INFORMAL GROUP ON GASEOUS FUEL VEHICLES

Within the UN GRPE (WP29)

PROPOSED WORK ITEM

Name of Organisation submitting Amendment/Work Item

AEGPL

Person submitting Item

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Regulation name and reference number

R.115

Name of Amendment/Work Item

New requirements for retrofit systems intended to be fitted on direct injection petrol vehicle

Specific language for Amendment/Work Item

English

Rationale: (Why is it important/required?)

The proposal of amendment aims at introducing new requirements for the type-approval of retrofit systems intended to be fitted on direct injection petrol vehicles.

Specific provisions are necessary since, in order to safeguard the petrol injectors, a certain amount of petrol need to be injected also in gas mode, especially when particular temperature conditions are reached.

Therefore, the total injection time on the entire test cycle could exceed the time limits currently set out for ordinary bi-fuel systems (90secs for Euro 3-4 and 60secs for Euro 5-6).

Notwithstanding that, the use of petrol remains limited, not being used as energy support but only for functional purposes.

At this regard and in order to avoid a misuse of petrol during the test cycle, the proposal prescribes an energy range limit to be met during the Type 1 test in gas mode.

The new Annex 6 provides a methodology to evaluate the respect of such an energy range limit, basing on formulas elaborated in the document GFV-10-02.

With regard to emission results, it is evident that only THC are influenced by fuel dependent parameters.

Yet, in the light of the conclusions of GFV 10-06 considering the cycle fully driven on gas - as presently required for ordinary bi-fuel systems - represents a conservative condition for correction factors calculation.

This assertion is likewise valid also in the case of consumption calculation.

In conclusion, for retrofit systems intended to be fitted on direct injection petrol vehicles, no specific rules have been defined for emissions and fuel consumption calculation, while a limitation for total cycle petrol energy utilization has been proposed together with its calculation method.

Analysis/testing or data requirements to support the Amendment/Work item

1. Amend the par 2.14 as follows:

"2.1.4. "A vehicle is considered bi-fuel", when after the retrofit, it is equipped to operate on both petrol **(petrol mode)** and LPG or CNG **(LPG or CNG mode),** with a petrol tank capacity exceeding 15 litres**; in LPG or CNG mode a limited use of petrol is also permitted."**

2. Amend the par. 6.1.2.2., letter (b), as follows:

" …….

(b) both unleaded petrol or LPG (bi-fuel)[1]**;**

……."

Adding the related new footnote as follows:

"[1]**In accordance with the definition of bi-fuel vehicle of par. 2.1.4, in LPG mode a limited use of petrol is also permitted."**

3. Amend the par 6.1.2.4.1.6 as follows:

"6.1.2.4.1.6 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).

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.

In case of LPG retrofit systems intended to be installed on vehicles powered on petrol through a direct injection feeding system, the time periods set out above shall not apply, provided that, during the entire test cycle, the energy use of petrol does not exceed 20% of the total energy consumed.
This percentage shall be evaluated in accordance with the methodology provided in Annex 6."

4. Insert a new annex 6 as follows:

"Annex 6

The condition as referred in para. 6.1.2.4.1.6. of the present regulation shall be evaluated as follows:

$$E_{petrol} <= 20\% * (E_{petrol} + E_{lpg})$$

Where:

$$E_{petrol} = FC_{petrol} * d * 100^{-1} * D_{petrol} * H_{petrol}$$
$$E_{lpg} = FC_{lpg} * d * 100^{-1} * D_{lpg} * H_{lpg}$$

$$FC_{petrol} = W_{petrol}\ (0.1154 / D_{petrol}) \cdot [0.866 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO_2)]$$

$$FC_{lpg} = W_{lpg}\ (0.1212 / D_{lpg}) \cdot [(0.825 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO_2)]$$

$$W_{petrol} = M_{petrol} / (M_{petrol} + M_{lpg})$$
$$W_{lpg} = M_{lpg} / (M_{petrol} + M_{lpg})$$

$$M_{petrol} = M^1_{petrol} - [H_{lpg} * C_{petrol} * M^1_{petrol} - CO_2)] / (C_{petrol} * H_{lpg} - C_{lpg} * H_{petrol})$$
$$M_{lpg} = [H_{petrol} * (C_{petrol} * M^1_{petrol} - CO_2)] / (C_{petrol} * H_{lpg} - C_{lpg} * H_{petrol})$$

HC, CO and CO2 = emission results of the test cycle in LPG mode

M_{petrol} **= mass of petrol consumed in the test cycle in LPG mode (kg)**
M_{lpg} **= mass of LPG consumed in the test cycle in LPG mode (kg)**
M^1_{petrol} **=mass of petrol consumed in the test cycle in petrol mode (kg)**

$C_{petrol} = 1/[0.1154 * 0.273 * d * 100^{-1}]$ **(g * km^{-1} * kg^{-1})**
$C_{lpg} = 1/[0.1212 * 0.273 * d * 100^{-1}]$ **(g * km^{-1} * kg^{-1})**

d = distance travelled during the test cycle (km)

H_{lpg} **= lower heating value of LPG (MJ/kg)**
H_{petrol} **=lower heating value of petrol (MJ/kg)**

D_{petrol} **= density of petrol as defined in R.101 (kg/litre)**
D_{lpg} **= density of LPG as defined in R.101 (kg/litre)"**