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Agricultural and forestry tractors, non-road mobile machinery: UN Regulations Nos. 96 (Diesel emission (agricultural tractors)) and 120 (Net power of tractors and non-road mobile machinery)

Proposal for a new Supplement to the 02 series of amendments to UN Regulation No. 120 (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)

Submitted by the expert from Euromot *

The text reproduced below was prepared by the experts from the European Association of Internal Combustion Engine Manufacturers (EUROMOT). This document fixes spelling and typographic errors, as well as aiming to permit the use of hydrogen (H2) as fuel for 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. The modifications to the current text of the Regulation are marked in bold for new or strikethrough for deleted characters.

* In accordance with the programme of work of the Inland Transport Committee for 2023 as outlined in proposed programme budget for 2024 (A/78/6 (Sect. 20), table 20.5), the World Forum will develop, harmonize and update UN Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

I. Proposal

Paragraph 5.2.1., amend to read:

"5.2.1. The net power test shall consist of either**:**

(a) A run at full throttle for mechanically controlled positive ignition engines**;**

(b) A run at fixed full load fuel-injection-pump setting for mechanically controlled compression ignition engines; or

(c) A run at the required fuel system settings to produce the manufacturer specified power for electronically controlled engines.

The engine shall be equipped as specified in Table 1 of Annex 4 to this Regulation."

Paragraph 5.2.3., amend to read:

"5.2.3. The testing of an engine type or engine family shall be carried out by using the following reference fuels or fuel combinations described in Annex 7, as appropriate:

(a) Diesel;

(b) Petrol;

(c) Petrol/oil mixture, for two stroke SI engines;

(d) Natural gas/bio methane;

(e) Liquid petroleum gas (LPG);

(f) Ethanol;

(g) Hydrogen.

The engine type or engine family shall, in addition, meet the requirements set out in paragraph 5.1.1. in respect of any other specified fuels, fuel mixtures or fuel emulsions included by a manufacturer in an application for type- approval and described in Annex 1 to this Regulation."

Insert new Paragraph 5.4.2.1.3., to read:

"5.4.2.1.3. When a turbocharged engine is fitted with a system which allows compensating the ambient conditions temperature and altitude, at the request of the manufacturer, the correction factor $\alpha_{a\ or}\ \alpha_{d}$ shall be set to the value of 1."

Annex 1 - Appendix A1, paragraph 2.8.1., amend to read:

"2.8.1. Fuel Type [1]: Diesel (non-road gas-oil)/Ethanol for dedicated compression ignition engines (ED95)/Petrol (E10)/ Ethanol (E85)/(Natural gas/Biomethane)/Liquid Petroleum Gas (LPG) / **Hydrogen**"

Annex 1 - Appendix A1, paragraph 3.14.1., amend to read:

"3.14.1.	Fuel: LPG /NG-H/NG-L /NG-HL/LNG/Fuel specific LNG/**Hydrogen**"						

Annex 2, paragraph 2.8.1., amend to read:

"2.8.1. Fuel Type(s): Diesel (non-road gas-oil)/Ethanol for dedicated compression ignition engines (ED95)/Petrol (E10)/ Ethanol (E85)/(Natural gas/Biomethane)/Liquid Petroleum Gas (LPG) [2] / **Hydrogen**"

Annex 2 - Appendix A.1 - Template for Test Report A.1.3, insert new paragraph to read:

"4.5. Gaseous Fuel - Hydrogen

4.5.1. Make.....

4.5.2. Type.....

4.5.3. Grade.....

4.~~5~~**6**. Dual-fuel engine (in addition to relevant sections above)

4.~~5~~**6**.1. Gas energy ratio on test cycle: ....."

Annex 4, paragraph 3.10., amend to read:

"3.10. For C.I. engines, the fuel temperature shall be measured at the inlet of the fuel injection pump and maintained within 306 - 316 K (33-43 °C) for positive-ignition engines the fuel temperature shall be measured as near as possible to the inlet of the carburettor or **assembly** of fuel injectors and maintained within 293–303 K (20-30 °C)."

Annex 5, paragraph 2.3.6., amend to read:

"2.3.6. Fuel type

(a) Diesel (non-road gas-oil);

(b) Ethanol for dedicated compression ignition engines (ED95);

(c) Petrol (E10);

(d) Ethanol (E85);

(e) Natural gas/Biomethane:

(i) Universal fuel — high calorific fuel (H-gas) and low calorific fuel (L-gas);

(ii) Restricted fuel — high calorific fuel (H-gas);

(iii) Restricted fuel — low calorific fuel (L-gas);

(iv) Fuel specific (LNG);

(f) Liquid Petroleum Gas (LPG);

(g) Hydrogen"

Annex 7, insert new paragraph 3.3., to read:

3.3. Type: Hydrogen

Parameter	***Unit***	***Limits***		***Test method***
		Minimum	***Maximum***	
Hydrogen fuel index	**%**	**99.97**		[1]
Total non-hydrogen gases	**µmol/mol**		**300**	
Lists of non-hydrogen gases and the specification of each contaminant [6]:				
Water (H_2O)	**µmol/mol**		**5**	[5]
Total hydrocarbons except methane (C1 equivalent) [2]	**µmol/mol**		**2**	[5]
Methane (CH_4)	**µmol/mol**		**100**	[5]
Oxygen (O_2)	**µmol/mol**		**5**	[5]

Helium (He)	µmol/mol		300	5
Nitrogen (N_2)	µmol/mol		300	5
Argon (Ar)	µmol/mol		300	5
Carbon dioxide (CO_2)	µmol/mol		2	5
Carbon monoxide (CO) [3]	µmol/mol		0.2	5
Total sulphur compounds (H_2S basis) [4]	µmol/mol		0.004	5
Formaldehyde (HCHO)	µmol/mol		0.2	5
Formic acid (HCOOH)	µmol/mol		0.2	5
Ammonia (NH_3)	µmol/mol		0.1	5
Total halogenated compounds (Halogenate ion basis)	µmol/mol		0.05	5

Notes

[1] The hydrogen fuel index is determined by subtracting the "total non-hydrogen gases" in this table, expressed in mole per cent, from 100 mole per cent.

[2] Total hydrocarbons except methane include oxygenated organic species.

[3] The sum of measured CO, HCHO and HCOOH shall not exceed 0.2 µmol/mol

[4] As a minimum, total sulphur compounds include H2S, COS, CS2 and mercaptans, which are typically found in natural gas.

[5] Test method shall be documented. Test methods defined in ISO21087 are preferable.

[6] The analysis of specific contaminants depending on the production process shall be exempted. The manufacturer shall provide the approval authority reasons for exempting specific contaminants."

~~*Parameter*[1]~~	~~*Unit*~~	~~*Limits*~~	~~*Test method*~~
~~Minimum mole fraction of Hydrogen[2]~~	~~%~~	~~99.97~~	~~ISO 21087:2019~~
~~Total non-hydrogen gases (maximum~~	~~µmol/mol~~	~~300~~	~~ISO 21087:2019~~
~~Maximum individual contaminant concentrations:~~			
~~Water~~	~~µmol/mol~~	~~5~~	~~ISO 21087:2019~~
~~Total hydrocarbons except methane[3]~~	~~µmol/mol~~	~~2~~	~~ISO 21087:2019~~
~~Methane (CH4)~~	~~µmol/mol~~	~~100~~	~~ISO 21087:2019~~
~~Oxygen (O2)~~	~~µmol/mol~~	~~5~~	~~ISO 21087:2019~~

Helium (He)	µmol/mol	300	ISO 21087:2019
Nitrogen (N2)	µmol/mol	300	ISO 21087:2019
Argon (Ar)	µmol/mol	300	ISO 21087:2019
Carbon dioxide (CO2)	µmol/mol	2	ISO 21087:2019
Carbon monoxide (CO)[4]	µmol/mol	0.2	ISO 21087:2019
Total sulphur compounds (s1 equivalent) [5]	µmol/mol	0.004	ISO 21087:2019
Formaldehyde[4]	µmol/mol	0.2	ISO 21087:2019
Formic acid[4]	µmol/mol	0.2	ISO 21087:2019
Ammonia (NH3)	µmol/mol	0.1	ISO 21087:2019
Halogenated compounds (Halogen ion equivalent) [6]	µmol/mol	0.05	ISO 21087:2019
Maximum particulate concentrationg [7]	mg/kg	1	ISO 21087:2019

Notes:

[1] For the constituents that are additive, such as total hydrocarbons and total sulphur compounds, the sum of the constituents shall be less than or equal to the acceptable limit.

[2] The hydrogen fuel index is determined by subtracting the "total non-hydrogen gases" in this table, expressed in mole percent, from 100 mole percent.

[3] Total hydrocarbons except methane include oxygenated organic species. Total hydrocarbons except methane shall be measured on a C1 equivalent (µmol/mol).

[4] The sum of measured CO, HCHO and HCOOH shall not exceed 0.2 µmol/mol.

[5] As a minimum, total sulphur compounds include H2S, COS, CS2 and mercaptans, which are typically found in natural gas.

[6] All halogenated compounds which could potentially be in the hydrogen gas [for example, hydrogen chloride (HCl) and organic chlorides (R-Cl)] should be determined by the hydrogen quality control plan discussed in ISO 19880-8. Halogenated compounds shall be measured on a halogen ion equivalent (µmol/mol).

[7] Particulate includes solid and liquid particulates comprises of oil mist. Large particulates can cause issues with vehicle components and should be limited by using filter as specified in ISO 19880-1. No visible oil shall be found in fuel at a nozzle.