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Gaseous and Hydrogen Fuelled

Vehicles: Regulation No. 115

Proposal for an amendment to Regulation No. 115

Submitted by the Chair of the informal group on Gaseous Fuelled Vehicles*

The text reproduced below was prepared by the Chair of the informal group on Gaseous Fuelled Vehicles (GFV) to redefine the class of bi-fuel vehicles to permit the simultaneous use of gas and petrol in gas mode in Regulation No. 115. This document is based on Informal document GRPE-63-06-Rev.1, distributed at the sixty-third session of the Working Party on Pollution and Energy (GRPE) and updated as indicated in ECE/TRANS/WP.29/GRPE/63, paragraph 72. The modifications to the original English text are marked using track changes. The same modifications in the French and Russian versions are marked in bold for new or strikethrough for deleted characters.

* In accordance with the programme of work of the Inland Transport Committee for 2010–2014 (ECE/TRANS/208, para. 106 and ECE/TRANS/2010/8, programme activity 02.4), the World Forum will develop, harmonize and update Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

I. Proposal

Paragraphs 2.1.3. and 2.1.4., amend to read:

- "2.1.3. "A vehicle is considered *mono-fuel*" when, after the retrofit operation, **it is designed primarily for permanent running on LPG or CNG, but may still have a petrol system for emergency purposes, where the capacity of the petrol tank does not exceed 15 litres**~~it is equipped with a petrol tank of capacity ≤ 15 litres, that can only be used to "limp home"~~.
- 2.1.4. "A vehicle is considered *bi-fuel*" when after the retrofit ~~it is equipped to operate on both petrol and LPG or CNG, with a petrol tank capacity exceeding 15 litres~~**operation, it is equipped with a gas storage and a separate petrol storage with a capacity exceeding 15 litres, and is designed to run on only one fuel at a time. The simultaneous use of both fuels is limited in amount or duration.**"

Paragraph 6.1.2.2., amend to read:

- "6.1.2.2. Fuel requirements by the engine: the type of fuel normally used by the engine could be:
- (a) LPG only (**LPG model**) **in case of** ~~{mono-fuel}~~⁴;
 - (b) ~~Both~~-**Either** unleaded petrol (**petrol mode**) or LPG (**LPG mode**) **in case of** ~~{bi-fuel}~~;
 - (c) Both diesel fuel or diesel fuel and LPG (dual fuel).
- (Provisions for dual fuel have still to be defined)."

Paragraph 6.1.2.4.1.3., add a title to read:

"6.1.2.4.1.3. **Exhaust emissions test in petrol mode**

Subject to the requirements of paragraph 6.1.2.4.1.5., the tests shall be repeated three times using reference petrol. The parent vehicle(s), equipped with the retrofit system, shall comply with the limit values according to the type approval of the original vehicle(s) including the deterioration factors applied during the type approval of the original vehicle(s)."

Paragraph 6.1.2.4.1.6., add a title to read:

"6.1.2.4.1.6. **Exhaust emissions test in LPG mode**

Subject to the requirements of paragraph 6.1.2.4.1.8., the tests shall be repeated three times with each reference LPG. The parent vehicle, equipped with the retrofit system, shall comply with the limit values according to the type approval of the original vehicle(s) including the deterioration factors applied during the type approval of the original vehicle(s).

..."

Insert new paragraphs 6.1.2.4.1.6.1. to 6.1.2.4.1.6.3., to read:

"6.1.2.4.1.6.1. **Engine starting-up**

It is permissible that the engine is started on petrol and switched to LPG after a predetermined period of time which cannot be changed by the driver.

6.1.2.4.1.6.2. Use of petrol

If the parent vehicle complies with Regulation No. 83, 05 series of amendments, or with Directive 98/69/EC, or with Regulation No. 49, 04 series of amendments, or with Directive 1999/96/EC, the vehicle shall not use petrol for more than a maximum of 90 seconds during each test.

For vehicles complying with later series of amendments to Regulations Nos. 83 and 49, or later amending Directives or European Regulations, this period shall not exceed 60 seconds.

6.1.2.4.1.6.3. Special provisions for petrol direct injection engines

Notwithstanding the paragraph 6.1.2.4.1.6.2, in case of vehicles with petrol direct injection engines, it is permissible to use petrol only or simultaneously with LPG during the entire test cycle provided that the energy consumption of gas is higher than 80 per cent of the total amount of energy consumed during the test.

This percentage shall be calculated in accordance with the method set out in Annex 6A."

Paragraph 6.2.2.2., amend to read:

"6.2.2.2. Fuel requirements by the engine, the type of fuels normally used by the engine:

- (a) CNG only (**CNG mode**) in case of ~~{mono-fuel}~~⁴;
- (b) ~~Both~~ Either unleaded petrol (**petrol mode**) or CNG (**CNG mode**) in case of ~~{bi-fuel}~~;
- (c) Both diesel fuel or diesel fuel and CNG (dual fuel).

(Provisions for dual fuel have still to be defined)."

Paragraph 6.2.2.4.1.3., add a title to read:

"6.2.2.4.1.3. Exhaust emissions test in petrol mode

Subject to the requirements of paragraph 6.2.2.4.1.5. the tests shall be repeated three times using reference petrol. The parent vehicle(s), equipped with the retrofit system, shall comply with the limit values according to the type approval of the original vehicle(s) including the deterioration factors applied during the type approval of the original vehicle(s)."

Paragraph 6.2.2.4.1.6., add a title to read:

"6.2.2.4.1.6 Exhaust emissions test in CNG mode

Subject to the requirements of paragraph 6.2.2.4.1.8., the tests shall be repeated three times with each reference CNG. The parent vehicle(s), equipped with the retrofit system, shall comply with the limit values according to the type approval of the original vehicle(s) including the deterioration factors applied during the type approval of the original vehicle(s)."

Insert new paragraphs from 6.2.2.4.1.6.1. to 6.2.2.4.1.6.3., to read:

"6.2.2.4.1.6.1.Engine starting-up

It is permissible that the engine is started on petrol and switched to CNG after a predetermined period of time which cannot be changed by the driver.

6.2.2.4.1.6.2. Use of petrol

If the parent vehicle complies with Regulation No. 83, 05 series of amendments, or with Directive 98/69/EC, or with Regulation No. 49, 04 series of amendments, or with Directive 1999/96/EC, the vehicle shall not use petrol for more than a maximum of 90 seconds during each test.

For vehicles complying with later series of amendments to Regulations Nos. 83 and 49, or later amending Directives or European Regulations, this period shall not exceed 60 seconds.

6.2.2.4.1.6.3. Special provisions for petrol direct injection engines

Notwithstanding the paragraph 6.2.2.4.1.6.2, in case of vehicles with direct injection petrol engines, it is permissible to use petrol only or simultaneously with CNG during the entire test cycle provided that the energy consumption of gas is higher than 80 per cent of the total amount of energy consumed during the test.

This percentage shall be calculated in accordance with the method set out in Annex 6B."

Insert a new Annex 6A, to read:

"Annex 6A

Bi-fuel vehicles with petrol direct injection engines - Calculation of LPG energy ratio

1. Measurement of the LPG mass consumed during the cycle

Measurement of the LPG mass consumed during the Type I test cycle shall be done by a fuel weighing system capable to measure the weight of the LPG storage container during the test in accordance with the following:

an accuracy of ± 2 per cent of the difference between the readings at the beginning and at the end of the test or better.

Precautions shall be taken to avoid measurement errors.

Such precautions shall at least include the careful installation of the device according to the instrument manufacturers' recommendations and to good engineering practice.

Other measurement methods are permitted if an equivalent accuracy can be demonstrated.

2. Calculation of the LPG energy ratio

The fuel consumption value shall be calculated from the emissions of hydrocarbons, carbon monoxide, and carbon dioxide determined from the measurement results assuming that only LPG is burned during the test.

The LPG ratio of the energy consumed in the cycle is then determined as follows:

$$G_{LPG} = M_{LPG} * 100 / (FC_{mean} * dist * d) * 100\%$$

Where:

G_{LPG} : the LPG energy ratio;

M_{LPG} : the LPG mass consumed during the cycle (kg);

FC_{mean} : the mean fuel consumption calculated in accordance with paragraph 6.1.2.4.3.2.;

dist: distance travelled during the cycle (km);

d: density $d=0.538\text{kg/liter}$."

Insert a new Annex 6B, to read:

"Annex 6B

Bi-fuel vehicles with petrol direct injection engines - Calculation of CNG energy ratio

1. Measurement of the CNG mass consumed during the cycle

Measurement of the CNG mass consumed during the Type I test cycle shall be done by a fuel weighing system capable to measure the weight of the CNG storage container during the test in accordance with the following:

an accuracy of ± 2 per cent of the difference between the readings at the beginning and at the end of the test or better.

Precautions shall be taken to avoid measurement errors.

Such precautions shall at least include the careful installation of the device according to the instrument manufacturers' recommendations and to good engineering practice.

Other measurement methods are permitted if an equivalent accuracy can be demonstrated.

2. Calculation of the CNG energy ratio

The fuel consumption value shall be calculated from the emissions of hydrocarbons, carbon monoxide, and carbon dioxide determined from the measurement results assuming that only CNG is burned during the test.

The CNG ratio of the energy consumed in the cycle is then determined as follows:

$$G_{CNG} = M_{CNG} * 100 / (FC_{mean} * dist * d) * 100\%$$

Where:

G_{CNG} : the CNG energy ratio;

M_{CNG} : the CNG mass consumed during the cycle (kg);

FC_{mean}: the mean fuel consumption calculated in accordance with paragraph. 6.2.2.4.3.2.;

dist: distance travelled during the cycle (km);

d: density d=0.654kg/m³."

II. Justification

1. These modifications are needed primarily for the approval of retrofit systems intended to be fitted on vehicles equipped with petrol direct injection systems, where, in order to safeguard the petrol injectors, a certain amount of petrol needs to be injected also in gas mode, especially when particular temperature conditions are reached.
 2. In order to avoid over-employment of petrol, provisions are provided to limit its use in amount and duration.
 3. In particular, the limit of 60/90secs presently applied to the entire test cycle has been restricted to starting-up phase of the engine while, over the cycle, a minimum limit has been fixed to gas energy ratio.
 4. A standard calculation method of the gas energy ratio is provided, based on a direct measurement of the gas consumption and a conservative calculation of the total energy consumed during the cycle.
 5. This is founded on the assumption that only gas is burned during the cycle in line with what is already applicable in accordance with the present regulation (the use of petrol is allowed within the time limit of 60/90secs).
 6. Indeed, such an assumption ensures a conservative condition to the calculation of total energy consumed as well as of pollutant emissions.
 7. Correction factors of pollutant emissions are, in fact, only slightly dependent on fuel type and the error committed under this hypothesis is conservative - and negligible - with respect to the real case, where a minor use of petrol is done.
 8. Following the comment raised by the Polish expert in the GRPE sixty third session, the informal document GRPE-63-06-Rev.1 has been modified in order to limit the scope of the provisions of Paragraph 6.1.2.4.1.6.2 and 6.2.2.4.1.6.2 (see new Paragraph 6.1.2.4.1.6.3 and 6.2.2.4.1.6.3) only to vehicles with petrol direct injection engines.
 9. For further clarifications see document GFV-16-02.
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