE 2 STANDARDS). NONE AFTER 2013.]

For the first three model years after a new emissions standard which results in more than an **XX** (percent or absolute) reduction, takes affect, the Certification or Type Approval Authority may allow an unlimited number of deficiencies per engine family. In the event the Certification or Type Approval Authority allows the use of deficiencies for a period longer than three model years after a new technology-forcing emissions standard is issued, the number of deficiencies shall be limited to three per engine family. In determining whether to extend the use of deficiencies beyond the first three model years after new emissions standard take effect or allow more than three deficiencies per engine family during that period, the Certification or Type Approval Authority may consider any relevant factors, including the factors identified in Section 9.2. If additional deficiencies are approved, the Certification or Type Approval Authority may set any additional conditions that he/she determines to be appropriate.

EDITORIAL GROUP AGREED TO ADD LANGUAGE THAT SUGGESTS/REQUIRES DEFICIENCY REQUESTS BE MADE 2 YEARS PRIOR TO THE MODEL YEAR BEING CERTIFIED

**10.0 NTE Carve-Outs and Technology-based NTE exclusions**.
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**10.1** NTE cold temperature operating exclusion. Engines equipped with exhaust gas recirculation (EGR) are not subject to the NTE emission limits when the engine is operated during cold temperature conditions as specified using either of the following two criteria even when the engine is operated within the NTE control area specified in Section 7.1.

**10.1.1** Intake manifold temperature (IMT) less than or equal to the temperature defined by the following relationship between IMT and absolute intake manifold pressure (IMP) for the corresponding IMP:

Where:
P = absolute intake manifold pressure in bars.
IMT = intake manifold temperature in degrees Fahrenheit.

SUGGESTION MADE TO ELIMINATE AND HANDLE VIA THE DEFICIENCY PROVISIONS IF NECESSARY. PROVISION CREATES POSSIBLE COMPETITIVNESS ISSUE.FOR MANUFACTURERS THAT SELECT DIFFERENT TECHNOLOGIES. PROVISIONS NEED TO BE TECHNOLOGY NEUTRAL. THIS PROVISION IS STATIC WHEREAS TECHNOLOGY DEVELOPS. POSSIBLE THIS PROVISION MAY NOT BE NECESSARY IN THE FUTURE FOR EGR ENGINES.

**10.1.2** Engine coolant temperature (ECT) less than or equal to the temperature defined by the following relationship between ECT and absolute intake manifold pressure (IMP) for the corresponding IMP:

Where:

P = absolute intake manifold pressure in bars.

ECT = engine coolant temperature in degrees Fahrenheit.

**10.2** NOX and NMHC Aftertreatment warm-up.
For engines equipped with one or more aftertreatment devices that reduce NOX or NMHC emissions, the NTE NOX and NMHC emission limits do not apply when the exhaust gas temperature is measured within 12 inches of the outlet of the aftertreatment device and is less the 250 deg.C. For multi-bed systems, it is the temperature at the outlet of the device with the maximum flow rate that determines whether the NTE limits apply.

SEE COMMENTS IN SECTION 10.1

**10.3** NTE Carve-Outs. Manufacturers may petition the Certification or Type Approval Authority to limit NTE testing 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. The 5.0 percent is calculated on a time-weighted basis, e.g. no more than 2 seconds out of 40 seconds. Approval of this limit by the Certification or Type Approval Authority 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 weightings approved by the Certification or Type Approval Authority) for the in-use engines of that configuration (or sufficiently similar engines). At a minimum, this demonstration must include operational data from representative in-use vehicles.

INSERT RELEVANT TEXT FROM AC-24 Q&A GUIDANCE, OR CREATE ANNEX WHICH CONTAINS THE BODY OF THE GUIDANCE.

QUESTIONS 6, 7, 8 , 9, 10, 11 ALL ADDRESS GUIDANCE ON THE 5% CARVE-OUT REGION.

REQUEST FUTURE COMMENT ON HOW THE INFORMATION IN THE GUIDANCE SHOULD BE EXPLICITLY INCLUDED IN THE GTR OR IN AN ANNEX TO THE GTR.

## 11.0 Documentation for Application for Compliance *(or Annex)*

**11.1** Statement of NTE compliance.
The manufacturer must provide a statement in the application for certification that the diesel heavy-duty engine for which certification is being requested will comply with the applicable Not-To-Exceed Limits specified in Section 5.0 when operated under all conditions which may reasonably be expected to be encountered in normal vehicle operation and use.

> **11.1.1** Example statement of compliance.
> "These engines will comply with the NTE limits specified in Section 5.1 when operated under all conditions which may reasonably be encountered in normal vehicle operation and use."

**11.2** Basis for NTE compliance statement.
The manufacturer also must maintain records at the manufacturers facility which contain all test data, engineering analyses, and other information which provides the basis for this statement, where such information exists. The manufacturer must provide such information to the Certification or Type Approval Authority upon request.

ISSUE RAISED THAT TYPE APPROVAL AUTHORITIES WILL NOT ACCEPT A COMPLIANCE STATEMENT WITHOUT ACTUAL EMISSIONS DATA.

REQUEST MADE TO DESCRIBE THE MINIMUM LEVEL OF LABORATORY DATA AND ENGINEERING JUDGEMENT REQUIRED FOR CERTIFICATION/TYPE APPROVAL.

FOR EXAMPLE, TEST AT 30 STEADY-STATE DATA POINTS IN LAB. EXTRAPOLATE LAB RESULTS TO NTE CONDITIONS NOT INCLUDED DURING LAB TESTING WITH CORRECTION FACTORS DEVELOPED FROM REAL-WORLD EVALUATIONS.

REFER TO RELEVANT SECTIONS OF ADVISORY CIRCULAR 24-3. QUESTIONS 1, 2, 3, 4 FOCUS ON WHAT INFORMATION A MANUFACTURER HAS TO HAVE IN POSSESSION TO SUPPORT AN NTE STATEMENT. PERHAPS CREATE AN ANNEX THAT INCLUDES THIS INFORMATION TO PROVIDE GUIDANCE TO MANUFACTURERS.

**11.3** Technology exclusion descriptions.
For engines equipped with exhaust gas recirculation, the manufacturer must provide a detailed description of the control system the engine will use to comply with the requirements of Sections 6.2 and 10.1 for the NTE cold temperature operating exclusion, including but not limited to the method the manufacturer will use to access this exclusion during normal vehicle operation. Specifically, the manufacturer must

describe how control system will identify the conditions described in Section 10.6 and limit access to the cold temperature exclusion during normal vehicle operation.

WOULD ELIMINATE THIS TEXT IF ELIMINATE TECH EXCLUSIONS IN SECTION 10.

**11.4** NOX and NMHC Aftertreatment warm-up.
For engines equipped with one or more aftertreatment devices that reduce NOX or NMHC emissions, the manufacturer must provide a detailed description of the control system the engine will use to comply with the requirements of Section 10.2 for the NTE exhaust aftertreatment warm-up exclusion, including but not limited to the method the manufacturer will use to access this exclusion during normal vehicle operation. Specifically, the manufacturer must describe how control system will identify the conditions described in Section 10.2.

WOULD ELIMINATE THIS TEXT IF ELIMINATE TECH EXCLUSIONS IN SECTION 10.

**11.5** Deficiency Descriptions.
For each engine model and/or horsepower rating within an engine family for which a manufacturer is applying for an NTE deficiency(ies) under the provisions of Section 8.0, the manufacturer's application for an NTE deficiency(ies) must include a complete
description of the deficiency, including but not limited to: the specific description of the deficiency; why the deficeincy is needed, what pollutant the deficiency is being applied for, all engineering efforts the manufacturer has made to overcome the deficiency, what specific engine and ambient operating conditions the deficiency is being requested for (i.e., temperature ranges, humidity ranges, altitude ranges, etc.), the frequency the deficiency will be used, (%VMT, % operation), the specific emissions control system parameters modulated in response to the deficiency and the purpose of that modulation if applicable, a full description of the auxiliary emission control device(s) which will be used to maintain emissions to the lowest practical level if applicable; and what the lowest practical emission level will be.

**11.6** 5% Carve-Out Descriptions and Demonstrations
For each engine model and/or horsepower rating within an engine family for which a manufacturer is applying for an 5% carve-out under the provisions of Section 10.3, the manufacturer's application for an NTE carve-out must include a complete description of the carve-out including but not limited to the range of engine load and speed which define the carve-out region and the methods or analyses used to arrive at the carve-out region. Manufacturers 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.

ADVISORY CIRCULAR 24-3 QUESTIONS 6, 7, 8 , 9, 10, 11 ALL ADDRESS GUIDANCE ON THE 5% CARVE-OUT REGION.

REQUESTING FUTURE COMMENT ON HOW THE INFORMATION IN THE GUIDANCE SHOULD BE EXPLICITLY INCLUDED IN THE GTR OR IN AN ANNEX TO THE GTR.

**11.7** NTE Exclusion Descriptions and Demonstrations

For any engine family which contains an engine-vehicle combination for which a manufacturer is applying for an NTE exclusion for certain operating points under the provisions of Section 8.1 and 8.2, the manufacturer must describe those operating points and the basis for concluding the engine is not capable of being operated at (Section 8.1 criteria) or expected to be operated at (Section 8.2 criteria) such points when used in the specified engine-vehicle combination(s).

RESERVE COMMENT UNTIL DECIDE WHETHER SECTIONS 8.1 AND 8.2 ARE MODIFIED OR ELIMINATED.