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

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Regulation name and reference number: Regulation 49 and 83

Name of Amendment/Work Item: Regulations 49 and 83 – LPG reference fuel

Specific language for Amendment/Work Item: English

Rationale: (Why is it important/required?)

The provisions in Regulations 49 and 83 related to LPG reference fuels have the following defects that may need correcting:

- composition of LPG reference fuels in Regulation 83 is not precisely defined,
- composition of LPG reference fuels B in Regulations 49 and 83 is different what is not justified,
- H/C ratio for LPG is not correct in Regulations 49 and 83.

It is proposed that GFV gives attention to the matter.

Analysis/testing or data requirements to support the Amendment/Work item
(could be anticipated or existing supporting documentation)

1. Composition of LPG reference fuels in Regulation 83

The composition of LPG reference fuels specified in Annex 10 A to Regulation 83 is as follows (Table 1).

Table 1

		Fuel A	Fuel B
Composition			
C3-content	per cent vol.	30±2	85±2
C4-content	per cent vol.	balance	balance

<C3, >C4	per cent vol.	max. 2	max. 2
Olefins	per cent vol.	max. 12	max. 15

It is not clear what "balance" means:

- balance = 100 - C3 (if so, the total may be higher than 100, e.g. C3 - 31, C4 – 69, <C3 – 2, total = 102) or
- balance = 100 - C3 - <C3 - >C4 (the most probable) or even
- balance = 100 - C3 - <C3 - >C4 – olefins.

It is proposed to clarify this problem and correct Regulation 83.

2. Different composition of LPG reference fuels B in Regulations 49 and 83

The composition of LPG reference fuels specified in Annex 7 to Regulation 49 is as follows (Table 2).

Table 2

		Fuel A		Fuel B	
		Minimum	Maximum	Minimum	Maximum
Composition					
C3-content	% vol.	48	52	83	87
C4-content	% vol.	48	52	13	17
Olefins	% vol.	0	12	0	14

There are the following differences between fuels B in Regulation 49 and Regulation 83:

- if "balance" in Regulation 83 means "balance = 100 – C3 - <C3 - >C4", C4 content may be different, e.g.
  - Regulation 83: C3 = 87, <C3 + >C4 = 2, C4 = 11% vol.,
  - Regulation 49: C4 can not be lower than 13 % vol.,
- <C3, >C4 are not permitted in Regulation 49,
- maximum content of olefins:
  - Regulation 83 – 15 % vol.,
  - Regulation 49 – 14 % vol.

These differences do not seem to be justified. It is proposed to harmonize the composition of LPG reference fuel B in both the Regulations.

3. H/C ratio for LPG

The H/C ratio for LPG is assumed to be equal to:

- 2,525 in Regulation 49 (paragraph 2.7),
- 2,525 in Regulation 83 (paragraph 2.4).

To verify the above ratios, the calculation has been made based on the compositions specified in Tables 1 and 2 and on the following assumptions:

- H/C ratio for LPG should be the mean value for the average composition of fuels A and B,
- H/C ratio is equal to:
  - 2,667 for C3 (without olefins),
  - 2,5 for C4 (without olefins),
  - 2 for all olefins,
  - 3 for <C3,
  - 2,4 for >C4,
- the average composition of fuels A and B is similar to that specified in Table 3 for Regulation 49 and Table 4 for Regulation 83.

Table 3

H/C	Remark	Fuel A [% vol.]	Fuel B [% vol.]	Density* [kg/dcm^3]
2,667	C3 without olefins	47	79,05	0,5074
2,5	C4 without olefins	47	13,95	0,5727
2	C3 olefins	3	5,95	0,5218
2	C4 olefins	3	1,05	0,6081

* Source: Keith Owen, Trevor Coley: Automotive Fuels Handbook.

Table 4

H/C	Remark	Fuel A [% vol.]	Fuel B [% vol.]	Density* [kg/dcm^3]
2,667	C3 without olefins	28,2	78,625	0,5074
2,5	C4 without olefins	64,8	12,875	0,5727
2	C3 olefins	1,8	6,375	0,5218
2	C4 olefins	4,2	1,125	0,6081
3	<C3	0,5	0,5	0,3730
2,4	>C4	0,5	0,5	0,6297

* Source: Keith Owen, Trevor Coley: Automotive Fuels Handbook.

The results of calculation are shown in Table 5 where the following properties are specified:

- the average density and H/C ratio for fuel A,
- the average density and H/C ratio for fuel B,
- the average density and H/C ratio for fuels A and B.

Table 5

	Regulation 49	Regulation 83

	Fuel A	Fuel B	Mean	Fuel A	Fuel B	Mean
Density [kg/dcm^3]	0,5416	0,5184	0,5300	0,5542	0,5178	0,5360
H/C ratio	2,542	2,593	**2,568**	2,512	2,589	**2,550**

To confirm the above results, the calculation for different compositions of the LPG reference fuels has been made. The average values of H/C ratio has been similar to those shown in Table 5. It proves that the average H/C ratio for LPG reference fuels differs from that specified in Regulations 49 and 83. It is important to note that the average H/C ratio for LPG specified in Regulation 49 should be different from that specified in Regulation 83 as the composition of fuels A is different (Table 1 and Table 2).

In light of the above, it is proposed to assume the following H/C ratio:

- **2.55 in Regulation 83,**
- **2.57 in Regulation 49.**

The HC density calculated for the above ratio is equal:

- 0.651 in Regulation 83,
- 0.652 in Regulation 49.

The following corrections are required, among other things:

- Regulation 83 – paragraph 2.4 in the body, paragraph 8.2 in Annex 4, paragraph 1.5.2.3 in Appendix 8 to Annex 4,
- Regulation 49 – paragraph 2.7 in the body, paragraph 4.3.1.1 in Appendix 2 to Annex 4.

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