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Working Party on Pollution and Energy (GRPE)  
(Forty-third session, 15-18 January 2002,  
agenda item 8.)

PROPOSAL FOR A DRAFT REGULATION

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF INTERNAL COMBUSTION ENGINES  
TO BE INSTALLED IN AGRICULTURAL AND FORESTRY TRACTORS AND IN NON-ROAD  
MOBILE MACHINERY WITH REGARD TO THE MEASUREMENT OF THE NET POWER

Addendum 1

Transmitted by the Expert from Italy

Note: The text reproduced below was prepared by the expert from Italy in order to update his original proposal (TRANS/WP.29/GRPE/2001/4). It is based on a document distributed without a symbol (informal document No. 4), modified by the comments which had been noted during the forty-second session of GRPE (TRANS/WP.29/GRPE/42, paras. 40-42).

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Note: This document is distributed to the Experts on Pollution and Energy only.

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**A. PROPOSAL**

Title, amend to read:

"UNIFORM PROVISIONS CONCERNING THE APPROVAL OF INTERNAL COMBUSTION ENGINES  
TO BE INSTALLED IN AGRICULTURAL AND FORESTRY TRACTORS  
AND IN NON-ROAD MOBILE MACHINERY WITH REGARD TO  
THE MEASUREMENT OF THE NET POWER, NET TORQUE AND SPECIFIC FUEL CONSUMPTION."

Paragraph 1.1., amend to read:

- "1.1. This Regulation applies to the representation of the curves as a function of engine speed of the power, torque and specific fuel consumption at full load, indicated by the manufacturer for internal combustion engines to be used:
- in category T vehicles 1/,
  - in machinery intended and suited, to move, or to be moved on the ground, with or without road, operated under intermittent or constant speed.

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1/ As described in annex 7 of the Consolidated Resolution on the construction of Vehicles (R.E.3) (document TRANS/WP.29/78/Rev.1/Amend.2)."

Paragraph 1.2., should be deleted.

Paragraph 2.9., amend to read (footnote 2/ being deleted):

- "2.9. "Rated speed" means the maximum full load speed allowed by the governor as specified by the manufacturer;"

Insert new paragraph 2.10., to read:

- "2.10. "Maximum net power speed" means the engine speed at which the maximum net power is obtained, as specified by the manufacturer;"

Paragraphs 2.10. (former) and 2.11., renumber as paragraphs 2.11. and 2.12.

Paragraph 4.4.1., the reference to footnote 3/ and footnote 3/ renumber as footnote 2/.

Paragraph 4.8., amend to read:

- "4.8. Every engine conforming to an engine type or an engine family approved under this Regulation must bear, in addition to the approval mark:"

Paragraph 5.2.2., amend to read:

- "5.2.2. Measurements shall be taken at a sufficient number of engine speeds to define correctly the power, torque and specific fuel consumption curves between the lowest and the highest engine speeds recommended by the manufacturer. This range of speeds must include the rotational speeds at which the engine produces its rated net power, its maximum net power and its maximum net torque."

Paragraph 5.2.3.3.3., amend to read (inserting also new footnote 3/):

"5.2.3.3.3. In the case of an engine labelled for a specific range of fuels:

The fuel used shall be the one available on the market with the Wobbe Index at least  $52.6 \text{ MJm}^{-3}$  (20 °C, 101.3 kPa) if the engine is labelled for the H-range of gases, or at least  $47.2 \text{ MJm}^{-3}$  (20 °C, 101.3 kPa) if the engine is labelled for the L-range of gases. In case of dispute the fuel used shall be the reference fuel G20 specified in annex 7 if the engine is labelled for the H-range of gases, or the reference fuel G23 if the engine is labelled for the L-range of gases, i.e. the fuel with the highest Wobbe Index for the relevant range, or 3/

3/ "Wobbe Index (lower  $W_l$ ; or upper  $W_u$ )" means the ratio of the corresponding calorific value of a gas per unit volume and the square root of its relative density under the same reference conditions:

$$W = \frac{H_{\text{gas}}}{\sqrt{\rho_{\text{air}} / \rho_{\text{gas}}}}$$

"

Insert new paragraph 5.3.3., to read:

"5.3.3. Fuel consumption

The fuel consumption curve declared by the manufacturer for the type of engine (or parent engine) shall be accepted if it does not differ by more than  $\pm 8$  per cent at all measurement points from the values measured for the same points by the technical service on the engine submitted for testing."

Paragraph 5.3.3. (former), renumber as paragraph 5.3.4.

Annex 1, item 5., amend to read:

"5. List further attachments:

5.1. Appendix 1 / Appendix 2 / Appendix 3 1/

5.2. Declared power, torque and specific fuel consumption curves for engine/parent engine and engines within the family 1/

5.3. Any further attachments, if any: ....."

Annex 1 - Appendix 1,

Items 1.8. and 1.9., should be deleted.

Items 1.10. to 1.18., renumber as items 1.8. to 1.16.

Item 2., correct to read:

"2. ADDITIONAL ANTI-POLLUTION DEVICES (if any, and if not covered by another heading)"

Insert new item 8., to read:

"8. Engine performance (declared by the manufacturer)

Rated speed (min <sup>-1</sup> )	
Maximum power speed (min <sup>-1</sup> )	
Maximum torque speed (min <sup>-1</sup> )	
Rated net power (kW)	
Maximum net power (kW)	
Maximum net torque (Nm)	

"

Annex 1 appendix 2,

Item 1.8., amend to read (inserting also a new footnote 3/):

"1.8. Proof of identical (or lowest for the parent engine) ratio: system capacity/fuel delivery per stroke, pursuant to diagram number(s)3/:

3/ See annex 5, paragraph 1.9."

Item 2.2. (table), amend to read:

"

Specification	Engines of the family				Parent engine <u>1/</u>
Engine type					
No. of cylinders					
Rated speed (min <sup>-1</sup> )					
Fuel delivery per stroke (mm <sup>3</sup> ) for compression-ignition engines, fuel flow (g/h) for positive-ignition engines					
Rated net power (kW)					
Maximum net power (kW)					
Maximum power speed (min <sup>-1</sup> )					
Maximum torque speed (min <sup>-1</sup> )					
Fuel delivery per stroke (mm <sup>3</sup> )					
Maximum torque (Nm)					
Low idle speed (min <sup>-1</sup> )					
Cylinder displacement (in % of the largest one) (see annex 5.1.3)					

"

Annex 2, item 11.1., amend to read:

"11.1. Approved data"

Annex 4,

Paragraph 1., amend to read:

- "1. These provisions apply to the method for determining the power curve at full load of an internal combustion engine operated under intermittent speed as a function of engine speed and the rated speed and rated net power of an internal combustion engine operated under constant speed."

Paragraph 2.4., table 2, amend to read:

"Table 2

SETTING CONDITIONS

1. Setting of carburettor(s), evaporator/pressure regulator	In accordance with the manufacturer's production specifications, and used without further alteration for the particular application.
2. Setting of injection pump delivery system	
3. Ignition or injection timing (timing curve)	
4. Governor setting	
5. Emission control devices	
6. Boost control	

"

Paragraph 5.4.2., correct the formula to read:

$$a_d = (f_a)^{f_m}$$

Paragraph 5.4.2.1.2., amend to read:

"5.4.2.1.2. Turbocharged engines with or without charge air cooling"

Paragraph 5.4.2.1.3., should be deleted.

Paragraph 5.4.2.3., correct the formula to read:

$$0.93 \leq a_a \leq 1.07$$

Annex 4 - Appendix,

Item 1.1., amend to read:

"1.1. Location of exhaust back-pressure measuring point"

Items 1.1.1. to 1.1.6., should be deleted.

Item 1.2., amend to read:

"1.2. Location of inlet depression measuring point"

Items 1.2.1. to 1.2.5.2., should be deleted.

Item 4., amend to read (footnotes \*/ and 1/ and 2/ not modified):

"4. Detailed results of measurements \*/

Engine speed, min <sup>-1</sup>		
Measured torque, Nm		
Measured power, kW		
Measured fuel flow, g/h		
Barometric pressure, kPa		
Water vapour pressure, kPa		
Inlet air temperature, K		
Power to be added for equipment and auxiliaries in excess of Table 1, kW	No. 1 No. 2 No. 3	
Total, kW		
Power correction factor		
Corrected brake power, kW		
Net power, kW		
Net torque, Nm		
Corrected specific fuel consumption g/(kWh) <u>2/</u>		
Cooling liquid temperature at outlet, K		
Lubricating oil temperature at measuring point, K		
Air temperature after pressure-charger, K <u>1/</u>		
Fuel temperature at injection pump inlet, K		
Air temperature after charge air cooler, K <u>1/</u>		
Pressure after pressure-charger, kPa		
Pressure after charge air cooler, kPa		
Inlet depression, Pa		
Exhaust back-pressure, Pa		
Fuel delivery, mm <sup>3</sup> /stroke or cycle <u>1/</u>		

\*/ The characteristic ....."

Annex 5,

Title and the text below, amend to read:

"Annex 5

ESSENTIAL CHARACTERISTICS OF THE ENGINE FAMILY

1. PARAMETERS DEFINING THE ENGINE FAMILY

The engine family may be defined by basic design ..... must be common:"

Paragraphs 6.1. and 6.2., renumber as paragraphs 1.1. and 1.2.

Paragraph 6.3., renumber as paragraph 1.3., and amend to read:

"1.3. Individual cylinder displacement

Individual cylinder displacement, within 85 and 100 per cent of the largest displacement within the engine family."

Paragraphs 6.4. to 6.9., renumber as paragraphs 1.4. to 1.9.

Paragraphs 7. to 7.2., renumber as paragraphs 2. to 2.2., and amend to read:

"2. CHOICE OF THE PARENT ENGINE

2.1. In the case of diesel engines the parent engine of the family shall be selected using the primary criteria of the highest fuel delivery per stroke at the declared maximum torque speed.

In the event that two or more engines share this primary criteria, the parent engine shall be selected using the secondary criteria of highest fuel delivery per stroke at rated speed. Under certain circumstances, the approval authority may conclude that the worst case emission rate of the family can best be characterized by testing a second engine. Thus, the approval authority may select an additional engine for test based upon features that indicate that it may have the highest emission levels of the engines within that family.

2.2. In the case of S.I. engines the parent engine of the family shall be selected using the primary criteria of the fuel flow (g/h)."

Annex 6., amend to read:

"Annex 6

CHECKS ON CONFORMITY OF PRODUCTION

1. GENERAL

These requirements are consistent with tests to be held to check conformity of production, according to paragraph 6.2. of this Regulation.

2. TEST PROCEDURES

The methods of testing and measuring instruments shall be those described in annexe 4 to this Regulation.

3. COLLECTION OF SAMPLES

3.1 Case of an engine type

One engine has to be chosen. If after the test of paragraph 5.1. below, the engine is not considered as conforming to the requirements of this Regulation, two more engines have to be tested.

3.2 Case of a family of engines

In case of an approval granted to a family of engines the COP shall be run on one member of the family, which is not the parent engine.

In case of failure of the COP test, the two more engines shall be of the same member type.

#### 4. MEASUREMENT CRITERIA

##### 4.1. Net power and specific fuel consumption of internal combustion engine

Measurements shall be taken at a sufficient number of engine speeds to define correctly the power, torque and specific fuel consumption curves between the lowest and the highest engine speeds recommended by the manufacturer as defined in paragraph 5 of this Regulation.

The values measured by the technical service for the engine sampled shall not differ by more than  $\pm 5$  per cent for the net power (torque), and  $\pm 10\%$  for the specific fuel consumption, at all measurement points on the curve with a tolerance of  $\pm 5$  per cent for engine speed.

#### 5. EVALUATION OF RESULTS

If the net power and fuel consumption figures of the second and/or third engine of paragraph 3. do not fulfil the requirements of paragraph 4. above, the production shall be considered not to conform to the requirements of this Regulation and the provision of paragraph 7. of this Regulation shall be put into effect."

Annex 7, paragraphs 1. and 2. (including the respective notes), amend to read (note 3/ deleted):

##### "1. Technical data of the LPG reference fuels

Parameter	Unit	Limits Fuel A		Limits Fuel B		Test Method
		Minimum	Maximum	Minimum	Maximum	
Motor Octane Number	1	92,5 <sup>(1)</sup>		92,5		EN 589 Annex B
Composition:						
C3 content	% vol	48	52	83	87	ISO 7941
C4 content	% vol	48	52	13	17	
Olefins	% vol		12		14	
Evaporation residue	mg/kg		50		50	NFM 41-015
Total sulphur content	ppm mass <sup>(1)</sup>		50		50	EN 24260
Hydrogen sulphide	---		None		None	ISO 8819
Copper strip corrosion	rating		Class 1		class 1	ISO 6251 <sup>(2)</sup>
Water at 0°C			free		free	visual inspection

(1) Value to be determined at standard conditions 293,2 K (20 °C) and 101,3 kPa

(2) This method may not accurately determine the presence of corrosive materials if the sample contains corrosion inhibitors or other chemicals, which diminish the corrosivity of the sample to the copper strip. Therefore, the addition of such compounds for the sole purpose of biasing the test method is prohibited.

2. Technical data of NG reference fuels

European market fuels are available in two ranges:

- the H range, whose extreme reference fuels are GR and G<sub>23</sub>;
- the L range, whose extreme reference fuels are G<sub>23</sub> and G<sub>25</sub>.

The characteristics of GR, G<sub>23</sub> and G<sub>25</sub> reference fuels are summarised below:

Reference fuel GR					
Characteristics	Units	Basis	Limits		Test Method
			Minimum	Maximum	
<i>Composition:</i>					
Methane		87	84	89	
Ethane		13	11	15	
Balance <sup>(*)</sup>	%-mole	-	-	1	ISO 6974
Sulphur content	mg/m <sup>3</sup> <sup>(**)</sup>	-	-	10	ISO 6326-5

(\*) Inerts +C<sub>2+</sub>

(\*\*) Value to be determined at standard conditions (293.2 K (20°C) and 101.3 kPa).

Reference fuel G <sub>23</sub>					
Characteristics	Units	Basis	Limits		Test Method
			Minimum	Maximum	
<i>Composition:</i>					
Methane		92.5	91.5	93.5	
Balance <sup>(*)</sup>	%-mole	-	-	1	ISO 6974
N <sub>2</sub>		7.5	6.5	8.5	
Sulphur content	mg/m <sup>3</sup> <sup>(**)</sup>	-	-	10	ISO 6326-5

(\*) Inerts (different from N<sub>2</sub>) +C<sub>2</sub> +C<sub>2+</sub>

(\*\*) Value to be determined at standard conditions (293.2 K (20°C) and 101.3 kPa).

Reference fuel G25					
Characteristics	Units	Basis	Limits		Test Method
			Minimum	Maximum	
<i>Composition:</i>					
Methane		86	84	88	
Balance <sup>(*)</sup>	%-mole	-	-	1	ISO 6974
N <sub>2</sub>		14	12	16	
Sulphur content	mg/m <sup>3</sup> <sup>(**)</sup>	-	-	10	ISO 6326-5

<sup>(\*)</sup> Inerts (different from N<sub>2</sub>) +C<sub>2</sub> +C<sub>2+</sub>

<sup>(\*\*)</sup> Value to be determined at standard conditions (293.2 K (20°C) and 101.3 kPa)."

\* \* \*

## B. JUSTIFICATION

### 1. General remarks:

Since times have not been considered ripe for the adoption of a new definition of rated speed (in line with CFR 40 Part 94.107) it was decided to make the draft more consistent with the existing EU and US exhaust emission legislation by taking into account the already agreed technical amendments as the proposal under discussion at the EU institutions e.g.

- more detailed definition of engine families
- updated correction factors
- inclusion of gaseous reference fuels
- etc.

Obviously all the suggestions and comments put on the table by the various experts were taken into account.

### 2. Specific justifications:

Re. Title and paragraph 1.1.: It seems logical to indicate all the parameters approved under the specification of the present regulation.

Re. paragraph 1.2.: The deleted text was redundant.

Re. paragraph 2.9.: To reflect the state of the art of Regulation No. 96, see the general remarks.

Re. paragraph 2.10.: The parameter is necessary to complete information.

Re. paragraph 4.8.: Text improvement.

Re. paragraph 5.2.2.: Also torque and the specific fuel consumption are relevant data for this Regulation.

Re. paragraph 5.2.3.3.3.: To give a definition of the Wobbe index.

Re. paragraph 5.3.3.: To introduce the acceptance parameters for the specific fuel consumption curve by providing more realistic tolerances.

Re. Annex 1, item 5: To give a better indication on the use of the appendixes to Annex 1.

Re. Annex 1 - Appendix 1, items 1.8. and 1.9.: These data have been transferred to the table at the end of appendix 1, new item 8 described later.

Re. Annex 1 - Appendix 1, item 8: To complete the data to be declared for the (parent) engine.

Re. Annex 1 - Appendix 2, item 1.8.: To provide more accurate information.

Re. Annex 1 - Appendix 2, item 2.2. (table): To complete the information to be given.

Re. Annex 2, item 11.1.: This is the correct reference for this annex.

Re. Annex 4, paragraph 1.: To describe adequately the conditions for engines operating under constant speed.

Re. Annex 4, table 1, note b/: Correction of a typing error.

Re. Annex 4, paragraph 2.4. table 2: To describe the case of gas fuelled engines.

Re. Annex 4, paragraph 5.4.2.: Editorial, the original formula was wrongly typed.

Re. Annex 4, paragraphs 5.4.2.1.2. and 5.4.2.1.3.: To align with 97/68/EC.

Re. Annex 4, paragraph 5.4.2.3.: To update correction factor limits.

Re. Annex 4 - Appendix, items 1.1. to 1.2.5.2.: All the deleted data are already included in the table in item 4.

Re. Annex 4 - Appendix, item 4: Editorial improvement.

Re. annex 5 the first sentence after the title: To improve the structure of the text.

Re. Annex 5, paragraphs 6.1. and 6.2. (renumbered 1.1. and 1.2.): Corrections of typing errors.

Re. Annex 5, paragraph. 6.3. (renumbered 1.3.): To give a correct reference for the displacement tolerance, in line with the proposed amendment of 97/68/EC.

Re. Annex 5 paragraphs 7. to 7.2. (renumbered 2.1. to 2.2.): Corrections of typing errors and to give the criteria for S.I. engines.

Re. Annex 6.: To give a complete set of conditions for the parameters to be evaluated and correct criteria for the engine sampling. This procedure further places the accent on conformity of production controls aiming at the verifications of engines not tested during the initial approval.

Re. Annex 7, paragraphs 1. and 2.: Update the gaseous fuels specifications to the most recent evolution.

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