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171 OctoberMay 2007¶
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A. Statement of Technical Rationale and Justification

1. Introduction

The objective of this Global Technical Regulation ("gtr") is to establish a harmonized regulation which ensures off-cycle emissions from heavy-duty engines and vehicles are appropriately controlled over a broad range of engine and ambient operating conditions encountered during normal in-use vehicle operation. The gtr is designed to be applicable to engines certified or type approved under the test procedures of the World-Harmonized Heavy-duty Certification (WHDC) gtr.

To that purpose, this Off-cycle Emissions (OCE) gtr includes provisions that prohibit the use of defeat strategies. This OCE gtr also adopts new harmonized emissions factors which cover a broad range of engine and ambient operating conditions, the World-Harmonized Not-to-Exceed requirements ("WNTE"). The gtr requires the control of emissions during engine and ambient operating conditions that are broader than those covered in emissions testing during the two components of the WHDC, the World-Harmonized Transient Cycle and the World-Harmonized Steady-state Cycle.

It is important to note that the WHDC gtr is being implemented as a global test procedure without emission limits as a first step towards the world harmonization of cycle-based emission certification requirements for heavy-duty engines. During this first stage, regional authorities are expected to introduce the WHDC test procedures into their individual regulatory programs. However, it is anticipated there will continue to be a range of WHDC-based emission limits in effect in the various regions until such time that world-wide emission limits are adopted as part of the WHDC gtr. This being the case, the WNTE-based emission limits defined in this gtr relate directly to the emission limits to which a specific engine has been certified based on the WHDC test procedures. This structure enables regional authorities to implement a common approach to establishing WNTE-based emission limits, even in the period where global WHDC emission limits are not set out in the WHDC gtr. The eventual adoption of global WHDC-based emission limits will effectively result in world harmonized WNTE emission limits.

Editorial Comment: Group needs to capture the following idea, subject to further discussion:

WNTE does not cover all operating conditions, therefore contracting parties may decide to introduce additional procedures for the control of off-cycle emissions. These could be subject to a future gtr, possibly an amendment to this gtr.

2. Background on Off-cycle Emissions

The basic regulatory approach historically utilized by a number of countries to reduce exhaust emissions from heavy-duty engines was to use a combination of an emissions certification test cycle with an emissions limit (or standard) and a prohibition against the use of defeat strategies.

The test cycle for heavy-duty engines, while different among various countries, had a number of common characteristics. The test cycle was based on an engine test, performed in a laboratory, under a limited range of ambient conditions, and the test cycle contained a pre-defined set of speed and load point always run in the same order. The prohibition against the use of defeat strategies generally required that the engine could not operate differently in-use in a manner which reduced the effectiveness of the engine's emission control system. Emissions which occur under conditions not well represented by the laboratory-based test cycle are typically called off-cycle emissions.

Heavy-duty vehicles are driven over a wide variety of operating conditions, including starts, stops, accelerations, decelerations, steady cruises, and under varying ambient conditions (e.g., temperature, humidity and barometric pressure). The establishment of the WHDC gtr will result in a laboratory based test cycle which reflects world-wide on-road heavy-duty engine operation, but as with any standardized test cycle, the wide variety of real world driving conditions are not fully incorporated.

Heavy-duty engines have progressed over the past decade to become very sophisticated electronic and mechanical systems. These systems are capable of controlling the performance of heavy-duty engines over a wide variety of driving conditions. A central aspect of this sophisticated engineering is the capability to continuously monitor a wide range of operating parameters, including engine rotational speed, vehicle ground speed, and intake manifold pressure and temperature, and to modify the performance of the engine and its emission control systems in real-time in response to the monitored data.

The defeat strategy provisions do not provide a quantified numerical emissions limit and associated test procedure for conditions not encountered on the regulatory test cycles. This has often resulted in the need for case-by-case decision making during the certification and type-approval process regarding whether a particular element of design constitutes a defeat strategy. These design-based reviews have become increasingly difficult as the engines and the emission control technologies have grown more complex.

The approach contained in this OCE gtr may reduce the reliance on case-by-case design reviews by additionally requiring compliance with the WNTE provisions. The WNTE supplements the prohibition against defeat strategies and can allow for a more efficient and objective performance-based means for evaluating off-cycle emissions behavior. The WNTE provisions accomplish this by substantially increasing the range of engine and ambient operating conditions which are subject to an emission limit, thereby reducing the scope of emissions considered to be off-cycle.

When considered as a whole, the WHDC gtr and this OCE gtr promote global harmonization of regulations that reduce air pollution from heavy-duty vehicles and engines.

3. Procedural Background and Development of GTR

This gtr was developed by the GRPE informal working group on Off-cycle Emissions (the OCE Informal group). A full report of the work of the OCE Informal group, its deliberations and conclusions is provided in the group's Technical Report, TRANS/WP.29/GRPE/xxxxx.

The work to develop this gtr began with the establishment of the OCE Informal group. The OCE Informal group had its first meeting in December 2001.

As required by the 1998 Global Agreement, a formal proposal for the establishment of a gtr was proposed to the Executive Committee for the 1998 Agreement (AC3) by the United States. At its session on 13th March 2005, the proposal from the United States was approved as a gtr project by AC.3 (TRANS/WP.29/AC.3/13).

The following is a summary of the key issues that were discussed and resolved during the development of this gtr by the OCE working group. Additional discussion of these issues can be found in the Technical Report.

WNTE Control Area
Engine Operating Conditions (e.g. Temperature, Humidity, Altitude)
Definition of Defeat Strategy and related items

One of the key issues discussed during the development of the OCE gtr was the scope of the gtr with respect to in-use, on-vehicle emissions testing. After considerable debate by the OCE working group, it was decided the OCE gtr would not include specifications for in-use, on-vehicle

emission measurement equipment. However, the OCE gtr was developed with the specific intent to enable the testing of compliance with the WNTE during in-use, on the road operation of the engine. Therefore, it may be appropriate in the future to consider the development of a gtr which would include harmonized test procedures for in-use on vehicle emissions measurement.

Editorial comment: need to revisit this paragraph after decision on Options is made.

4. Technical and Economic Feasibility

The OCE gtr has been developed with the input and expertise from a large number of stakeholders, including regulatory authorities, type approval authorities, engine and vehicle manufacturers, and independent technical consultants. The gtr has built upon the experience of many organizations and individuals with expertise in addressing off-cycle emissions.

The gtr has been designed to improve the control of off-cycle emissions, and the WNTE requirements specified in the gtr are based, in-part, on the approaches which exist in some Contracting Parties' existing legislation.

The WNTE requirements in this gtr are a function of the laboratory-based test cycle limits, specifically emission limits associated with the WHDC gtr's transient test cycle (the WHTC). However, the WHDC gtr does not currently contain any limit values. As such, no formal analysis of the technical and economic feasibility of the WNTE limits in this OCE gtr has been undertaken. It is recommended that Contracting Parties consider the technical and economic feasibility of the OCE gtr when they adopt this regulation into their national requirements.

5. Anticipated Benefits

This gtr is expected to result in a number of benefits, including: improved emissions control; more efficient certification or type approval methods, and reduced costs for engine and vehicle manufacturers.

The addition of harmonized defeat strategy provisions and WNTE requirements to the certification testing regime (e.g. the WHDC test cycles) will more adequately 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 adoption of this gtr by Contracting Parties will result in an improved level of emissions control.

The gtr may reduce the need for time consuming case-by-case design reviews and provide a more efficient and objective performance-based means for evaluating off-cycle emissions.

Finally, heavy-duty engines and vehicles are often produced for the world market. It is economically more efficient for manufacturers to design and produce models which meet emissions objectives specified in a common Global Technical Regulation rather than developing products to meet a wide array of different and potentially conflicting regulatory requirements in individual countries and regions. This in turn may allow manufacturers to develop new models more effectively at a lower cost.

6. Potential Cost Effectiveness

A formal cost-effectiveness analysis of the OCE gtr has not been performed for the reasons discussed in Section A 4.

However, it is fully expected that this information will be developed, generally, in response to the adoption of this regulation in national requirements and also at the time the WHDC gtr develops harmonized limit values, and the future corresponding amendments to this gtr. For example,

each Contracting Party adopting this gtr into its national law will be expected to determine the appropriate level of stringency associated with using these new test procedures, with these new values being at least as stringent as comparable existing requirements. Also, experience will be gained by the heavy-duty engine industry as to any costs and cost savings associated with using this test procedure. The cost and emissions performance data could be analyzed as part of a possible future amendment to this gtr to determine the cost effectiveness of the test procedures along with the application of any future harmonized WHDC limit values. While no formal cost-effectiveness has been done, the belief of the GRPE experts is that there are clear benefits associated with this gtr, as discussed in Section A 5.

B. Text of Regulations

1. Purpose

This gtr establishes performance-based off-cycle emission requirements and a prohibition on defeat strategies for heavy-duty engines and vehicles so as to achieve effective control of emissions under a broad range of engine and ambient operating conditions encountered during normal in-use vehicle operation.

2. Scope

This regulation applies to the emission of gaseous and particulate pollutants from compression-ignition engines, and positive-ignition engines fuelled with natural gas (NG) or liquefied petroleum gas (LPG), used for propelling motor vehicles of categories 1-2 and 2[2], having a design speed exceeding 25 km/h and having a maximum mass exceeding 3.5 tonnes.

Editorial comment:. Guidance required from GRPE linking scope to WHDC. AC3 guidance required regarding expansion of the scope to gasoline. Consider linkage/mirroring of WHDC position on expansion of scope.

3. Definitions **[Definitions from the WHDC GTR will inserted in the OCE GTR where applicable. The definitions in WHDC will be footnoted to alert the reader that changes to the WHDC definitions will have to be revaluated as to their applicability to the OCE GTR]**

Auxiliary Emission Strategy ("AES")

means an emission strategy that becomes active and replaces or modifies a base emission strategy for a specific purpose or purposes and in response to a specific set of ambient and/or operating conditions and only remains operational as long as those conditions exist. .

Base Emission Strategy ("BES")

means an emission strategy that is active throughout the speed and load operating range of the engine unless an AES is activated.

[2] See Special Resolution number 1, "Special Resolution concerning the common definition of vehicle categories masses and dimensions [SR1]."

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Defeat Strategy

means an emission strategy that does not meet the performance requirements for a base and/or auxiliary emission strategy as specified in this gtr.

Element of Design

Means

(a) any control system, including: computer software; electronic control systems; and computer logic;

(b) any control system calibration;

(c) the results of the interaction of systems; or

(d) any hardware.

Emission Strategy

means an element or set of elements of design that is incorporated into the overall design of an engine system or vehicle and used in controlling emissions.

Emission Control System

means the elements of design and emission strategies developed or calibrated for the purpose of controlling emissions.

Engine Family

means a manufacturer's grouping of engines as defined in gtr No. 4[3]

Engine Starting

means the process from the initiation of engine cranking until the engine reaches a speed 150 rpm below the normal, warmed up idle speed (as determined in the drive position for vehicles equipped with an automatic transmission).

Engine System

means the engine, the emission control system and the communication interface between the engine's electronic control unit(s) and any other powertrain or vehicle control unit.

Engine Warm-up

Means sufficient vehicle operation such that the coolant temperature reaches a minimum temperature of at least 70 degrees C.

Periodic Regeneration

means the regeneration process of an exhaust aftertreatment system that occurs periodically in typically less than 100 hours of normal engine operation.

Rated Speed

[Paste 3.1.23 from WHDC]

[3] Test Procedures for Compression-Ignition (C.I) Engines and Positive- Ignition Engines Fuelled with Natural Gas (NG) or Liquefied Petroleum Gas (LPG) with regard to the Emission of Pollutants (Established in The Global Registry on 15 November 2006)

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Deleted: Means either¶ (a) an AECSAES that reduces the effectiveness of the emission control relative to the BECSBES under conditions that may reasonably be expected to be encountered in normal vehicle operation and use, unless:¶ - the operation of the AECSAES is substantially included in the ... [1]

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4. General Requirements

Any engine system and any element of design liable to affect the emission of regulated pollutants shall be designed, constructed, assembled and installed so as to enable the engine and vehicle to comply with the provisions of this gtr.

4.1 Prohibition of Defeat Strategies

Engine systems and vehicles shall not be equipped with a defeat strategy.

4.2 WNTE Emission Requirement.

This gtr requires that engine systems and vehicles comply with the WNTE emission limit values described in Section 5.2. For laboratory based testing according to Section [7.4?] no test result shall exceed the emissions limits specified in Sections 5.2.

5. .Performance Requirements

5.1 Emission Strategies

emission strategies shall be designed so as to enable the engine system, in normal use, to comply with the provisions of this gtr. Normal use is not restricted to the conditions of use as specified in section 6.

5.1.1 Requirements for Base Emission Strategies

A BES shall not discriminate between operation on an applicable type approval or certification test and other operation for the purpose of providing a lesser level of emission control under conditions not substantially included in the applicable type approval or certification tests.

5.1.2 Requirements for Auxiliary Emission Strategies

An AES shall not reduce the effectiveness of the emission control relative to a BES under conditions that may reasonably be expected to be encountered in normal vehicle operation and use, unless the AES satisfies one the following specific exceptions:

- its operation is substantially included in the applicable type approval or certification tests, including the WNTE provisions of section 7.
-it is activated for the purposes of protecting the engine and/or vehicle from damage or accident.
-it is only activated during engine starting or warm up as defined in this gtr.
-its operation is used to trade-off the control of one type of regulated emissions in order to maintain control of another type of regulated emissions under specific ambient or operating conditions not substantially included in the type approval or certification tests. The overall affect of such an AES shall be to compensate for the effects of extreme ambient conditions in a manner that provides acceptable control of all regulated emissions.

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Engine systems shall be designed, constructed and assembled so as to comply with the provisions of this gtr including when installed in the vehicle.

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5.2 WNTE Limits for Gaseous and Particulate Exhaust Emissions

5.2.1 Exhaust emissions shall not exceed the applicable WNTE emission limits specified in 5.2.2 when the engine is operated in accordance with the conditions and procedures set out in Sections 6 and 7.

5.2.2 The applicable WNTE emission limits are determined, as follows:

WNTE Emission Limit =WHTC Emission Limit + WNTE Component

where

"WHTC Emission Limit" is the emission limit (EL) to which the engine is certified pursuant to the WHDC gtr; and

"WNTE Component" is determined by equations 1 to 4 in section 5.2.3

5.2.3 The applicable WNTE Components shall be determined using the following equations, when the ELs are expressed in g/kWh:

for NOx:	WNTE Component = 0.25 * EL + 0.1	(1)
for HC:	WNTE Component = 0.15 * EL + 0.07	(2)
for CO:	WNTE Component = 0.20 * EL + 0.2	(3)
for PM:	WNTE Component = 0.25 * EL + 0.003	(4)

Where the applicable ELs are expressed in units other than units of g/kWh, the additive constants in the equations shall be converted from g/kWh to the appropriate units.

The WNTE Component shall be rounded to the number of places to the right of the decimal point indicated by the applicable EL in accordance with the rounding method of ASTM E 29-06.

6. Applicable Ambient and Operating Conditions

The WNTE emission limits shall apply at

- all atmospheric pressures greater than or equal to 82.5 kPa,
- all temperatures less than or equal to the temperature determined by equation 5 at the specified atmospheric pressure:

$$T = -0.4514 * (101.3 - p_b) + 311 \quad (5)$$

where:
T is the ambient air temperature, K
p_b is the atmospheric pressure, kPa

- all engine coolant temperatures within the range of 343 K to 373 K (70°C to 100°C.

The applicable ambient atmospheric and temperature conditions are shown in figure 1

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5.1.1 . Any element of design and emission control strategy (ECS) liable to affect the emission of gaseous and particulate pollutants from diesel engines and the emission of gaseous pollutants from gas engines shall be so designed, constructed, assembled and installed as to enable the engine, in normal use, to comply with the provisions of this gtr. ECS consists of the base emission control strategy (BECS) and usually one or more auxiliary emission control strategies (AECS).¶
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5.1.2. . **Requirements for base emission control strategy¶**
5.1.2.1. The base emission control strategy (BECS) shall be so designed as to enable the engine, in no ... [12]

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Figure 1 : Illustration of Ambient Altitude and Temperature Conditions [figure to be revised by EPA]

WNTE Altitude and Temperature Range

7. WNTE Methodology

7.1 WNTE control area

The WNTE control area consists of the engine speed and load points defined in Sections 7.1.1 through 7.1.6. Figure 2 is an example illustration of the WNTE control area.

7.1.1 Engine speed range. The WNTE control area shall include all operating speeds between the 30th percentile cumulative speed distribution over the WHTC test cycle, including idle, (n_{30}) and the highest speed where 70% of the maximum power occurs (n_{hi}). Figure 3 is an example of the WNTE cumulative speed frequency distribution for a specific engine.

7.1.2 Engine torque range. The WNTE control area shall include all engine load points with a torque value greater than or equal to 30% of the maximum torque value produced by the engine.

7.1.3 Engine power range. Notwithstanding the provisions of Sections 7.1.1 and 7.1.2, speed and load points below 30% of the maximum power value produced by the engine shall be excluded from the WNTE Control Area for all emissions.

7.1.4 **Application of Engine Family Concept**. In principal, any engine within a family with a unique torque/power curve will have its individual WNTE control area. For in-use testing, the individual WNTE control area of the respective engine shall apply. For type approval (certification) testing under the engine family concept of the WHDC gtr the manufacturer may optionally apply a single WNTE control area for the engine family under the following provisions:

– A single engine speed range of the WNTE control area may be used; if the measured engine speeds n_{30} and n_{hi} are within ± 3 % of the engine speeds as declared by the manufacturer. If the tolerance is exceeded for any of the engine speeds, the measured engine speeds shall be used for determining the WNTE control area.

– A single engine torque/power range of the WNTE control area may be used, if it covers the full range from the highest to the lowest rating of the family. Alternatively, grouping of engine ratings into different WNTE control areas is permitted.

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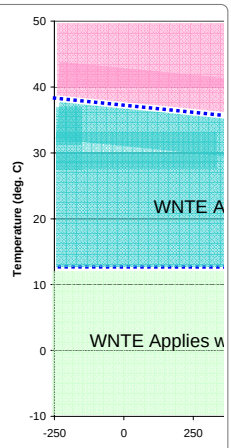

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Figure 3: Example of WNTE cumulative speed frequency distribution

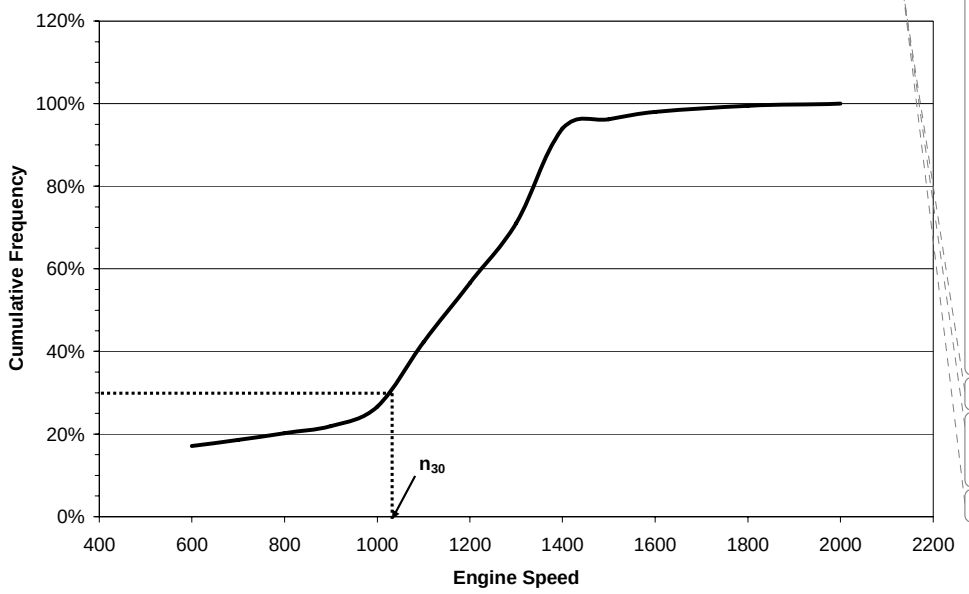

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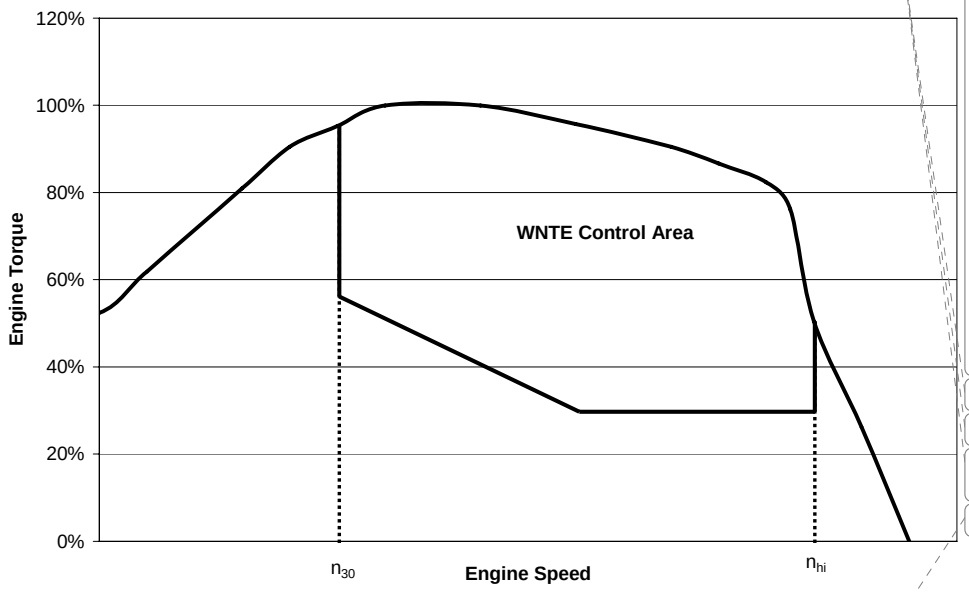
Figure 2: Example WNTE Control Area



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Editorial Comment: Will update diagrams to correspond with final control area established in gtr and will add example figures

7.1.5 Compliance exclusion from certain WNTE operating points.
The manufacturer may request that the approval authority excludes operating points from the WNTE control area defined in Section 7.1.1 through 7.1.4 during the certification/type approval The approval authority may grant this exclusion if the manufacturer can demonstrate that the engine is never capable of operating at such points when used in any vehicle combination.

7. 2 Minimum WNTE event duration and data sampling frequency

7.2.1 To determine compliance with the WNTE emissions limits specified section 5.2, the engine shall be operated within the WNTE control area defined in section 7.1 and its emissions shall be measured and integrated over a minimum period of 30 seconds. A WNTE event is defined as a single set of integrated emissions over the period of time. For example, if the engine operates for 65 consecutive seconds within the WNTE control area and ambient conditions this would constitute a single WNTE event and the emissions would be averaged over the full 65 second period. In the case of lab testing the integrating period of time of 7.3 shall apply.

7.2.2 For engines equipped with emission controls that include periodic regeneration events, if a regeneration event occurs during the WNTE test, then the averaging period shall 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 7.2.2 only applies for engines that send an electronic signal indicating the start of the regeneration event.

7.2.3 A WNTE event is a sequence of data collected at the frequency of at least 1hz during engine operation in the WNTE control area for the minimum event duration or longer. The measured emission data shall be averaged over the duration of each WNTE event.

7.3 WNTE in-use testing

If a Contracting Party selects this gtr as basis for in-use testing, the engine shall be operated under actual in-use conditions. The test results out of the total data set that comply with the provisions of sections 6, 7.1 and 7.2 shall be used for determining compliance with the WNTE emission limits specified in section 5.2. It is understood that emission during some WNTE events may not be expected to comply with the WNTE emission limits; therefore,; Contracting Parties should define and implement statistical methods for determining compliance that are consistent with Sections 7.2 and 7.3

7.4 WNTE laboratory testing

If a contracting party selects this gtr for the basis for laboratory testing the following provision shall apply.

7.4.1. The specific mass emissions of regulated pollutants shall be determined on the basis of randomly defined test points distributed across the WNTE control area. All the test points shall be contained within 3 randomly selected grid cells imposed over the control area. The grid shall be comprised of 9 cells for engines with a rated speed less than 3000 rpm and 12 cells for engines with a rated speed greater than or equal to 3000 rpm as defined as follows:

- The outer boundaries of the grid are aligned to the WNTE control area;
- 2 vertical lines spaced at equal distance between engine speeds n30 and ,n_{hi} for rated speed less that 3000rpm, or 3 vertical lines spaced at equal distance between engine speeds n30 and n_{hi} for rated speeds greater than or equal to 3000rpm

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- 2 horizontal lines spaced at equal distance of engine torque (⅓) at each vertical line within the WNTE control area; and[text to be provided by EC to sync w figure 5]

An example of the grid applied to a specific engine is shown in Figure 5.[examples of both the 9 and 12 grid figures will be provided by the EC]

7.4.2. The 3 selected grid cells shall each include 5 random test points, so a total of 15 random points shall be tested within the WNTE control area. Each cell shall be tested sequentially; therefore all 5 points in one grid cell are tested before transiting to the next grid cell. The test points are combined into a single ramped steady state cycle.

7.4.3. The order in which each of the grid cells are tested, and the order of testing the points within the grid cell, shall be randomly determined. The 3 grid cells to be tested, the 15 test points, the order of testing the grid cells, and the order of the points within a grid cell shall be selected by the type approval or certification authority using acknowledged statistical methods of randomisation.

7.4.4. The average specific mass emissions of regulated gaseous pollutants shall not exceed the WNTE limit values specified in section 5.2 when measured over any of the cycles in a grid cell with 5 test points.

7.4.5. The average specific mass emissions of regulated particulate pollutants shall not exceed the WNTE limit values specified in section 5.2 when measured over the whole 15 test point cycle.

7.5. Laboratory test procedure

7.5.1. After completion of the WHSC cycle, the engine shall be preconditioned at mode 9 of the WHSC for a period of three minutes. The test sequence shall start immediately after completion of the preconditioning phase.

7.5.2. The engine shall be operated for 2 minutes at each random test point. This time includes the preceding ramp from the previous steady state point. Ramps between the test points shall be linear for engine speed and load and shall last a maximum of 20 seconds.

7.5.3. The total test time from start until finish shall be 30 minutes. The test of each set of 5 selected random points in a grid cell shall be 10 minutes, measured from the start of the entry ramp to the 1st point until the end of the steady state measurement at the 5th point. Figure 5 illustrates the sequence of the test procedure.

7.5.4 The WNTE laboratory test shall meet the validation statistics of section 7.7.2 of the WHDC gtr.

7.5.5. The measurement of the emissions shall be carried out in accordance with paragraph 7.8 of WHDC gtr.

7.5.6. The calculation of the test results shall be carried out in accordance with paragraph 8 of WHDC gtr.

Figure 4: Schematic example of the start of the WNTE test cycle

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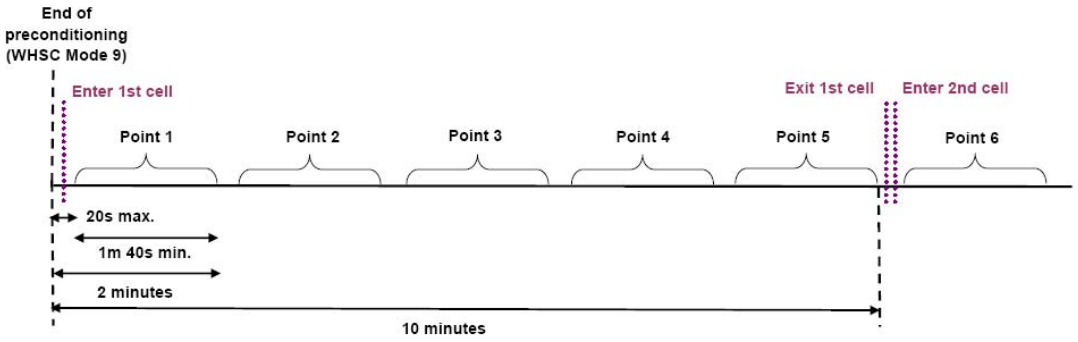
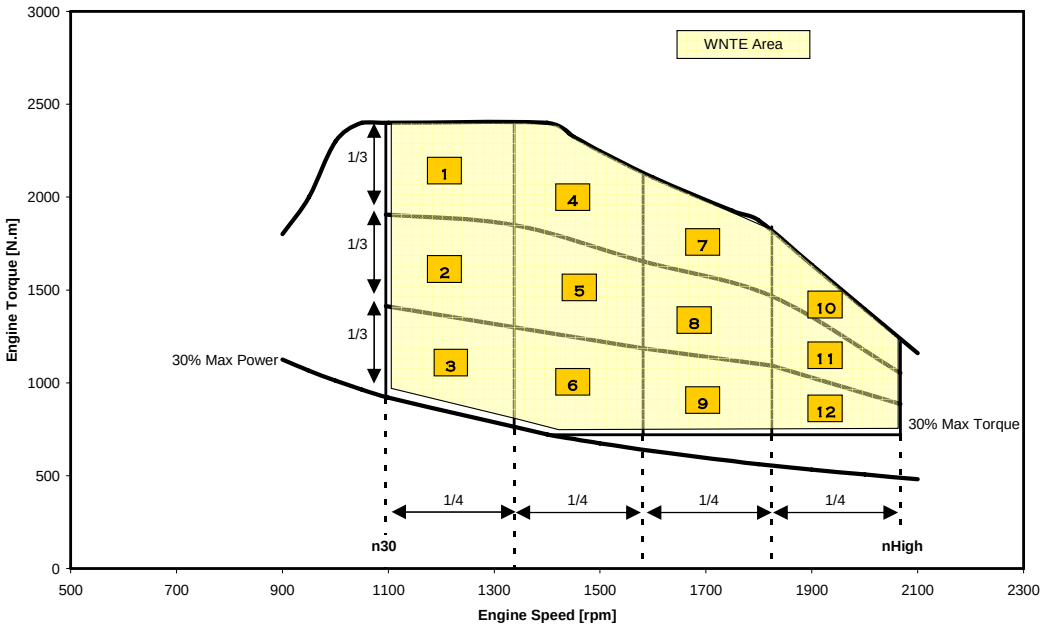


Figure 5: WNTE test cycle grid [new figure to be provided by EC]



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7.6. Rounding.

Each final test result shall be rounded in one step to the number of places to the right of the decimal point indicated by the applicable WHDC emission standard plus one additional significant figure, in accordance with ASTM E 29-06. No rounding of intermediate values leading to the final brake specific emission result is permitted.

8. WNTE deficiencies

The concept of a deficiency is to allow an engine or vehicle to be certified as compliant with a regulation even though specific requirements, limited in scope, are not fully met. A WNTE deficiency provision would allow a manufacturer to apply for relief from the WNTE emission requirements under limited conditions, such as extreme ambient temperatures and/or severe operation where vehicles do not accumulate significant mileage. Contracting parties may wish to consider providing WNTE deficiency provisions in regional legislation.

9. WNTE exemptions

The concept of an exemption, with respect to the WNTE, would be a set of technical conditions specified by a Contracting Party under which the WNTE limits set out in this gtr would not apply. A WNTE exemption shall apply to all engine and vehicle manufacturers.

A Contracting Party may decide to provide a WNTE exemption, in particular with the introduction of more stringent emission limits. For example a WNTE exemption may be necessary if a Contracting Party determines that certain engine or vehicle operation within the WNTE control area cannot achieve the WNTE emission limits. In such a case, the Contracting Party may determine that it is not necessary for engine manufacturers to request a WNTE deficiency for such operation, and that the granting of a WNTE exemption is appropriate. The Contracting Party can determine both the scope of the exemption with respect to the WNTE requirements, as well as the period of time for which the exemption is applicable.

10. Documentation for Application for Compliance *(or Annex)*

Sections 10.1 and 10.2 provide the minimum documentation requirements placed on the manufacturer for this gtr. Annex? provides more information that certification and type approval authorities may wish to consider requiring.

10.1 Statement of OCE compliance.

In the application for certification or type approval the manufacturer shall provide a statement that the engine family or vehicle complies with the requirements of this OCE gtr. In addition to this statement, compliance with the WNTE limits shall be verified through additional tests and certification procedures defined by the contracting parties.

10.1.1 Example statement of OCE compliance.

The following is an example compliance statement:
"(Name of manufacturer) attests that the engines within this engine family comply with all requirements of the OCE gtr. (Name of manufacturer) makes this statement in good faith, after having performed an appropriate engineering evaluation of the emissions performance of the engines within the engine family over the applicable range of operating and ambient conditions."

10.2 Basis for OCE compliance statement.

The manufacturer shall maintain records at the manufacturer's facility which contain all test data, engineering analyses, and other information which provides the basis for the OCE compliance statement. The manufacturer shall provide such information to the Certification or Type Approval Authority upon request.

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[Move the following paragraphs including 10.3, 10.4 to the Annex]

The basis for the OCE Compliance Statement shall be determined by the engine or vehicle manufacturer, and shall rely on data, engineering analysis, and other information sufficient for the manufacturer to have the confidence necessary to ensure compliance with the applicable portions of the OCE gtr. As an example, the basis for the Compliance Statement could include WHTC data, WHSC data or data from laboratory testing (e.g., an emissions map of similar resolution to the engine's base fuel injection timing map) under the conditions covered by the OCE gtr. Data generated from in-use highway vehicle testing could also be part of this combination, or depending upon the extent of the in-use data, it could be the primary basis for the Compliance Statement. This information is part of section 10.3 (b).

10.3 Documentation requirements related to Emission Control System

Editorial Comment: Include language in here about confidentiality (reference OBD gtr Section 8.1.1 Module B).
Editorial Comment: US EPA to review documentary requirements in the US regulations for comparative purposes.

The manufacturer shall provide a documentation package that describes any element of design and emission strategy of the engine system and the means by which it controls its output variables, whether that control is direct or indirect.

When a contracting party adopts this gtr into its implementing regulation it is recommended they consider documentation requirements related to AES, BES, Emission Control Strategy … as described below:

(a) the formal documentation package, which shall be supplied to the technical service at the time of submission of the type-approval/certification application, shall include a full description of the emission control strategy. This documentation may be brief, provided that it exhibits evidence that all outputs permitted by a matrix obtained from the range of control of the individual unit inputs have been identified. This information shall be attached to the documentation required in [CERTIFICATION SECTION];

(b) additional material that shows the parameters that are modified by any auxiliary emission control strategy (AES) and the boundary conditions under which the AES operates. The additional material shall include a description of the fuel system control logic, timing strategies and switch points during all modes of operation. The additional material shall also contain a justification for the use of any AES and include additional material and test data to demonstrate the effect on exhaust emissions of any AES installed to the engine or on the vehicle. The justification for the use of an AES may be based on test data and/or sound engineering analysis. This additional material shall be made available to the type-approval authority on request.

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At the option of the contracting party a manufacturer shall submit data generated from the following subsection at the time of certification or type approval.¶
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Editorial Note: the following sections have been drafted by OICA and the plenary group must determine if, how and where they are to be incorporated in text of gtr:¶
¶
7.2.1 For the WNTE mapping, … [63]

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Example of WNTE Limits for Selected Limit Values¶
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Pollutant ... [64]

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Means either

(a) an AECSAES that reduces the effectiveness of the emission control relative to the BECSBES under conditions that may reasonably be expected to be encountered in normal vehicle operation and use, unless:

- the operation of the AECSAES is substantially included in the applicable type approval or certification tests, including the WNTE requirements; or
- the AECSAES is activated for the purposes of protecting the engine and/or vehicle from damage or accident; or
- the AECSAES is only activated during engine starting or warm up; or
- the AECSAES is used to trade-off the control of one type of regulated emissions in order to maintain control of another type of regulated emissions under specific ambient or operating conditions not substantially included in the type approval or certification tests. The overall affect of such an AECSAES is to compensate for the effects of extreme ambient conditions in a manner that provides acceptable control of all regulated emissions

or

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(b) a BECSBES that discriminates between operation on an applicable type approval or certification test and other operations and provides a lesser level of emission control under conditions not substantially included in the applicable type approval or certification tests.

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Editorial comment: group should consider combining the element of design definition into the emission control strategy definition and eliminating element of design.

Group to consider including the defeat strategy definition diagram in the gtr as an Annex.

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Means hardware and software on a vehicle which has been developed or calibrated for the purpose of controlling emissions (e.g. particulate filter, charge air cooler, EGR cooler)

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(the WHDC gtr) have similar emission characteristics; all members of the family must comply with the applicable emission limit values

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Editorial Comment: refer to California OBD regulation for potential language

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;

Editorial comment: OICA is going to consider changes to the Engine System definition to make it consistent with the WHDC and OBD gtrs and any related changes to other definitions

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Editorial Comment: refer to California OBD/EU Directive/OBD gtr for potential language

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Steady State Engine Operation

Editorial comment: definition needed (referring to smoke requirements)

Transient Engine Operation [referring to smoke requirements]

means a period of operation during which engine speed and/or load are changing relatively quickly.

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Editorial Note: The following text from OICA is included so that the Plenary Group can review it for consideration.

Editorial Comment: pending discussion this OICA proposed section 5.1 Emission Control Strategy, we should consider whether we should have a single ambient operating (e.g. Section 6) region section that applies to the WNTE and the Emission Control Strategy

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Editorial comment: Chair requested that contracting parties, who have a type approval process and who requested additional clarity for the implementation of this gtr provide comment on how the prohibition on defeat strategies could be implemented by a type approval authority.

5.1 Emission Control Strategies [Editorial Comment: Alternative proposals should be provided to the w/g in advance of the next meeting]

5.1.1. Requirements for base emission control strategy

The base emission control strategy (BECS) shall be so designed as to enable the engine, in normal use, to comply with the provisions of this gtr. Normal use is not restricted to the conditions of use as specified in section 6.

5.1.1.1 . A (BES) shall not violate the prohibition of a defeat strategy

5.1.2. Requirements for auxiliary emission control strategy

An auxiliary emission control strategy (AECS) may be installed to an engine or on a vehicle provided that the AECS:

- operates only outside the conditions of use specified in section 6 or,
- is activated only temporarily within the conditions of use specified in section 6

5.1.2.1 An (AES) shall not violate the prohibition of a defeat strategy

5.1.2.2. An auxiliary emission control strategy (AECS) that operates within the conditions of use specified in section 6 and which results in the use of a different or modified emission control strategy (ECS) to that normally employed during the applicable emission test cycles will be permitted if it is fully demonstrated that the measure does not permanently reduce the effectiveness of the emission control system. In all other cases, such strategy shall be considered to be a defeat strategy.

5.1.2.3. An auxiliary emission control strategy (AECS) that operates outside the conditions of use specified in section 6 will be permitted if the manufacturer fully demonstrates that the measure is the minimum strategy necessary with respect to environmental protection and other technical aspects. In all other cases, such a strategy shall be considered to be a defeat strategy

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5.1.1 Any element of design and emission control strategy (ECS) liable to affect the emission of gaseous and particulate pollutants from diesel engines and the emission of gaseous pollutants from gas engines shall be so designed, constructed, assembled and installed as to enable the engine, in normal use, to comply with the provisions of this gtr. ECS consists of the base

emission control strategy (BECS) and usually one or more auxiliary emission control strategies (AECS).

5.1.2. Requirements for base emission control strategy

5.1.2.1. The base emission control strategy (BECS) shall be so designed as to enable the engine, in normal use, to comply with the provisions of this gtr. Normal use is not restricted to the conditions of use as specified in section 5.1.3.4.

5.1.3. Requirements for auxiliary emission control strategy

5.1.3.1. An auxiliary emission control strategy (AECS) may be installed to an engine or on a vehicle provided that the AECS:

operates only outside the conditions of use specified in section 5.1.3.4 for the purposes defined in paragraph 5.1.3.5 or,

is activated only temporarily within the conditions of use specified in section 5.1.3.4 for the purposes defined in section 5.1.3.5 and not longer than is needed for these purposes.

5.1.3.2. An auxiliary emission control strategy (AECS) that operates within the conditions of use specified in section 5.1.3.4 and which results in the use of a different or modified emission control strategy (ECS) to that normally employed during the applicable emission test cycles will be permitted if, in complying with the requirements of section 5.1.4, it is fully demonstrated that the measure does not permanently reduce the effectiveness of the emission control system. In all other cases, such strategy shall be considered to be a defeat strategy.

5.1.3.3. An auxiliary emission control strategy (AECS) that operates outside the conditions of use specified in section 5.1.3.4 will be permitted if the manufacturer fully demonstrates that the measure is the minimum strategy necessary for the purposes of section 5.1.3.5 with respect to environmental protection and other technical aspects. In all other cases, such a strategy shall be considered to be a defeat strategy.

5.1.3.4. As provided for in section 5.1.3.1, the following conditions of use apply under steady state and transient engine operations:

an altitude not exceeding 1 600 meters (or equivalent atmospheric pressure of 83.5 kPa), and,

an ambient temperature within the range 275 K to 308 K (2°C to 35°C) and,

engine coolant temperature within the range 343 K to 373 K (70°C to 100°C).

5.1.3.5. An auxiliary emission control strategy (AECS) may be installed to an engine, or on a vehicle, provided that:

the operation of the AECS is substantially included in the applicable test cycle, or,

the AECS is activated only by on-board signals for the purpose of protecting the engine system (including air-handling device protection) and/or vehicle from damage, or

the AECS is activated for purposes such as operational safety, permanent emission default modes and limp-home strategies, or

the AECS is activated for such purposes as excessive emissions prevention, cold start or warming-up, or

the AECS is used to trade-off the control of one regulated pollutant under specific ambient or operating conditions in order to maintain control of all other regulated pollutants within the emission limit values that are appropriate for the engine in question. The overall effects of such an AECS is to compensate for naturally occurring phenomena and do so in a manner that provides acceptable control of all emission constituents.

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~~**5.2.1** Exhaust emissions from an engine system shall not exceed the applicable WNTE emission limits when the engine is operated under the specified engine speed and load points defined by the WNTE Control Area. These emission limits apply to engine system use under the ambient conditions specified in section 6. The emissions are determined in accordance with the measurement procedures specified in section 7.~~

~~These emission limits apply to engine use which can reasonably be expected to be encountered in normal operation. The applicable ambient conditions are specified in section 6.0. The emissions are determined in accordance with the measurement procedures specified in section 7.0.~~

~~**5.2.2** The applicable WNTE emission limits shall be determined using the following formula~~

For the purposes of section 5.2.1, the applicable WNTE emission limits expressed in g/kWh for an engine shall be determined using the following formula

Editorial Comment: will insert the most recent proposal from OICA for consideration by group, including a new example table. [Inserted "OICA WNTE modified.doc" discussed on December 7, 2007. This proposal replaces the complete current section entitled 5.2 WNTE Limits for Gaseous and Particulate Exhaust Emissions shown in strikethrough text above and below this notation. On December 7, 2007 NL also presented "NL proposal for WNTE equations.doc and "Dutch proposal for simple equations.ppt"]

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5.2.1 Exhaust emissions from an engine shall not exceed the applicable WNTE emission limits when the engine is operated under the specified engine speed and load points defined by the WNTE Control Area in section 7. These emission limits apply to engine use under the ambient conditions specified in section 6. The emissions are determined in accordance with the measurement procedures specified in section 7.

5.2.2 For the purposes of section 5.2.1, the applicable WNTE emission limits expressed in g/kWh for an engine are defined, as follows:

WNTE Emission Limit =WHTC Emission Limit + WNTE Component (or Constituent)

where

"WHTC Emission Limit" is the emission limit (EL) to which the engine is certified pursuant to the WHTC test procedures expressed in g/kWh; and

"WNTE Component" is determined by equations 1 to 4 in section 5.2.3

5.2.3 The applicable WNTE Components expressed in g/kWh shall be determined using the following equations:

for NOx:	$WNTE\ Component = -0.02 * EL^2 + 0.3 * EL + 0.09$	(1)
for HC:	$WNTE\ Component = 0.15 * EL^2 + 0.1$	(2)
for CO:	$WNTE\ Component = 0.02 * EL^2 + 0.1 * EL + 0.2$	(3)
for PM:	$WNTE\ Component = 1.3 * EL^2 + 0.1 * EL + 0.004$	(4)

The WNTE Component shall be rounded to the number of places to the right of the decimal point indicated by the applicable emission limit, in accordance with ASTM E 29-04.

Examples of WNTE Components for current emission limits are shown in Annex I.

~~WNTE Emission Limit =WHTC Emission Limit + WNTE AdjustmentFactor~~

~~where~~

~~"WHTC Emission Limit" is the emission limit to which the engine is certified usingpursuant to the WHTC test procedures expressed in g/kWh; and~~

~~"WNTE Factor" is determined by reference to Table 1 and is based on the engine's WHTC Emission Limit~~

~~**Editorial comment: some consideration has to be given to rounding practices and significant figures**~~5.2.3 The applicable WNTE Adjustment~~s~~ expressed in g/kWh shall be determined using the following ~~equations~~:

~~for NOx: WNTE Adjustment = - 0.0248 * EL^2 + 0.2946 * EL + 0.0963 (1)~~
~~for HC: WNTE Adjustment = 0.15 * EL^2 + 0.01 * EL + 0.09 (2)~~
~~for CO: WNTE Adjustment = 0.025 * EL^2 + 0.1 * EL + 0.2 (3)~~
~~for PM: WNTE Adjustment = 1.25 * EL^2 + 0.0875 * EL + 0.005 (4)~~

~~The WNTE Adjustment shall be rounded to the number of places to the right of the decimal point indicated by the applicable emission limit, in accordance with ASTM E 29-04.~~

~~Examples of WNTE Adjustments for current emission limits are shown in Annex I.~~

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).[EPA to check consistency w NTE parameter]

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The WNTE emission limits apply within the ambient operating region specified in this Section.

Editorial comment: EMA and OICA would like the current altitude value to be expressed in an equivalent barometric pressure value and will look at data and bring forward a proposal to the group for consideration.

The WNTE emission limits apply at all altitudes less than or equal to 1700 meters above sea-level, for temperatures less than or equal to the temperature determined by the following equation at the specified altitude:

T = -0.00464 x A + 38

Where:

T = ambient air temperature in degrees Celsius

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

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Test Procedures Heading may need to change to remain consistent w possible changes in Suppart A

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Editorial comment: It should be noted that any engine with a unique torque curve will have a specific WNTE control area.

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Engine speed range. The WNTE control area shall include all operating speeds greater than the 30th percentile cumulative speed distribution over the WHTC test cycle (including idle). Figure x is a representative example of the WNTE speed range for an example engine.

Editorial comment: [Pplenary group should discuss if the there should be an upper limit in OICA proposal is acceptable]

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Editorial Comment: OICA will make a proposal to allow flexibility to apply the 30th percentile speed from the parent engine within a family to other engine family members under certain conditions.

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load

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or more

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[EU will be prepared at the next meeting to provide data and rationale to support their position to delete 7.1.3, also considering ramifications for current WHDC and WNTE adjustments.]

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Reinstatement of old 7.1.4 on CVT's can be justified by w/g members if required]

7.1.4 Additional WNTE Area Requirements for Vehicles Using Continuously Variable Transmission (CVT). All operating speed and load points with brake specific fuel consumption (BSFC) values within 5% of the minimum BSFC value of the engine are included in the WNTE control area when the engine is used in a vehicle with a continuously variable transmission. BFSC must be calculated under the general test cell conditions specified in [the WHDC gtr]. **[Editorial comment: include language to describe applicable test.**

Editorial Comment: Will insert WNTE control area speed and load diagram for engines with PM below "x g/kW-hr" in this location

7.1.5 Particulate matter engine speed and load carve-out. For engines certified to a WHTC PM emission limit greater than 0.07 g/kW-hr [**Editorial Comment: OICA has suggested 0.05g/kW-hr]**, speed and load points determined by using the applicable method described below shall be excluded from the WNTE Control Area for the purposes of compliance with the WNTE PM emission limits.

7.1.5.1 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 7.1.5.1.1 and 7.1.3.1.2:

7.1.5.1.1 30% of maximum torque or 30% of maximum power, whichever is greater, at the B speed; and

7.1.5.1.2 70% of maximum power at 100% speed (n_{hi})

7.1.5.2 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 7.1.5.2.1 and 7.1.3.2.2 and below the line formed by connecting the two points in Section 7.1.5.2.2 and 7.1.5.2.3:

7.1.5.2.1 30% of maximum torque or 30% of maximum power, whichever is greater, at the B speed;

7.1.5.2.2 50% of maximum power at 2400 rpm or B speed, whichever is greater **Editorial comment: this is a proposal from Japan**

7.1.5.2.3 70% of maximum power at 100% speed (n_{hi}).

7.1.5.3 Determining 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]*:

Editorial Comment: The method for determining the B and C speeds should be described herein or consider redefining in terms of the WHDC cumulative speed percentiles.

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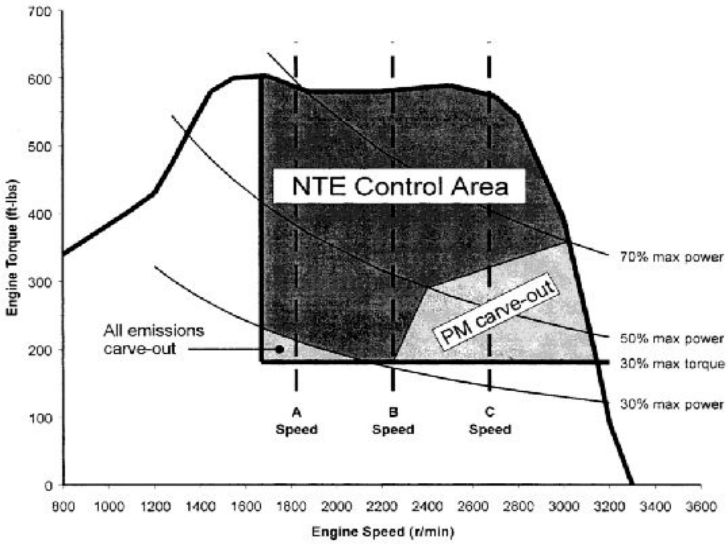

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particular engine-vehicle combinations and may petition

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during certification or type approval to

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(s)

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Editorial Comment: EMA to review this section with other EMA members to determine if this is a necessary provision. It was generally agreed that most other members of the Editorial Committee were neutral on keeping or deleting this provision.

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2 Minimum

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sampling period.

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When determining compliance with the emissions limits specified Section 5.2 and 5.3, an engine shall operate within the WNTE 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 7.2.2.

Editorial Comment: Include example. If the engine operates for 35 consecutive seconds within the WNTE conditions this could be construed to be a single WNTE event with one set of average emissions or this could be divided into 5 separate 30 second events each with its own set of average emission values.

Editorial comment: EMA and OICA support the single event interpretation[EU to study and provide feedback based on lab testing]

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Editorial Comment: EMA to draft additional language to clarify the regeneration requirements. EPA will also draft additional language to clarify these regeneration requirements.

~~7.2.3 WNTE Limited Testing Region Provision.~~

~~Manufacturers may request that the Certification or Type Approval Authority approve a limited testing region in a single defined region of speeds and loads within the WNTE control area. 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 a 40 second WNTE averaging period could be within the approved limited testing region. Such a defined region must generally be of elliptical or rectangular shape, and must share some portion of its torque/speed boundary with the torque/speed boundary of the WNTE control area. Approval of this limited testing region by the Certification or Type Approval Authority is contingent on the manufacturer satisfactorily demonstrating that operation at the speeds and loads within that region is projected to account 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.~~
[to be deleted at next meeting unless there are objections]

Editorial Comment: Most members of group are willing to eliminate this provision, EMA will provide further comments to group

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[Two testing proposals (OICA and EU) were brought to the plenary group for review]

[OICA WNTE laboratory testing proposal for discussion at the next meeting]

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For the first three years after an emission limit is implemented which results in a more stringent WNTE emission limit, a manufacturer may request from the Certification or Type Approval Authority a WNTE deficiency at the time of certification. The Certification or Type Approval Authority has the discretion to decide the duration of the WNTE deficiency, provided that the deficiency does not extend beyond the three year period.

8.2 Evaluation criteria.

Deficiencies will be granted only if compliance would be infeasible or unreasonable.

The certification authority shall take into consideration data from the manufacturer that details such factors as but not limited to:

technical feasibility of the given hardware;
lead time and production cycles including phase-in or phase-out of engines or vehicle designs; or
programmed upgrades of computers.

A WNTE deficiency may be granted 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.

Editorial Comment: Will look the EU 70/220/EEC – ANNEX XI, to see if additional evaluation criteria is available.

Editorial Comment: Explicitly 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 deficiency cause emissions to increase, how frequently the deficiency will activate in terms of vehicle miles traveled and/or % of operation etc.

8.3 Number of deficiencies.

The number of deficiencies allowed shall notcannot be greater than three per engine family.

Editorial Comment: Consider having an unlimited number of deficiencies, but a contracting party would have the option to cap the number of deficiencies granted per engine family.

8.4 Deficiency Descriptions.

For each engine family, for which a manufacturer is applying for a WNTE deficiency, the manufacturer's application shall include, as a minimum:

the specific power or torque rating(s) within the family for which the deficiency is being requested;
the specific description of the deficiency;
an explanation of why the deficiency is needed;
the pollutant(s) for which the deficiency is being applied for;
an explanation of the engineering efforts the manufacturer has made to overcome the need for the deficiency;
the specific engine and ambient operating conditions for which the deficiency is being requested (i.e. temperature ranges, humidity ranges, altitude ranges);
the frequency with which the deficiency will be used (i.e. % operation);
if applicable, the specific emission control strategy parameters that are modulated in response to the deficiency and the purpose of that modulation;
if applicable, a full description of the auxiliary emission control strategy which will be used to maintain emissions at the lowest practical level; and
data on the lowest practical emission level.
WNTE Exemptions

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This provision for Contracting Party specified WNTE exemptions is considered to be a transitional measure during the period of time when emission limits are not harmonized. With harmonized emission limits the WNTE Exemptions shall be specified in the gtr or eliminated, furthermore, the exemptions specified by a Contracting Party in its regional legislation should come to an end.

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Editorial Comment: compare this language to WHDC and OBD gtrs regarding future amendments to gtrs and the establishment of global emission limits.

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applicable WNTE emission limits in Section 5, when operating under all conditions which may reasonably be encountered in normal vehicle operation and use, and which are subject to the requirements of the WNTE regulation. For contracting parties that operate a type approval system for vehicles and/or engines, this compliance statement is the beginning of the authorization procedure.

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The manufacturer shall provide a statement which affirms that the engines and the engines control strategies within this engine family complies with the applicable WNTE emission limits when operating under all conditions which may reasonably be encountered in normal vehicle operation and use, and which are subject to the requirements of the WNTE regulation. The manufacturer shall make this statement on the basis of the engines emissions performance over a wide range of operating and ambient conditions.

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the applicable WNTE emission limits when operating under all conditions

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which may reasonably be encountered in normal vehicle operation and use, and which are subject to the requirements of the WNTE regulation

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Editorial Comment: status of compliance statement for the type approval process to be considered further

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, where such information exists.

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Editorial Note: the following sections have been drafted by OICA and the plenary group must determine if, how and where they are to be incorporated in text of gtr:

7.2.1 For the WNTE mapping, the engine shall be warmed up and then operated at a minimum of 20 steady-state test modes throughout the WNTE control area. A representative set of test modes shall be established by the manufacturer and approved by the type approval authority prior to the start of the test. The engine shall be operated with standard settings of inlet and exhaust restriction and at standard test cell temperature and humidity.

7.2.2 Upon completion of the WNTE map at the above test conditions, the 5 modes having the highest emissions shall be determined individually for each emission component, and those

modes shall repeated under a worst case sets of test conditions (e.g. high inlet temperature, high charge air cooler outlet temperature etc.).

7.5 Calculating WNTE emissions during steady-state operation in a laboratory.
Editorial Note: Initial suggestion from OICA to calculate WNTE emissions, taken from WHDC.

The emissions shall be calculated as follows:
Gas_{mass} = (u_{gas} x c_{gas} x q_{mew}) divided by P

$$PT_{mass} = \frac{m_f}{m_{sep}} \times \frac{\overline{q_{medf}}}{1000} \times P$$

Editorial Comment: terms used in equations must be defined by OICA

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Annex I

Example of WNTE Limits for Selected Limit Values

Pollutant	Emission Limit [g/kWh]	WNTE Component [g/kWh]	WNTE Limit [g/kWh]
NOx	3.5	0.9	4.4
	2.0	0.6	2.6
	1.5	0.5	2.0
	0.70	0.29	0.99
	0.40	0.21	0.61
	0.30	0.18	0.48
PM	0.13	0.04	0.17
	0.10	0.03	0.13
	0.07	0.02	0.09
	0.03	0.01	0.04
	0.02	0.01	0.03
	0.01	0.01	0.02
HC	0.78	0.19	0.97
	0.55	0.15	0.70
	0.46	0.13	0.59
	0.25	0.11	0.36
	0.19	0.11	0.30
	0.16	0.10	0.26
CO	20.8	10.9	31.7
	5.5	1.4	6.9
	4.0	1.0	5.0
	3.0	0.7	3.7
	2.2	0.5	2.7
	1.5	0.4	1.9