GFV-xx.xx

INFORMAL GROUP ON GASEOUS FUEL VEHICLES
Within the UN GRPE (WP29)

Name of Organisation submitting Amendment/Work Item
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Regulation name and reference number
Regulation 83

Name of Amendment/Work Item
Amendment on Regulation R83 and document GRPE Working Document ECE/TRANS/WP.29/GRPE/2012/6 regarding the use of petrol in gas mode and its limitation for bi fuel gas vehicles and the verification during type approval.

Rationale: (Why is it important/required?)

In "Working Document ECE/TRANS/WP.29/GRPE/2012/6" it is proposed to amend regulation R83 in view of the type approval of gas fuelled vehicles. The proposed amendments are aimed at redefining the class of bi-fuel vehicles to permit the simultaneous use of gas and petrol in gas mode.
These modifications are needed primarily for the approval of some bi-fuel vehicles equipped with petrol direct injection systems, where, in order to safeguard the petrol injectors, a certain amount of petrol may need to be injected also in gas mode, especially when particular temperature conditions are reached.
In order to avoid over-employment of petrol, provisions are provided to limit its use in amount and duration.
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
In Appendix 1 and 2 of this document, it is proposed to determine the amount of consumed fuel during the type 1 test by measuring the weight of an additional external fuel tank for the gaseous fuel (NG or LPG or H2).
From the CLEPA point of view this procedure might entail practical and safety problems during development and type approval. For that reason CLEPA proposes an alternative procedure in order to determine the fuel consumption of petrol and the gaseous fuel in the test cycle as an equivalent option as a new Appendix 3.

Justification
The test procedure described in GRPE Working Document ECE/TRANS/WP.29/GRPE/2012/6 was evaluated by automotive suppliers (CLEPA members) as well car manufacturer's test center departments and it was concluded, that the weighing of gas tanks might entail practical and safety issues for several reasons.

- The additional and separate gas fuel tank which has to be stored in the test cell during type approval might lead to safety problems. The gas tank has to be connected to the vehicle where gas leakages might occur during connecting or disconnecting. Then the test cell would be contaminated with additional HC background emission. In addition to that the risk of fire or explosions could occur.
- Current safety regulations do not allow the separate gas tank to stay in the test cell over night without observation.
- The fill up procedure before the test and the draining of the gas tank after the test can lead to very high efforts, as safety regulations do not allow the transport of unsecured gas tanks on public roads. The practical problem arises how to fill a small NG or LPG gas tank if no on-site refueling facility is available.
- The disconnection of NG/LPG fuel hoses from and to the vehicle might present a safety risk because especially for liquid LPG injection systems a high leakage rate can occur.
- LPG liquid fuel injection requires a fuel pump which is mounted inside the tank. Therefore, also a fuel pump has to be available inside the reference tank for weighing.
- The connection of hoses and tubes to the tank can lead to errors during weighing of the fuel tank, as it is difficult to determine the full weight of the hoses and tubes.
- Additional costs for the type approval for the tank installation, the weighing and safety equipment and continuous costs for maintenance will occur.

If a manufacturer wants to avoid these practical and safety issues, the proposal permits to use other measurement methods if an equivalent accuracy can be demonstrated.

CLEPA proposes as an alternative method to calculate the fuel consumption (or fuel mass M_{petrol} and M_{gas} (NG or LPG or H_2)) by the ECU based on the injection time and flow rate through the fuel injectors. Usually, these values should be available in the ECU or in the additional gas control unit (GCU).

The integral fuel masses, calculated in a driving cycle after ignition key-on shall be provided to the Generic SCAN tool (J1979 / ISO 15031-5) as a new PID:

• The integral engine fuel consumption (FC) of M_{petrol} and of M_{gas} is calculated since ignition key-on in a resolution of 2 Byte, 0 …FFFF = 0 … 32769 g and a resolution of 0,5 g = 500 mg.
• The ECU internal resolution of FC accumulation shall be as high as the injection output in order not to miss any injected fuel quantity.
• The update rate for M_{petrol} and of M_{gas} send to the scan tool shall be <=1 s.
• The integral fuel consumption is reset at ignition key-on event when the engine speed = 0 rpm.

As an example, figure 1 is showing a comparison of fuel consumption measurement (modal data) in the NEDC for a vehicle equipped with a mono-fuel CNG engine.

- Firstly the FC was determined by the exhaust gas measurement system using the CO_2 measurement data (carbon balance method) in the test center.
- Secondly the FC was calculated from the injected fuel mass in the engine control unit.
It can be seen, that the results from both measurement systems show the same behavior.

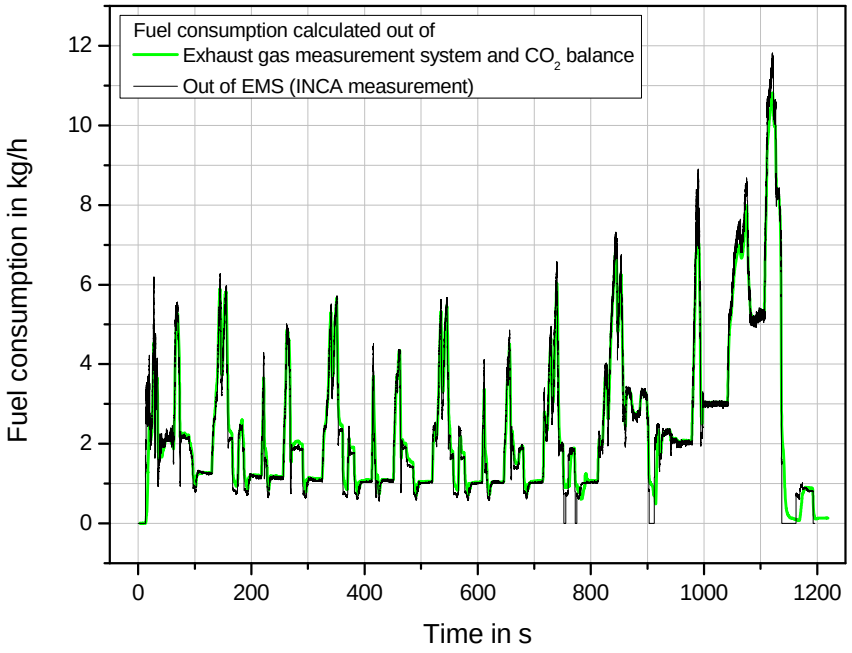

Figure 1: Comparison of fuel consumption measurement in the NEDC.

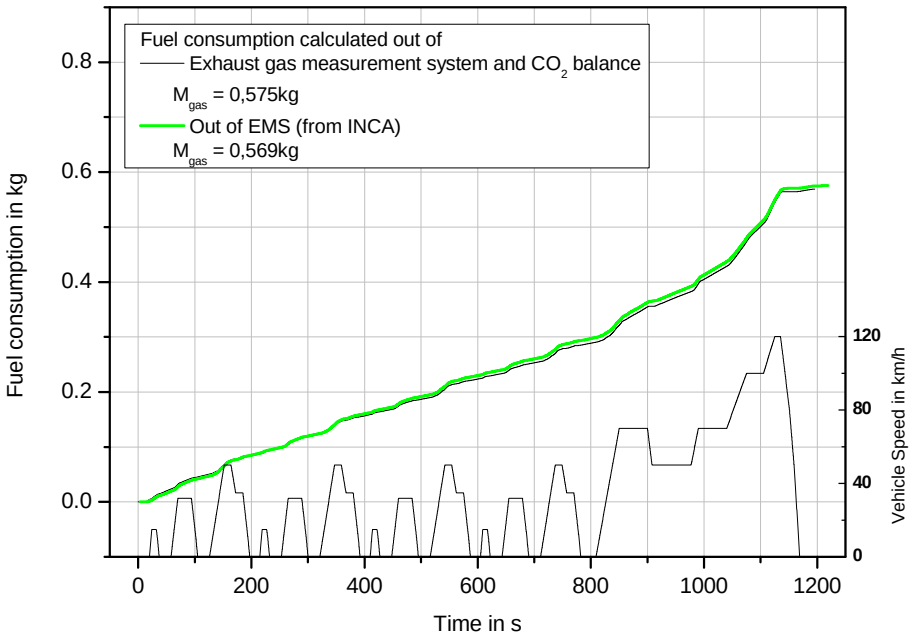

Figure 2: Integrated values of fuel consumption measurement in the NEDC.

In figure 2, the modal FC values in kg/h were integrated to a total FC in kg over the whole cycle. Here it can be seen, that the deviation is below 2% of the overall injected fuel mass.

Required Additional Efforts:

- A new PID has to be requested at the SAE J1979-community.
  (Note: All vehicles certified according to ECE-R83 have to support ISO 15031-5 = SAE J1979 "E/E Diagnostic Test Modes")
- The new PID has to be implemented into the ECU or the GCU only for gas fuelled vehicles

Advantages of the proposed method:

- No use and weighing of an external and separate gas tank (NG or LPG or H2).
- M_{Petrol} could be easily verified by comparison with the Fuel Consumption calculated based on the bag analysis (of a test run on petrol only).
- M_{Petrol} and M_{Gas} could be verified by calculation of resulting CO_2-Emission of M_{Petrol} and M_{Gas} and comparison with the CO_2- Emission based on the bag analysis.
- M_{Petrol} and M_{Gas} could be verified by comparison with the injection pulses: If there are pulses on both kinds of injectors, M_{Petrol} and M_{Gas} must increase.

Considered cases

Two separate fuel tank vehicle type	Possible fuel/s in use at a time during ECE+EUDC cycle test				
	First fuel (liquid)	Second fuel (gas) (*)	Both fuels	Retrofit considered?	Who must support new PID?
Monofuel (gas)	yes (<15 l-tank)	yes	no +	no	Original ECM
Bifuel	yes	yes	no +	yes	Retrofit ECM2
Mixed-fuel (§)	yes	yes	yes	yes	Retrofit ECM2
Dual-fuel	yes (pilot fuel)	no	yes	no	Original ECM
Fuel to be used during tests	Yes. except Monofuel vehicle type	Yes, except mixed and dual fuel vehicle types	Yes, except Monofuel and Bifuel vehicle types		
(*) first fuel usage for starting and/or with current time limit not to be considered. (§) using only the first fuel or a combination single and mixed fuel phases, during the cycle.					

- The proposed method can also be used for Retrofit-systems as they must support OBD-requirements, too. Either the retrofit ECU communicates with scan tools according to SAE J1979 or the original ECM is modified (re-programmed) to do so.

Amendment

Transmitted by GFV

Informal document **GRPE-XX-**
(XX GRPE, XX – YY XX 2012,
agenda item)

Proposal for an amendment to Regulation No. 83

Submitted by the informal GFV group

I. Background information from Working Document ECE/TRANS/WP.29/GRPE/2012/6

Paragraphs 2.22.1., 2.23. and 2.23.1., amend to read:

2.22.1 "*Mono-fuel gas vehicle*" means a vehicle that is designed primarily for permanent running on LPG or NG/biomethane or hydrogen, but may also have a petrol system for emergency purposes or starting only, where the capacity of the petrol tank does not exceed 15 litres.

2.23. "*Bi-fuel vehicle*" means a vehicle with two separate fuel storage systems that is designed to run on only one fuel at a time. The simultaneous use of both fuels is limited in amount or duration.

2.23.1. "*Bi-fuel gas vehicle*" means a bi fuel vehicle that can run on petrol (petrol mode) and also on either LPG, NG/biomethane or hydrogen (gas mode).

Par. 6.4.1.3. of Annex 4a, amend to read:

6.4.1.3 In cases where LPG or NG/biomethane is used as a fuel it is permissible that the engine is started on petrol and switched to LPG or NG/biomethane after a predetermined period of time which cannot be changed by the driver. This period of time shall not exceed 60 seconds.

Par. 3.2.5. of Annex 12, amend to read:

3.2.5 Without prejudice to paragraph 6.4.1.3. of Annex 4a, during the Type I test it is permissible to use petrol only or simultaneously with gas when operating in gas mode provided that the energy consumption of gas is higher than 80 % of the total amount of energy consumed during the

test. This percentage shall be calculated in accordance with the method set out in Appendix 1 (LPG) or Appendix 2 (NG/biomethane) of this Annex.

II. Proposal for an amendment to Working Document ECE/TRANS/WP.29/GRPE/2012/6

Par. 3.2.5. of Annex 12, amend to read:

3.2.5 Without prejudice to paragraph 6.4.1.3. of Annex 4a, during the Type I test it is permissible to use petrol only or simultaneously with gas when operating in gas mode provided that the energy consumption of gas is higher than 80 % of the total amount of energy consumed during the test. This percentage shall be calculated in accordance with the method**s** set out in Appendix 1 (LPG) or Appendix 2 (NG/biomethane) **or alternatively in Appendix 3 (LPG and NG/biomethane)** of this Annex.

Annex 12, add a new appendix 3 to read :

Appendix 3

Bi-fuel gas vehicle - Calculation of LPG resp. CNG energy ratio

This Appendix describes an alternative method for the determination of the LPG or CNG energy ratio to the methods described in Appendices 1 and 2. The determination of the fuel consumption of LPG and petrol is performed by the installed Engine Control Unit or the additional connected Gas Control Unit (GCU) by transmitting the integrated injected fuel masses via a PID to a Generic Scan tool according to SAE J1979 / ISO 15031-5 . The output is M_{Petrol} and M_{Gas}

Procedure

- The integral engine fuel consumption as M_{Petrol} and M_{Gas} is calculated since engine start in a resolution of 2 Byte, 0 …FFFF = 0 … 32769 g and a resolution of 0,5 g = 500 mg.
- The ECU internal resolution of FC accumulation shall be as high as the injection output in order not to miss any injected fuel quantity.
- The accuracy of the ECU determined fuel consumption must be better than 10 % of the fuel consumption calculated from the bag measurements.
- The update rate for M_{Petrol} and M_{Gas} send to the scan tool is <=1 s.
- The integral fuel consumption is reset at engine speed = 0 rpm and ignition key-on.

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 or CNG is burned during the test.

The LPG energy ratio is calculated as described in Appendix 1.

The CNG energy ratio is calculated as described in Appendix 2.