

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

Amendment 1 to document TRANS/WP.29/GRPE/2001/4

Transmitted by the Expert from Italy

Note: The text reproduced below was prepared by the expert from Italy following the engagements taken at the 41st session of the GRPE the document takes into account some written and oral suggestions presented by other delegations.

It consists in two parts:

1. Amendments proposed and their justification.
2. Copy of a note received from the Polish delegate. The note is completed by Italian comments.

PART 1

▪ **Amendment 1**

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."

Justification: It seems logical to indicate all the parameters approved under the specification of the present regulation

- **Amendment 2:** paragraph 1.1.

Amend to read: "1.1. This Regulation applies to the representation of the curve 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:" ... The rest unchanged.

Justification: same reason as Amendment 1

- **Amendment 3:** paragraph 1.2.

To be deleted

Justification: the text is redundant.

- **Amendment 4:** paragraph 2.9.

Amend to read:

2.9. "Rated speed" means the maximum full load speed allowed by the governor as specified by the manufacturer.; 2/
and the note 2/

2/ This definition shall be modified to follow Regulation No. 96 when the rated speed will be defined according to CFR 40 Part 94.10 Code of Federal Regulations of the United States of America.

Justification: To reflect the state of the art of Regulation R96, but give information about the possible development, to be adopted at the same time no to generate incoherence.

- **Amendment 5:** paragraph 2.10.

New texts

2.10. "Maximum net power speed" means the engine speed at which the maximum net power is obtained, as specified by the manufacturer; (Renumber following definitions)

Justification: The parameter is necessary to complete information

- **Amendment 6:** paragraphs 2.10. and 2.11.

To be renumbered as 2.11. and 2.12

Justification: Consequence of amendment 5

Amendment 7: 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:

Justification: Better text.

Amendment 8: 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."

Justification: Also torque and the specific fuel consumption are relevant data for this regulation.

- **Amendment 9 :** paragraph 5.2.3.3.3.

Amend to read:

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 MJm⁻³ (20° C, 101.3 kPa) if the engine is labeled for the H-range of gases, or at least 47.2 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 labeled 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 4/

4/ "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:

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

Justification: Give a definition for the Wobbe index.

- **Amendment 10:** paragraph 5.3.3.

Insert a new paragraph

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 ± 5 per cent at all measurement points from the values measured for the same points by the technical service on the engine submitted for testing."

Justification: Introduce the acceptance parameters for the specific fuel consumption curve.

- **Amendment 11:** paragraph 5.3.3.

To be renumbered as 5.3.4. and

Justification: Consequence of amendment 10

Amendment 12: annex 1 item 5

Amend to read:

- 5. List further attachments:
- 5.1. Appendix 1/Appendix 2 and 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 attachment (if any) 1/

Justification: give a better indication on the use of the appendixes to Annex 1.

Amendment 13 Annex 1 - Appendix 1 : items 1.8 and 1.9

To be deleted, and as a consequence items from 1.10 to 1.18 are to be renumbered

Justification: These data are given in the table.

- **Amendment 14:**annex 1 appendix 1 item 2

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

Justification: Editorial.

- **Amendment 15:** annex 1 appendix 1 after item 7 add new item 8

8.Engine performance (declared by the manufacturer)

Rated speed (min ⁻¹)	
Maximum power speed (min ⁻¹)	
Maximum torque speed (min ⁻¹)	
Rated net power (kW)	
Maximum net power (kW)	
Maximum net torque (Nm)	

Justification: Complete data to be declared for the (parent) engine.

- **Amendment 16:** annex 1 appendix 1 item 1.8

Amend to read:

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.

Justification: Give clarification

- **Amendment 17:** annex 1 appendix 2 item 2 (table)

Amend to read:

Specification	Engines of the family				Parent engine <u>1</u> /
Engine type					
No. Of cylinders					
Rated speed (min ⁻¹)					
Fuel delivery per stroke (mm ³) for compression-ignition engines, fuel flow (g/h) for positive-ignition engines					
Rated net power (kW)					
Maximum net power (kW)					
Maximum power speed (min ⁻¹)					
Maximum torque speed (min ⁻¹)					
Fuel delivery per stroke (mm ³)					
Maximum torque (Nm)					
Low idle speed (min ⁻¹)					
Cylinder displacement (in % of parent engine)					100

Justification: Complete information to be given.

- **Amendment 18:** annex 2 item 11.1

Amend to read:

"11.1. Approved data"

Justification: This is the correct reference for this annex.

- **Amendment 19:** annex 4 item 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"

Justification: Describe adequately the conditions for engines operating under constant speed.

- **Amendment 20:** annex 4 table 2

Amend to read:

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	

Justification: Describe the case of gas fuelled engines.

- **Amendment 21:** annex 4 item 5.4.2.

formula to be Corrected as follows

$$\hat{a}_d = (f_a)^{f_m}$$

Justification: editorial, the original formula had been wrongly typed.

- **Amendment 22:** annex 4 item 5.4.2.1.2.

formula to be Corrected as follows

$$f_a = \left(\frac{99}{p_s}\right)^{0.7} * \left(\frac{T}{298}\right)^{1.2}$$

Justification: same as above

- **Amendment 23:** annex 4 item 5.4.2.1.3.

formula to be Corrected as follows

$$f_a = \left(\frac{99}{p_d}\right)^{0.7} * \left(\frac{T}{298}\right)^{0.7}$$

Justification: same as above

- **Amendment 24:** annex 4 item 5.4.2.3

formula to be Corrected as follows

$$0.93 \leq \hat{a}_a \leq 1.07$$

Justification: Update correction factor limits.

Amendment 25: Annex-4 - Appendix items from 1.1. to 1.2.5.2.

Amend to read:

- 1.1. Location of exhaust back-pressure measuring point
 - 1.2. Location of inlet depression measuring point
- The rest unchanged

Justification: all the deleted data are already included in the table in item 4.

- **Amendment 26:** Annex-4 - Appendix item 4

Table under item 4: amend to read:

Engine speed, min ⁻¹		
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	
Total, kW	No. 3	
	(C)	
Power correction factor		
Corrected brake power, kW		
Net power, kW		
Net torque, Nm		
Corrected specific fuel consumption g/(kWh) 2/		
Cooling liquid temperature at outlet, K		
Lubricating oil temperature at measuring point, K		
Air temperature after pressure-charger, K 1/		
Fuel temperature at injection pump inlet, K		
Air temperature after charge air cooler, K 1/		
Pressure after pressure-charger, kPa		
Pressure after charge air cooler, kPa		
Inlet depression, Pa		
Exhaust back-pressure, Pa		
Fuel delivery, mm ³ /stroke or cycle 1/		

Justification: Editorial correction.

Amendment 27:annex 5 title:

Amend to read:

ESSENTIAL CHARACTERISTICS OF THE ENGINE FAMILY

Amendment 28: Annex 5 first sentence after the title(not numbered)
amend by adding number 1 and a title as follows:

1. PARAMETERS DEFINING THE ENGINE FAMILY" The rest unchanged

Justification: Improve the structure

Amendment 29: annex 5 paragraph 6.1., 6.2., and 6.3.
Renumber as 1.1., 1.2., and 1.3.

Justification: typing errors

Amendment 30: Annex 5 former paragraph 6.3. now 1.3.

Amend to read:

"1.3. Individual cylinder displacement

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

Justification: give a correct reference for the displacement tolerance, in line with the proposed amendment of 97/68/EC.

Amendment 31: annex 5 paragraph 7, 7.1., and 7.2

Renumber as 2, 2.1, and 2.2

Justification: typing errors

Amendment 32: Annex 5 former paragraphs 7.1. and 7.2. now 2.1 and 2.2.

amend to read:

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 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 which indicate that it may have the highest emission levels of the engines wit in 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).

Justification: give the criteria for S.I. engines.

▪ **Amendment 33:** Annex 6.

Replace all the annex with the following one:

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 ± 5 per cent for the net power (torque), and $\pm 7\%$ for the specific fuel consumption, at all measurement points on the curve with a tolerance of ± 2 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.

Justification: Give a complete set of conditions for the parameters to be evaluated and correct criteria for the engine sampling.

▪ **Amendment 34:**annex 7 items 1 and 2

Replaces the item 1 and 2 and the notes with the following ones:

"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		92,5 ⁽¹⁾		92,5		EN 589 Annex B
Composition						
C3 content	% vol	48	52	83	87	
C4 content	% vol	48	52	13	17	ISO 7941
Olefins	% vol		12		14	
Evaporation residue	mg/kg		50		50	NFM 41-015
Total sulphur content	ppm weight ⁽¹⁾		50		50	EN 24260
Hydrogen sulphide	---		None		None	ISO 8819
Copper strip corrosion	rating		Class 1		class 1	ISO 6251 ⁽²⁾
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 G₂₃;
- the L range, whose extreme reference fuels are G₂₃ and G₂₅.

The characteristics of GR, G₂₃ and G₂₅ 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 ^(*)	%-mole	-	-	1	ISO 6974
Sulphur content	mg/m ³ ^(**)	-	-	10	ISO 6326-5

(*) Inerts +C₂₊

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

Reference fuel G23					
Characteristics	Units	Basis	Limits		Test Method
			Minimum	Maximum	
<i>Composition:</i>					
Methane		92.5	91.5	93.5	
Balance ^(*)	%-mole	-	-	1	ISO 6974
N ₂		7.5	6.5	8.5	
Sulphur content	mg/m ³ ^(**)	-	-	10	ISO 6326-5

(*) Inerts (different from N₂) +C₂ +C₂₊

(**) 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 ^(*)	%-mole	-	-	1	ISO 6974
N ₂		14	12	16	
Sulphur content	mg/m ³ ^(**)	-	-	10	ISO 6326-5

(*) Inerts (different from N₂) +C₂ +C₂₊

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

Justification: Update the gaseous fuels specifications to the most recent evolution.

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Part 2

The list below is derived from the suggestions offered by the Polish delegate integrated with the Italian comments (*in italic and underlined*).

COMMENTS

TO 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

Transmitted by the expert from Poland

I. GENERAL

1. We have doubts that WP.29 and, consequently, GRPE have a mandate to set requirements for small SI engines intended to be fitted for instance in lawn mowers or chain saws. This problem should be clarified. In my view the scope of application of the proposed Regulation should be initially limited to engines covered by regulation 96. In the future when a new Regulation for small SI engines is developed, the proposed regulation could be parallelly revised.

This issue will be raised for discussion during the meeting.

However, further comments are made under assumption that the proposed Regulations will be applicable to such engines.

2. The proposed regulation is supposed to be applicable also to gas engines (par.5.2.3.), but the description of their fuel feed is not included in Annex 1, Appendix 1 - 3 and in Annex 5.

This issue will be raised for discussion during the meeting.

3. The performance to be verified are:

- rated net power;
- maximum net power;
- maximum net torque

but these performances are not consistently defined and listed in the text.

New definitions have been included.

II. SPECIFIC COMMENTS

1. Par 1, amend to read:

".....:

- used in category I **vehicles powered by a compression-ignition engine (having....."**
- justification: Regulation 96.

The scope of this Regulation should not be limited to compression ignition engines, a decision might be derived from the discussion about the power limits to be applied to the engine categories.

2. Para 1, amend to read:

".....operated under intermittent speed, including....."

Justification: Para 1.2 refers to engines operated under constant speed.

It was preferred to delete paragraph 1.2 with the same effect.

3. Insert a new paragraph 2.10 defining the wording "maximum (net) power speed"

See relevant amendment

4. Para 4.8, amend to read:

"The **Every** engine conforming to an engine type or an engine family approved a technical unit **under this Regulation must bear**....."

See relevant amendment

5. Para 5.2.3.2, amend to read:

".....engine produces its rated net power, maximum net power and its maximum net torque"

Justification: rated power must be also measured (see Annex 2, para 11.1.1); as regards "net" see the definitions

See relevant amendment

6. Annex 1, para 3

This paragraph seems to be redundant. The proposed Regulation is applicable to engines, not machinery. The required characteristics should be given in Appendix 1, para 1.17 and 1.18

This paragraph corresponds to item 1.3 Annex of directive 97/68/EC.

7. Annex 1, para 2.1 and 4. Amend to read:

".....of the **engine**/parent engine....."

Justification: see Annex 1, Appendix 1, title

It is coherent with 97/68/EC, the list of appendixes in annex 1 has been updated to clarify it.

8. Annex 1, Appendix 1, para 1.1, 1.1.2:

These two paragraphs seem to be redundant. The same information should be given in Annex 1, para 1.3, 1.5

It is coherent with 97/68/EC.

9. Annex 1, Appendix 1, para 1.8, 1.9. should be deleted

Justification: see item 10 below

Agree, in fact the reference to the curves to be declared has been included.

10. Annex 1, Appendix 1, insert a new paragraph 8

"8. Engine performance (declared by manufacturer)

Rated speed (RPM)	
Maximum power speed (rpm)	
Maximum torque speed (rpm)	
Rated net power (kW)	
Maximum net power (kW)	
Maximum net torque (Nm)	

Justification: The performances must be declared before they are approved
Agreed with further development

11. Annex 1, Appendix 2, para 1.8

Is the criterion "proof of identical....." applicable also to SI engines?

Note added.

12. Annex 1, Appendix 2, para 2.2.

Insert in the column "specification" also items "maximum net power" and "maximum power speed"

Justification: The performances must be declared before they are approved

Agreed see relevant amendment

13. Annex 2, para 11.1, amend to read:

"Declared Approved data"

Agreed see relevant amendment

14. Annex 4, para 1., amend to read:

".....combustion engine operated under intermittent speed as a function of engine speed and the rated net power of an internal combustion engine operated under constant speed"

Remark: It is desirable to specify in Annex 4 how to determine the rated speed.

Agreed see relevant amendment

15. Annex 4, para 2., table 2., amend to read:

"1. Setting of carburettor(s), evaporator/pressure regulator"

Justification: for some gas engines

Agreed see relevant amendment

16. Annex 4, Appendix, amend to read:

"1. TEST CONDITIONS

1.1. Location of exhaust back-pressure measuring point

1.2. Location of inlet depression measuring point"

Justification: Para 1.1. to 1.2.5.2. seem to be redundant. All required data are included in table in para 4

Agreed see relevant amendment

17. Annex 5, para 6.3

It is not clear how to calculate that the total spread does not exceed 15%. Should the spread (in cm³) be divided by the smallest, medium or largest displacement?

The provision as been modified in agreement with the latest amendment proposal of 97/68/EC.

18. Annex 5, para 7.7

No parameters for gas engines are listed.

These parameters depend from the ignition system rather than from the fuel.

19. Annex 5, para 7.1.

Are these criteria applicable to SI engines?

Updated according to the latest amendment proposal of 97/68/EC.

Annex 7, note (9)

The wording from 01 series of amendments to R.96 should be used (but the current wording is not correct)

The proposed wording is already in line with R 96/01 and 97/68/EC.
