**PROPOSAL FOR AMENDMENT TO GLOBAL TECHNICAL REGULATION N° 4
(WHDC)**

The text reproduced below was prepared by the WHDC secretary in order to amend gtr n°4 in line with the WP.29/AC.3 mandate of November 2006. The modifications to the current text of the gtr are marked in *italic* characters. The text reflects
- the agreements reached by the informal working group on WHDC at its 25th meeting in October 2008,
- the WP.29/AC.3 decision on options 3 and 4 (document WP.29-145-07)
- alignment with the draft gtr on nonroad mobile machinery (status November 2008)

6.2.   Engines with charge air-cooling

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If a test laboratory system or external blower is used, *the coolant flow rate shall be set to achieve a* charge air temperature within ± 5 K of the maximum charge air temperature specified by the manufacturer at the rated speed and full load. Coolant temperature and coolant flow rate of the charge air cooler at the above set point shall not be changed for the whole test cycle, unless this results in unrepresentative overcooling of the charge air. The charge air cooler volume shall be based upon good engineering practice and shall be representative of the production engine's in-use installation.

If the engine manufacturer specifies pressure-drop limits across the charge-air cooling system, it shall be ensured that the pressure drop across the charge-air cooling system at engine conditions specified by the manufacturer is within the manufacturer's specified limit(s). The pressure drop shall be measured at the manufacturer's specified locations.

6.3.   Engine power

The basis of specific emissions measurement is uncorrected *net* power.

6.3.1.   General engine installation

The engine shall be submitted for testing with the auxiliaries needed for operating the engine (e.g. fan, water pump, etc.). Auxiliaries, which are only necessary for the operation of the vehicle and which may be mounted on the engine, shall be removed for the emissions test. The auxiliaries are listed in Annex 7.

If auxiliaries are not installed as required, their power shall be taken into account in accordance with paragraphs 6.3.2. to 6.3.4.

6.3.2.   Auxiliaries to be fitted for the emissions test

If it is inappropriate to install the auxiliaries needed for engine operation on the test bench, the power absorbed by them shall be determined and subtracted from the measured engine power over

the whole engine speed range of the WHTC and over the test speeds of the WHSC.

6.3.3.   Auxiliaries to be removed for the test

Where the auxiliaries only needed for operation of the vehicle cannot be removed, the power absorbed by them may be determined and added to the measured engine power over the whole engine speed range of the WHTC and over the test speeds of the WHSC. If this value is greater than 3 per cent of the maximum power at the test speed it shall be verified by the type approval or certification authority.

6.3.4.   Determination of auxiliary power

The power absorbed by the auxiliaries needs only be determined, if
(a) auxiliaries needed for operating the engine, are not fitted to the engine
and/or
(b) auxiliaries not needed for operating the engine, are fitted to the engine.

The measurement/calculation method of auxiliary power shall be submitted by the engine manufacturer for the whole operating area of the test cycles, and approved by the certification or type appproval authority.

6.3.4.   Reference power

The generation of the WHSC and WHTC reference cycles (see paragraph 7.6.) and the calculation of cycle work (see paragraph 7.7.1.) shall be based upon net engine power according to paragraph 6.3.1. In this case, P(a) and P(b) of equation 4 are zero.

If auxiliaries are installed according to paragraphs 6.3.2. and 6.3.3., the power absorbed by them shall be used to adjust the reference values and to calculate the cycle work, as follows:

$$P = P(e) + (P(a) - P(b)) \qquad\qquad (4)$$

where,
P   is the net engine power, kW
P(e)   is the measured engine power, kW
P(a)   is the power absorbed by auxiliaries to be fitted, kW
P(b)   is the power absorbed by auxiliaries to be removed, kW

6.4. Engine air intake system

An engine air intake system or a test laboratory system shall be used presenting an air intake restriction within ± 300 Pa of the maximum value specified by the manufacturer for a clean air cleaner at the rated speed and full load. *The static differential pressure of the restriction shall be measured at the location and at the speed and torque set points specified by the manufacturer.*

6.5. Engine exhaust system

An engine exhaust system or a test laboratory system shall be used presenting an exhaust backpressure within *80 to 100%* of the maximum value specified by the manufacturer at the rated speed and full load. The exhaust system shall conform to the requirements for exhaust gas sampling, as set out in paragraphs 8.3.2.2. and 8.3.3.2.

6.6. Engine with exhaust after-treatment system

If the engine is equipped with an exhaust after-treatment system, the exhaust pipe shall have the same diameter as found in-use for at least four pipe diameters upstream of the expansion section containing the after-treatment device. The distance from the exhaust manifold flange or turbocharger outlet to the exhaust after-treatment system shall be the same as in the vehicle configuration or within the distance specifications of the manufacturer. The exhaust backpressure or restriction shall follow the same criteria as above, and may be set with a valve. *For variable-restriction aftertreatment devices, the maximum exhaust restriction is defined at the aftertreatment condition (degreening/aging and regeneration/loading level) specified by the manufacturer. If the maximum restriction is 5 kPa or less, the set point shall be no less than 1.0 kPa from the maximum.* The after-treatment container may be removed during dummy tests and during engine mapping, and replaced with an equivalent container having an inactive catalyst support.

6.6.2. Periodic regeneration

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The manufacturer shall declare the normal parameter conditions under which the regeneration process occurs (soot load, temperature, exhaust back-pressure, etc.). *The manufacturer shall also provide the frequency of the regeneration event in terms of fraction of tests during which the regeneration occurs (F). The exact procedure to determine this fraction shall be agreed by the type approval or certification authority based upon good engineering judgement.*
……..

The hot start emissions shall be weighted as follows:

$$e_w = e_r \; x \; F + (1\text{-}F) \; x \; e \qquad\qquad (5)$$

where:

F *is the frequency of regeneration [-]*
e *is the average specific emission outside regeneration, g/kWh*
e_r *is the average specific emission during regeneration, g/kWh*

At the choice of the manufacturer and based on upon good engineering analysis, the regeneration adjustment factor k_r may be determined either multiplicative or additive as follows:

$$k_{\mathrm{r}} = \frac{e_{\mathrm{w}}}{e} \qquad (6)$$

or

$k_r = e_w - e$ *(upward)* $\qquad (7)$

$k_r = e_w - e_r$ *(downward)* $\qquad (8)$

With reference to paragraph 8.5. on brake specific emission calculations, the regeneration factor k_{r} :

(a)   shall be applied to the weighted WHTC test result of paragraph 8.5.2.2.,

(b)   may be applied to the WHSC and cold WHTC, if a regeneration occurs during the cycle,

(c)   may be extended to other members of the same engine family,

(d)   may be extended to other engine families using the same aftertreatment system with the prior approval of the type approval or certification authority based on technical evidence to be supplied by the manufacturer that the emissions are similar.

6.9.   <u>Specification of the reference fuel</u>

~~The use of one standardized reference fuel has always been considered as an ideal condition for ensuring the reproducibility of regulatory emission testing, and Contracting Parties are encouraged to use such fuel in their compliance testing. However, until performance requirements (i.e. limit values) have been introduced into this gtr, Contracting Parties to the 1998 Agreement are allowed to define their own reference fuel for their national legislation, to address the actual situation of market fuel for vehicles in use.~~

The diesel reference fuel listed in Annex 2 shall be used for testing. Since fuel characteristics influence the engine exhaust gas emission, the characteristics of the fuel used for the test shall be determined, recorded and declared with the results of the test.

No CNG and LPG reference fuels are listed due to the significant differences in local fuel qualities.

The fuel temperature shall be in accordance with the manufacturers recommendations.

7.1.   <u>Principles of emissions measurement</u>

To measure the brake-specific emissions, the engine shall be operated over the test cycles defined in paragraphs 7.2. and 7.3. The measurement of brake-specific emissions requires the determination of the mass of pollutants in the exhaust and the corresponding engine work.

In this gtr, two measurement principles are described that are functionally equivalent. Both principles *are based on a combination of the sampling methods described in paragraphs 7.1.1. and 7.1.2. and* may be used for both the WHTC and the WHSC test cycle:
……..

The following general sampling methods may be used:

7.1.1. Continuous sampling

In continuous sampling, the pollutant's concentration is measured continuously from raw or dilute

exhaust. This concentration is multiplied by the continuous (raw or dilute) exhaust flow rate at the emission sampling location to determine the pollutant's flow rate. The pollutant's emission is continuously summed over the test cycle. This sum is the total mass of the emitted constituent.

7.1.2. Batch sampling

In batch sampling, a sample of raw or dilute exhaust is continuously extracted and stored for later measurement. The extracted sample shall be proportional to the raw or dilute exhaust flow rate. Examples of batch sampling are collecting diluted gaseous emissions in a bag and collecting PM on a filter. The batch sampled concentrations are multiplied by the total mass or mass flow (raw or dilute) from which it was extracted during the test cycle. This product is the total mass or mass flow of the emitted constituent. To calculate the PM concentration, the PM deposited onto a filter from proportionally extracted exhaust shall be divided by the amount of filtered exhaust.

7.2.   Transient test cycle WHTC

The transient test cycle WHTC is listed in Annex 1 as a second-by-second sequence of normalized speed and torque values *applicable to all engines covered by this gtr*. In order to perform the test on an engine test cell, the normalized values shall be converted to the *reference* values for the individual engine under test based on the engine-mapping curve. The conversion is referred to as denormalization, and the test cycle so developed as the reference cycle of the engine to be tested. With those reference speed and torque values, the cycle shall be run on the test cell, and the actual speed, torque and power values shall be recorded. In order to validate the test run, a regression analysis between reference and actual speed, torque and power values shall be conducted upon completion of the test.

For calculation of the brake specific emissions, the actual cycle work shall be calculated by integrating actual engine power over the cycle. For cycle validation, the actual cycle work must be within prescribed limits of the cycle work of the reference cycle (reference cycle work).

For the gaseous pollutants, continuous sampling (raw or dilute exhaust gas) or batch sampling (dilute exhaust gas) may be used. The particulate sample shall be diluted with conditioned ambient air, and collected on a single suitable filter. The WHTC is shown schematically in figure 3.

7.3.   Ramped steady state test cycle WHSC

The ramped steady state test cycle WHSC consists of a number of normalized speed and load modes, *which cover the typical operating range of heavy duty engines, shall be converted to the reference values for the individual engine under test based on the engine-mapping curve. Mode 0 is not run, but is only accounted for mathematically by a weighting factor (WF) of 0.24 and zero emissions and power*. The engine shall be operated for the prescribed time in each mode, whereby engine speed and load shall be changed linearly within 20 seconds. In order to validate the test run, a regression analysis between reference and actual speed, torque and power values shall be conducted upon completion of the test.
During each mode and the ramps between the modes the concentration of each gaseous pollutant, exhaust flow and power output shall be determined, and the measured values averaged over the test cycle. The gaseous pollutants may be *determined by continuous sampling (raw or dilute exhaust gas) or batch sampling (dilute exhaust gas)*. The particulate sample shall be diluted with conditioned ambient air. *One sample over the complete test procedure shall be taken*, and collected on a single suitable filter.

For calculation of the brake specific emissions, the actual cycle work shall be calculated by integrating actual engine power over the cycle.

The WHSC is shown in table 1. The weighting factors (WF) are given for reference only. The idle mode is separated in two modes, mode 1 at the beginning and mode 13 at the end of the test cycle.

7.6.   Generation of the reference test cycle

The following denormalization procedures apply to both the WHTC and the WHSC.

7.6.1.   Denormalization of engine speed

The speed shall be denormalized using the following equation:

$$Reference \text{ speed} = n_{norm} \text{ x } (0.45 \text{ x } n_{lo} + 0.45 \text{ x } n_{pref} + 0.1 \text{ x } n_{hi} - n_{idle}) \text{ x } 2.0327 + n_{idle} \qquad (9)$$

7.6.2.   Denormalization of engine torque

The torque values in the engine dynamometer schedule of Annex 1 are normalized to the maximum torque at the respective speed. The torque values of the reference cycle shall be denormalized, using the mapping curve determined according to paragraph 7.5.2., as follows:

$$Reference \text{ torque} = \frac{per \text{ cent torque} \times max.\text{ torque}}{100} \qquad (10)$$

for the respective *reference* speed as determined in paragraph 7.6.1.

7.6.3.   Example of denormalization procedure

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results in:

$$reference \text{ speed} = \frac{43 \times (0.45 \times 1{,}015 + 0.45 \times 1{,}300 + 0.1 \times 2{,}200 - 600) \times 2.0327}{100} + 600$$
$$= 1{,}178 \text{ min}^{-1}$$

With the maximum torque of 700 Nm observed from the mapping curve at 1,178 min^{-1}

$$reference \text{ torque} = \frac{82 \times 700}{100} = 574 \text{ Nm}$$

7.7.   Validation of the test run

7.7.1.   Calculation of the cycle work

The work shall be determined over the test cycle by synchronously multiplying speed and torque to calculate instantaneous values for engine power. Engine power shall be integrated over the test cycle to determine total work.

Before calculating *actual* cycle work, any points recorded during engine starting shall be omitted. The *actual* cycle work W_{act} (kWh) shall be calculated based on *actual* engine ~~feedback~~ speed and torque values *from the test cycle*. The reference cycle work W_{ref} (kWh) shall be calculated based on *the* engine reference speed and torque values *determined according to paragraphs 7.6.1. and 7.6.2.* The actual cycle work W_{act} is used for comparison to the reference cycle work W_{ref} and for calculating the brake specific emissions (see paragraph 8.5.2.1.).

To align with the nonroad draft gtr and to better reflect the sequence of actions, the secretariat suggests revision of paragraph 7, as follows:

7.1	*Principles*
7.2	*Test cycles*
7.3	*Engine mapping*
7.4	*Reference cycle*
7.5	*Pre-test procedures*
7.6	*WHTC cycle run*
7.7	*WHSC cycle run*
7.8	*General test sequence*
7.9	*Post-test procedures*

8.3.3.   Particulate determination

8.3.3.1.   General requirements

The determination of the particulates requires dilution of the sample with filtered ambient air, synthetic air or nitrogen *(the diluent). The partial flow dilution system shall be set as follows:*
(a) completely eliminate water condensation in the dilution and sampling systems,
(b) maintain the temperature of the diluted exhaust gas between 315 K (42 °C) and 325 K (52 °C) within 20 cm upstream or downstream of the filter holder(s),
(c) the diluent temperature shall be ≥ 288 K (15 °C) in close proximity to the entrance into the dilution tunnel
(d) the minimum dilution ratio shall be within the range of 5:1 to 7:1 based on the maximum engine exhaust flow rate,
(e) the residence time in the system shall be between 1 and 5 seconds, as measured from the point of diluent introduction to the filter holder(s).

Dehumidifying the *diluent* before entering the dilution system is permitted, and especially useful if *diluent* humidity is high.

The partial flow dilution system has to be designed to extract a proportional raw exhaust sample from the engine exhaust stream, thus responding to excursions in the exhaust stream flow rate~~, and introduce dilution air to this sample to achieve a temperature between 315 K (42 °C) and 325 K (52 °C) at the test filter~~. For this it is essential that the dilution ratio or the sampling ratio r_d or r_s be determined such that the accuracy requirements of paragraph 9.4.4. are fulfilled.

To determine the mass of the particulates, a particulate sampling system, a particulate sampling filter, a microgram balance, and a temperature and humidity controlled weighing chamber, are required. The details of the system are described in paragraph 9.4.

8.4.3.   Particulate determination

8.4.3.1.   Introduction

The determination of the particulates requires ~~double~~ dilution of the sample with filtered ambient air, synthetic air or nitrogen *(the diluent)*. *The full flow ~~double~~ dilution system shall be set as follows*:
(a) completely eliminate water condensation in the dilution and sampling systems,
(b) maintain the temperature of the diluted exhaust gas between 315 K (42 °C) and 325 K (52 °C) within 20 cm upstream or downstream of the filter holder(s),
(c) the diluent temperature shall be ≥ 288 K (15 °C) in close proximity to the entrance into the dilution tunnel
(d) the minimum overall dilution ratio shall be within the range of 5:1 to 7:1 and at least 2:1 for the primary dilution stage based on the maximum engine exhaust flow rate,
(e) the overall residence time in the system shall be between 1 and 5 seconds, as measured from the point of diluent introduction to the filter holder(s),
(f) the residence time in the secondary dilution system shall be at least 0.5 seconds, as measured from the point of secondary diluent introduction to the filter holder(s).

Dehumidifying the *diluent* before entering the dilution system is permitted, and especially useful if *diluent* humidity is high.

To determine the mass of the particulates, a particulate sampling system, a particulate sampling filter, a microgram balance, and a temperature and humidity controlled weighing chamber, are required. The details of the system are described in paragraph 9.4.

~~8.5.2.2.   Exhaust after-treatment systems with periodic regeneration~~

Note: This paragraph is moved to paragraph 6.6.2.

9.3.3.1.   Pure gases

The required purity of the gases is defined by the contamination limits given below. The following gases shall be available for operation:

a)   For raw exhaust gas

Purified nitrogen
(Contamination ≤ 1 ppm C1, ≤ 1 ppm CO, ≤ 400 ppm CO_2, ≤ 0.1 ppm NO)

Purified oxygen
(Purity > 99.5 per cent vol O_2)

Hydrogen-helium mixture
(40 ± 2 per cent hydrogen, balance helium)
(Contamination ≤ 1 ppm C1, ≤ 400 ppm CO_2)

Purified synthetic air
(Contamination ≤ 1 ppm C1, ≤ 1 ppm CO, ≤ 400 ppm CO_2, ≤ 0.1 ppm NO)
(Oxygen content between 18-21 per cent vol.)

b)   For dilute exhaust gas (optionally for raw exhaust gas)

Purified nitrogen
(Contamination ≤ 0.05 ppm C1, ≤ 1 ppm CO, ≤ 10 ppm CO_2, ≤ 0.02 ppm NO)

Purified oxygen
(Purity > 99.5 per cent vol O_2)

Hydrogen-helium mixture
(40 ± 2 per cent hydrogen, balance helium)
(Contamination ≤ 0.05 ppm C1, ≤ 10 ppm CO_2)

Purified synthetic air
(Contamination ≤ 0.05 ppm C1, ≤ 1 ppm CO, ≤ 10 ppm CO_2, ≤ 0.02 ppm NO)
(Oxygen content between 20.5 - 21.5 per cent vol.)

9.3.9.2.3.   Maximum allowable quench
(a)   For raw measurement:
Combined CO_2 and water quench: 3 per cent of full scale
(b)   For dilute measurement:
Combined CO_2 and water quench: 2 per cent of full scale

9.4.2.   Particulate sampling filters

The diluted exhaust shall be sampled by a filter that meets the requirements of paragraphs 9.4.2.1. to 9.4.2.3. during the test sequence. ~~*Selection of the options in paragraphs 9.4.2.1. and 9.4.2.2. shall be decided by the Contracting Parties.*~~

9.4.2.1.   Filter specification

All filter types shall have a 0.3 µm DOP (di-octylphthalate) collection efficiency of at least 99 per cent. The filter material shall be either:
(a)   fluorocarbon (PTFE) coated glass fiber, or
(b)   fluorocarbon (PTFE) membrane.

9.4.2.2.   Filter size

The filter shall be circular with a nominal diameter of 47 mm (tolerance of 46.50 ± 0.6 mm) and an exposed diameter (filter stain diameter) of at least 38 mm.

9.4.2.3.   Filter face velocity

The face velocity through the filter shall *be between 0.90 and 1.00 m/s. The face velocity shall be measured as the volumetric flow rate of the sample at the pressure upstream of the filter and temperature of the filter face, divided by the filter's exposed area.*~~*The pressure drop increase between the beginning and the end of the test shall not exceed 25 kPa.*~~

9.4.3. Weighing chamber and analytical balance specifications

The chamber (or room) environment shall be free of any ambient contaminants *(such as dust, aerosol, or semi-volatile material) that could contaminate the particulate filters.* ~~Disturbances to weighing room specifications as outlined in paragraph 9.4.3.1. will be allowed if the duration of the disturbances does not exceed 30 minutes.~~ The weighing room shall meet the required specifications ~~prior to personal entrance into the weighing room~~ *for at least 60 min before weighing filters.*

9.4.3.1. Weighing chamber conditions

The temperature of the chamber (or room) in which the particulate filters are conditioned and weighed shall be maintained to within 295 K ± *1* K (22 °C ± *1* °C) during all filter conditioning and weighing. The humidity shall be maintained to a dew point of 282.5 K ± *1* K (9.5 °C ± *1* °C) and a relative humidity of 45 per cent ± 8 per cent. ~~*For sensitive balances, it is recommended that the tolerance for the weighing chamber room air temperature and the dew point be ± 1 K.*~~

If the stabilization and weighing environments are separate, the temperature of the stabilization environment shall be maintained at a tolerance of 295 K ± 3 K (22 °C ± 3 °C), but the dew point requirement remains at 282.5 K ± 1 K (9.5 °C ± 1 °C).

Dew point and ambient temperature shall be recorded.

9.4.3.2. Reference filter weighing

~~*The chamber (or room) environment shall be free of any ambient contaminants (such as dust) that would settle on the particulate filters during their stabilization. Disturbances to weighing room specifications as outlined in paragraph 9.4.3.1. will be allowed if the duration of the disturbances does not exceed 30 minutes. The weighing room shall meet the required specifications prior to personal entrance into the weighing room.*~~ At least two unused reference filters shall be weighed within 12 hours of, but preferably at the same time as the sample filter weighing. They shall be the ~~*same size and*~~ material as the sample filters.

If the average weight of the reference filters changes between sample filter weighings by more than 10 µg, all sample filters shall be discarded and the emissions test repeated.

9.4.3.3. Analytical balance

The analytical balance used to determine the filter weight shall meet the linearity verification criterion of paragraph 9.2., table 6. This implies a precision (standard deviation) of at least 2 µg and a resolution of at least 1 µg (1 digit = 1 µg).

The balance shall be installed as follows:
(a) installed on a vibration-isolation platform to isolate it from external noise and vibration.
(b) shielded from convective airflow with a static-dissipating draft shield that is electrically grounded.

9.4.3.4. Elimination of static electricity effects

The filter shall be neutralized prior to weighing, e.g. by a Polonium neutralizer or a device of similar effect. *The neutralizer shall be grounded in common with the balance. If a PTFE membrane filter is used, the static electricity shall be measured and is recommended to be within ± 2.0 V of neutral.*

In addition, static electric charge shall be minimized in the balance environment, as follows:
(a) The balance shall be electrically grounded.
(b) Stainless steel tweezers shall be used if PM samples must be handled manually.
(c) Tweezers shall be grounded with a grounding strap, or a grounding strap shall be provided for the operator such that the grounding strap shares a common ground with the balance. Grounding straps shall have an appropriate resistor to protect operators from accidental shock.

DIESEL REFERENCE FUEL

Parameter	Unit	Limits 1/		Test method 5/	
		Minimum	Maximum		
Cetene number		*45*	*55*	ISO 5165	
Density at 15 °C	kg/m^3	*835*	*845*	ISO 3675	
Distillation:				ISO 3405	
- 50 per cent vol.	°C	*243*	*295*		
~~- 95 per cent vol~~	~~°C~~	~~*345*~~	~~*350*~~		
- final boiling point	°C	*321*	*366*		
Flash point	°C	*50*		ISO 2719	
~~Cold filter plugging point~~	~~°C~~		~~*-5*~~	~~EN 116~~	
Kinematic viscosity at 40 °C	mm^2/s	*2.0*	*4.0*	ISO 3104	
Polycylic aromatic hydrocarbons	per cent m/m	2.0	6.0	EN 12916	
~~Conradson carbon residue (10 per cent DR)~~	~~per cent m/m~~		~~0.2~~	~~ISO 10370~~	
~~Ash content~~	~~per cent m/m~~		~~0.01~~	~~EN-ISO 6245~~	
Water content	per cent m/m		0.02	EN-ISO 12937	
Sulphur content	mg/kg		*15*	EN-ISO 14596	
Total aromatics	*per cent m/m*	*10*	*25*	*EN 12916*	
~~Copper corrosion at 50 °C~~			~~*1*~~	~~EN-ISO 2160~~	
Lubricity (HFRR wear scan diameter at 60 °C)	µm		400	EN ISO 12156	
~~Neutralisation number~~	~~mg KOH/g~~		~~0.02~~		
Oxidation stability @ 110°C 2/3/	*h*	*20*		*EN 14112*	
FAME 4/	*per cent v/v*	*4.5*	*5.5*	*EN 14078*	

1/ The values quoted in the specification are "true values". In establishment of their limit values the terms of ISO 4259 "Petroleum products - Determination and application of precision data in relation to methods of test.' have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R (R = reproducibility).

Notwithstanding this measure, which is necessary for statistical reasons, the manufacturer of fuels should nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the question as to whether a fuel meets the requirements of the specifications, the terms of ISO 4259 should be applied.

2/ *Even though oxidation stability is controlled, it is likely that shelf life will be limited. Advice shall be sought from the supplier as to storage conditions and life*

3/ *Oxidation stability can be demonstrated by EN-ISO 12205 or by EN 14112. This requirement shall be revised based on CEN/TC19 evaluations of oxidative stability performance and test limits.*

4/ *FAME quality according EN 14214 (ASTM D 6751)*

5/ *The latest version of the respective test method applies*

Annex 7

INSTALLATION OF AUXILIARIES FOR EMISSIONS TEST

Number	Auxiliaries	Fitted for emission test
1	Inlet system	
	Inlet manifold	Yes
	Crankcase emission control system	Yes
	Control devices for dual induction inlet manifold system	Yes
	Air flow meter	Yes
	Air inlet duct work	Yes
	Air filter	Yes
	Inlet silencer	Yes
	Speed-limiting device	Yes
2	Induction-heating device of inlet manifold	Yes, if possible to be set in the most favourable condition
3	Exhaust system	
	Exhaust manifold	Yes
	Connecting pipes	Yes
	Silencer	Yes
	Tail pipe	Yes
	Exhaust brake	No, or fully open
	Pressure charging device	Yes
4	Fuel supply pump	Yes
5	Equipment for gas engines	
	Electronic control system, air flow meter, etc.	Yes
	Pressure reducer	Yes
	Evaporator	Yes
	Mixer	Yes
6	Fuel injection equipment	
	Prefilter	Yes
	Filter	Yes
	Pump	Yes
	High-pressure pipe	Yes
	Injector	Yes
	Air inlet valve	Yes
	Electronic control system, sensors, etc.	Yes
	Governor/control system	Yes
	Automatic full-load stop for the control rack depending on atmospheric conditions	Yes

Number	Auxiliaries	Fitted for emission test
7	Liquid-cooling equipment	
	Radiator	No
	Fan	No
	Fan cowl	No
	Water pump	Yes
	Thermostat	Yes, may be fixed fully open
8	Air cooling	
	Cowl	No
	Fan or Blower	No
	Temperature-regulating device	No
9	Electrical equipment	
	Generator	No
	Coil or coils	Yes
	Wiring	Yes
	Electronic control system	Yes
10	Pressure charging equipment Compressor driven either directly by the engine and/or by the exhaust gases	Yes
	Charge air cooler	Yes, or test cell system
	Coolant pump or fan (engine-driven)	No
	Coolant flow control device	Yes
11	Anti-pollution device (exhaust after-treatment system)	Yes
12	Starting equipment	Yes, or test cell system
13	Lubricating oil pump	Yes