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PROPOSAL FOR DRAFT SUPPLEMENT 1 TO REGULATION No. 115

(Specific LPG and CNG retrofit systems)

Transmitted by the Working Party on Pollution and Energy (GRPE)

Note: The text reproduced below was adopted by GRPE at its forty-ninth session, and is transmitted for consideration to WP.29 and to AC.1 (TRANS/WP.29/GRPE/49, para. 35). It is based on documents TRANS/WP.29/GRPE/2005/7 and TRANS/WP.29/GRPE/2005/8, both amended (TRANS/WP.29/GRPE/49, paras. 32 and 34).

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Paragraphs 1.4. and 1.5., amend to read:

"1.4. This Regulation applies to retrofit systems intended to be fitted on vehicles of categories M and N, with the exception of:

- (a) vehicles type-approved pursuant to Regulation No. 83, approval A and C,
- (b) vehicles type-approved pursuant to Regulation No. 83, others than M1 and N1 categories,
- (c) vehicles type-approved pursuant to Regulation No. 83, series of amendments 01 or 02 or 03 or 04 series,
- (d) vehicles type-approved pursuant to Regulation No. 49, series of amendments 01 or 02 or 03 series.

The requirements for the different categories (M₁, N₁ or others) are defined in paragraphs 2. to 7. 1/ "

Insert a new footnote 1/, to read:

"1/ Regarding safety requirements, it is recommended that the minimum requirements of Regulation No. 67, 01 series of amendments and Regulation No. 110 shall apply to all retrofitted vehicles."

Paragraph 1.5., should be deleted (including the footnotes 1/ and 2/).

Paragraphs 2.1.1. and 2.1.2., correct the words "installation instructions manual" to read "instruction manuals".

Paragraph 2.1.3., amend to read:

"2.1.3. "A vehicle is considered mono-fuel", when, after the retrofit operation, it is equipped with a petrol tank of capacity \leq 15 litres, that can only be used to "limp-home".

Insert new paragraphs 2.1.4., 2.1.5. and 2.1.6., to read:

"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.

2.1.5. "Non intrusive system" means a retrofit system in which the LPG or CNG fuelling system does not change the original air and petrol feed system to the engine.

2.1.6. "Master-slave system" means a retrofit system in which the LPG ECU or CNG ECU is able to translate the petrol ECU control strategy in LPG or CNG operation."

Paragraph 2.2.3., amend to read (deletion of the points "... " at the end of the sentence):

"2.2.3. gas fuelling system type by or multi-point injection system);"

Paragraph 2.2.4., amend to read:

"2.2.4. sensors and actuators set types;"

Paragraph 2.2.5., amend to read:

"2.2.5. the fuel container type (i.e. as amended by TRANS/WP.29/GRPE/2005/8 liquid take off/ vapour pressure, vapour take off, liquid take off / pressurized by pump), the safety devices and fuel container accessories, as required by Regulation No. 67, 01 series of amendments, or Regulation No. 110, where applicable (i.e. relief valve, ...);"

Paragraphs 2.2.6. and 2.2.7., should be deleted.

Paragraphs 2.2.8. and 2.2.9., renumber as paragraphs 2.2.6. and 2.2.7.

At the bottom of the page, in the note, amend the reference to "paragraphs 2.2.5., 2.2.6., 2.2.7. and 2.2.8.," to read "paragraphs 2.2.4., 2.2.5. and 2.2.6.,".

Paragraph 2.2.10., renumber as paragraph 2.2.8. and amend to read:

"2.2.8. basic software principles and control strategy;"

Paragraph 2.2.11., renumber as paragraph 2.2.9.

Paragraph 2.2.12., renumber as paragraph 2.2.10 and amend to read:

"2.2.10. end-user manual (see para. 7)."

Paragraph 2.3., amend to read:

"2.3. "System manufacturer" means an organization which can assume technical responsibility for the manufacturing of LPG and CNG retrofit systems and can demonstrate that it possesses the features required and the necessary means to achieve quality assessment and conformity of production of the retrofit system."

Insert a new paragraph 2.4., to read:

"2.4. "Installer" means an organization which can assume technical responsibility for the correct and safe installation of the approved LPG and CNG retrofit system, in conformity with respectively paragraphs 6.1.1.3. and 6.2.1.3. of this Regulation 2/. "

Insert a new footnote 2/, to read:

"2/ In the bounds of the legislative power of the Contracting Party, as stated in paragraph 1.3. of this Regulation, in order to ensure a proper qualification of the installer, it is recommended to require valid certificates, issued by the system manufacturer and/or by skilled organizations, attesting the personnel's necessary expertise and the workshop's suitability to carry out retrofit system's installation."

Paragraphs 2.4. to 2.4.1.(former), renumber as paragraphs 2.5. to 2.5.1.

Paragraphs 2.4.1.1.(former), renumber as paragraph 2.5.1.1. and amended to read:

- "2.5.1.1. (a) It is produced by the same vehicle manufacturer.
(b) It is classified in the same category M_1 or M_2 or M_3 or N_1 or N_2 or N_3 . Vehicles of category M_1 and N_1 class I may belong to the same family.
(c) It is subject to the same emission limits or those specified in earlier series of amendments of the applicable Regulation.
(d) If the gas fuelling system has a central metering for the whole engine: it has **an** approved power output between 0.7 and 1.15 times that of the engine of the parent vehicle. If the gas fuelling system as an individual metering per cylinder: it has **an** approved power output per cylinder between 0.7 and 1.15 times that of the engine of the parent vehicle.
(e) Fuel feed and combustion process (injection: direct or indirect, single-point or multi-point).
(f) It has the same pollution control system:
- same type of catalyst if fitted (three-way, oxidation, de NO_x)
- air injection (with or without)
- exhaust gas recirculation (EGR) (with or without)
If the tested vehicle was not equipped with air-injection or EGR, engines with these devices are allowed."

Paragraph 2.4.1.2. (former), renumber as paragraph 2.5.1.2 and amend to read:

- "2.5.1.2. With regard to the requirement of paragraph 2.5.1.1.(a), the vehicle family can also cover vehicles produced by other vehicle manufacturers if it can be demonstrated to the type approval authority that the same engine type and emission strategy is used."

Paragraph 2.4.1.3.(former), renumber as paragraph 2.5.1.3 and amend to read:

- "2.5.1.3. With regard to requirement of paragraph 2.5.1.1.(d):
- in the case of a central metering for the whole vehicle where a demonstration shows that two gas fuelled vehicles could be members of the same family with the exception of their approved power output, respectively P_1 and P_2 ($P_1 < P_2$), and both are tested as if they were parent vehicles, the family relation will be considered valid for any vehicle with an approved power output between $0.7*P_1$ and $1.15*P_2$;

- in the case of an individual metering per cylinder where a demonstration shows two gas fuelled vehicles could be members of the same family with the exception of their approved power output, respectively P1 and P2 ($P1 < P2$), and both are tested as if they were parent vehicles, the family relation will be considered valid for any vehicle with an approved power output between $0.7*P1$ and $1.15*P2$."

Insert a new paragraph 2.5.1.4., to read:

- "2.5.1.4. With regard to the requirement of paragraph 2.5.1.1.(f) in case of a "master-slave" system, as defined in paragraph 2.1.6., the family relation will be considered valid regardless of the presence of the air injection or the EGR."

Paragraphs 2.5. and 2.6. (former), renumber as paragraphs 2.6. and 2.7.

Insert new paragraphs 3.2.5. and 3.2.6., to read:

- "3.2.5. If needed for the purpose of paragraph 5.2., notice of approval of the retrofit system for a parent vehicle which is different from those the approval is applied for, certifying that the retrofit system has been approved as a "non intrusive" system, as defined in paragraph 2.1.5.
- 3.2.6. If needed for the purpose of paragraph 5.3., notice of approval of the retrofit system for a parent vehicle which is different from those the approval is applied for, certifying that the retrofit system has been approved as a "master-slave" system, as defined in paragraph 2.1.6."

Paragraphs 3.3. to 3.5., amend to read:

- "3.3. Part I of the installation manual for the retrofit system installation on vehicle(s).
- 3.4. End-user manual.
- 3.5. A sample of the specific retrofit system, properly installed in the parent vehicle(s)."

Insert new paragraphs 5.2. and 5.3., amend to read:

- "5.2. Retrofit systems, which have already been approved as "non intrusive" systems on at least one parent vehicle, do not need to comply with paragraph 6.1.2.2. or 6.2.2.2. of this Regulation.
- 5.3. Retrofit systems, which have already been approved as "master-slave" systems on at least one parent vehicle, do not need to comply with paragraph 6.1.4.4.2.1. or 6.2.4.4.2.1. of this Regulation."

Paragraphs 5.2. to 5.6. (former), renumber as paragraphs 5.4. to 5.8.

Paragraph 6.1.1.1., amend to read:

"6.1.1.1. An LPG retrofit system shall consist at least of the following components:"

Paragraph 6.1.1.1.3., amend to read:

"6.1.1.1.3. End-user manual."

Paragraph 6.1.2. and 6.1.2.1., amend to read:

"6.1.2. Pollutants emissions and CO₂ emissions (for category M₁ and N1 vehicles only)

6.1.2.1. One LPG retrofit system sample, as described in paragraph 2. of this Regulation, installed into the parent vehicle(s), as described in paragraph 2. of this Regulation, shall be submitted to the test procedures described in Regulations No. 83 4/ and No. 101, or No. 49 5/, where applicable, in the limits of the requirements of paragraphs 6.1.2.5. and 6.1.2.6. The vehicles and/or the engines are also submitted to a maximum power comparison test, as described in Regulation No. 85 for engines, or defined in paragraph 6.1.3. below for vehicles."

Insert a new paragraph 6.1.2.2., to read:

"6.1.2.2. In order to prove that the retrofit system is "non intrusive", as defined in paragraph 2.1.5., the system manufacturer shall provide data and/or engineering evaluations which adequately demonstrate that the original air and petrol feed system to the engine is not affected by the installation of the retrofit system."

Paragraphs 6.1.2.2. and 6.1.2.3. (former), renumber as paragraphs 6.1.2.3. and 6.1.2.4. and amend to read:

"6.1.2.3. Fuel requirements by the engine: the type of fuel normally used by the engine could be:

- (a) LPG only
- (b) both unleaded petrol or LPG
- (c) both diesel fuel or diesel fuel and LPG.

6.1.2.4. "Gaseous pollutants" means:

- (i) carbon monoxide

4/ According to Regulation No. 83, the series of amendments in force during the initial type approval of the engine.

5/ According to Regulation No. 49, the series of amendments in force during the initial type approval of the engine.

- (ii) hydrocarbons assuming a ratio:
 - CH_{1,85} for petrol,
 - CH_{1,86} for diesel fuel,
 - CH_{2,52} for LPG,
 - CH (to be defined) for dual fuel;
- (iii) oxides of nitrogen, the latter being expressed in nitrogen dioxide (NO₂) equivalent.
- (iv) particulates, etc."

Paragraph 6.1.2.4. (former), renumber as paragraphs 6.1.2.5. to 6.1.2.5.3.5. and amend to read:

"6.1.2.5. Exhaust emissions and CO₂ emissions (M₁ and N₁ category of vehicles):

6.1.2.5.1. Specific requirements on the Type I test (verifying the average exhaust emissions after a cold start) as defined in Regulation No. 83, 05 series of amendments (for vehicles having the maximum mass not exceeding 3,500 kg):

6.1.2.5.1.1. Three measurements of tailpipe emissions shall be performed after a cold start with each fuel:

- (i) reference petrol,
- (ii) reference LPG A,
- (iii) reference LPG B.

The emissions of CO, HC, NO_x and HC + NO_x are calculated according Regulation No. 83. 4/.

6.1.2.5.1.2. The test vehicle(s) equipped with the retrofit system, and with the reference petrol, shall comply with the limit values according to the type approval of the vehicle(s) including the deterioration factors applied during the type approval of the vehicle(s).

This condition is deemed to be met if the emissions values for each pollutant or combination of pollutants obtained in each test with reference petrol are less than the limits.

However, one of the three test values obtained may exceed, by not more than 10 per cent, the limit prescribed, provided that the arithmetical mean of the three values is below this limit.

Where the prescribed limits are exceeded for more than one pollutant or combination of pollutants, it is immaterial whether this occurs in the same test or different tests.

6.1.2.5.1.3. The requirements regarding emissions of the vehicle(s) equipped with the retrofit system, and with the two reference gases, shall be deemed to be fulfilled if the results meet the following conditions for each regulated pollutant (CO, HC + NO_x) or (CO, HC, NO_x) according to the requirements the petrol parent vehicle had to comply with

at the date of its approval:

- (1) $(MA + MB)/2 < 0.85S + 0.4G$
- (2) $MA \text{ and } MB < G$

where:

MA: mean value of the emissions of one pollutant (CO/HC/NO_x) $\frac{4}{4}$ or the sum of two pollutants (HC + NO_x) obtained from the three Type I tests with the retrofit system and with LPG A,

MB: mean value of the emissions of one pollutant (CO/HC/NO_x) $\frac{4}{4}$ or the sum of two pollutants (HC + NO_x) obtained from the three Type I tests with the retrofit system and with LPG B,

S: mean value of the emissions of one pollutant (CO/HC/NO_x) $\frac{4}{4}$ or the sum of two pollutants (HC + NO_x) obtained from the three Type I tests with the reference petrol,

G: limit value of the emissions of one pollutant (CO/HC/NO_x) $\frac{4}{4}$ or the sum of two pollutants (HC + NO_x) according to the type approval of the vehicle(s) divided by the deterioration factors.

6.1.2.5.1.4. Notwithstanding the provisions of paragraphs 6.1.2.5.1.1. to 6.1.2.5.1.3., for non intrusive retrofit system as defined in paragraph 2.1.5., the Type I test shall be carried out only with each LPG reference fuel.

6.1.2.5.1.4.1. Subject to the requirements of paragraph 6.1.2.5.1.4.2. the tests shall be repeated three times.

The test vehicle(s) with each reference LPG shall comply with the limits values according to the type approval of the vehicle(s) including the deterioration factors applied during the type approval of the vehicle(s).

6.1.2.5.1.4.2. The number of emission tests to be performed on one LPG reference fuel can be reduced in the conditions hereinafter defined:

- only one test is performed if the result obtained for each pollutant or for the combined emission of two pollutants subject to limitation is less than or equal to 0.7 the emission limit (i.e. $M1 \leq 0.70 G$);
- only two tests are performed if, for each pollutant or for the combined emission of two pollutants subject to limitation the following requirements are met:

$$M1 \leq 0.85 G \text{ and } M1 + M2 \leq 1.70 G \text{ and } M2 \leq G$$

where:

- M1: value of the emission of one pollutant obtained from the first test of the Type I performed;
- M2: value of the emission of one pollutant obtained from the second test of the Type I performed;
- G: limit value of the emissions of one pollutant (CO/HC/NO_x) or the sum of two pollutants (HC + NO_x) according to the type approval of the vehicle(s) divided by the deterioration factors.

- 6.1.2.5.2. Specific requirements on the Type II test (carbon monoxide emission test at idling speed) for vehicles having a maximum mass exceeding 3,500 kg:
 - 6.1.2.5.2.1. One LPG retrofit system sample, as described in paragraph 2. of this Regulation, installed into the parent vehicle, as described in paragraph 2. of this Regulation, shall be submitted to the Type II test procedures described in Regulation No. 83.
 - 6.1.2.5.2.2. Notwithstanding the provisions of Annex 5 of Regulation No. 83, 05 series of amendments, the Type II test shall be performed at the request of the system manufacturer with only one LPG reference fuel chosen at the discretion of the type-approval technical service responsible for the test.
- 6.1.2.5.3. Calculation of the CO₂ emissions and fuel consumption (for M1 and N1 category of vehicles)
 - 6.1.2.5.3.1. The emissions of CO₂ are calculated according to Regulation No. 101 for each parent vehicle, if applicable.

The mean of CO₂ emissions shall be calculated as follows:

$$\text{CO}_{2\text{LPG}} = 1/n \sum_{i=1}^n (\text{CO}_{2\text{Ai}} + \text{CO}_{2\text{Bi}}) / 2$$
$$\text{CO}_{2\text{petrol}} = 1/n \sum_{i=1}^n \text{CO}_{2\text{petrol.i}}$$

where:

- i: number of parent vehicles (i = 1 to n)
- CO_{2Ai}: mean value of the emissions of CO₂ obtained from the three Type I tests with the retrofit system and with LPG A for vehicle No. i,
- CO_{2Bi}: mean value of the emissions of CO₂ obtained from the three Type I tests with the retrofit system and with LPG B for vehicle No. i;
- CO_{2petrol.i}: mean value of the emissions of CO₂ obtained from the three Type I tests with reference petrol for vehicle No. i.

6.1.2.5.3.2. The mean fuel consumption shall be calculated in the same way as for the mean of CO₂ emissions, as defined in paragraph 6.1.2.5.3.1.

6.1.2.5.3.3. The ratios of CO₂ emissions and fuel consumption shall be calculated as follows:

$$K_{CO_2} = CO_{2LPG} / CO_{2petrol}$$

$$K_{Cons} = Cons_{LPG} / Cons_{petrol}$$

for each vehicle of the family, the official values of CO₂ emissions and fuel consumption are multiplied by the above ratios.

6.1.2.5.3.4. Notwithstanding the provisions of paragraph 6.1.2.5.3.1., for non intrusive system, as defined in paragraph 2.1.5. of this Regulation, the value of the petrol CO₂ emission may be the official CO₂ emission value of the vehicle(s) No. i."

Paragraph 6.1.2.5. (former), renumber as paragraph 6.1.2.6.

Paragraph 6.1.3.1., amend to read:

"6.1.3.1. One LPG retrofit system sample as described in paragraph 2 of this Regulation, installed in the parent vehicle(s) or on the parent engine(s) shall be submitted to the test procedures of paragraph 6.1.3.2. or 6.1.3.3. The measured power with LPG shall be lower than that measured with petrol + 5 per cent."

Paragraph 6.1.3.2., amend to read:

"6.1.3.2. Chassis dynamometer method:

The maximum power at the wheels is measured on a chassis dynamometer on each parent vehicle with the following fuels:

- (i) reference petrol,
- (ii) reference LPG A or B,

The mean of power measurements shall be calculated as follows:
...."

Insert a new paragraph 6.1.3.4., to read:

"6.1.3.4. Notwithstanding the provisions of paragraph 6.1.3.1., with regard to the way to calculate the mean of maximum power on petrol in paragraphs 6.1.3.2. and 6.1.3.3., for non intrusive system, as defined in paragraph 2.1.5. of this Regulation, the value of maximum power on petrol of the vehicle(s) No. i may be the official value."

Insert new paragraphs 6.1.4. to 6.1.4.4.2.4., to read:

- "6.1.4. OBD requirements and tests for vehicles retrofitted with LPG retrofit system.
- 6.1.4.1. For the purposes of this paragraph, the following definitions apply:
- 6.1.4.1.1. "original emission-related component" means any component in the air inlet, exhaust or evaporative system which supplies an input to or receives an output from the petrol controller.
- 6.1.4.1.2. "LPG emission-related component" means any component in the air inlet exhaust or evaporative system which supplies an input to or receives an output from the LPG controller.
- 6.1.4.2. In the case that there is a need, to fit properly the LPG retrofit system in the vehicle, it is allowed to simulate the right operation of the original emission-related components which are not in use on LPG mode.
- 6.1.4.3. The LPG retrofit system, as described in paragraph 2. of this Regulation, installed into the parent vehicle(s), shall comply with the requirements and tests of Annex 11 of Regulation No. 83, 05 series of amendments on both petrol and LPG modes.
- 6.1.4.4. Specific OBD requirements and tests for "master-slave" retrofit system:
- 6.1.4.4.1 Notwithstanding the requirements of the paragraph 6.1.4.3., a "Master-slave" retrofit system shall fulfil the following requirements:
- (a) The petrol ECU shall remain activated for engine management in both petrol and LPG modes
 - (b) during petrol operations the petrol OBD system shall remain the only on-board diagnostic system of the vehicle
 - (c) during LPG operations the petrol OBD system shall continue to monitor original emission related components with the exception of those which are not in use
 - (d) during LPG operations the LPG ECU shall only monitor for the LPG emission-related components as well as their electrical connections;
- 6.1.4.4.2. Notwithstanding the requirements of paragraph 6.1.4.3., the LPG retrofit system shall be submitted to the following tests, which, in the case of Type I tests, shall be performed according to Annex 11, Appendix 1, of Regulation No. 83, 05 series of amendments.
- 6.1.4.4.2.1. The following tests shall be carried out on one parent vehicle, equipped with the LPG retrofit system:

- the LPG ECU shall follow the petrol ECU on fuel strategies (e.g. injection). This can be demonstrated by a monitoring (diagnostic) programme, while modifying the signal of one of the petrol system's sensors with an impact on the injection time;
- during a Type I test on petrol the original MI shall activate due to the electrical disconnection of any original emission-related component;
- during a Type I test on LPG the original MI shall activate due to the electrical disconnection of any original emission-related component, which is in use during LPG operations.

6.1.4.4.2.2. The following tests shall be carried out on the parent vehicle(s), equipped with the LPG retrofit system, only on LPG operating mode:

- (a) during a Type I test, electrical disconnection of one LPG emission-related component;
- (b) during a Type I, test replacement of one LPG emission-related component with a deteriorated and defective one or electronic simulation of such a failure.

The original MI or automatic switch from LPG mode to petrol mode shall activate before the end of the tests under any of the conditions above.

6.1.4.4.2.3. Fault codes due to malfunctions of the LPG emission-related components and their electrical connections shall be stored in the LPG ECU.

6.1.4.4.2.4. The system manufacturer shall provide specific instructions as to read out the LPG fault codes referred to in paragraph 6.1.4.4.2.3."

Paragraph 6.2.1.1., amend to read:

"6.2.1.1. A CNG retrofit system shall consist at least of the following components:"

Paragraph 6.2.1.1.3., amend to read:

"6.2.1.1.3. End-user manual."

Paragraph 6.2.2., amend to read:

"6.2.2. Pollutants emissions and CO₂ emissions (for category M₁ and N₁ vehicles only)"

Paragraph 6.2.2.1. amend to read:

"6.2.2.1. and No. 101 or No. 49 5/, where applicable, in the limits of the requirements of paragraphs 6.2.2.5. and 6.2.2.6.

....."

Insert a new paragraph 6.2.2.2., to read:

"6.2.2.2. In order to prove that the retrofit system is "non intrusive", as defined in paragraph 2.1.5., the system manufacturer shall provide data and/or engineering evaluations which adequately demonstrate that the original air and petrol feed process to the engine is not affected by the installation of the retrofit system."

Paragraph 6.2.2.2. (former), renumber as paragraph 6.2.2.3. and amend to read:

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

- (a) CNG only
- (b) both unleaded petrol or CNG
- (c) both diesel fuel or diesel fuel and CNG "

Paragraph 6.2.2.3. (former), renumber as paragraph 6.2.2.4. and amend to read:

"6.2.2.4. "Gaseous pollutants" means:

.....

- (iii) oxides of nitrogen, the latter being expressed in nitrogen dioxide (NO₂) equivalent;
- (iv) particulates, etc. "

Paragraph 6.2.4. (former), renumber as paragraph 6.2.2.5.

Insert new paragraphs 6.2.2.5.1. to 6.2.2.5.3.5., to read:

"6.2.2.5.1. Specific requirements on the Type I test (verifying the average exhaust emissions after a cold start) as defined in Regulation No. 83, 05 series of amendments (for vehicles having the maximum mass not exceeding 3,500 kg):

6.2.2.5.1.1. Three measurements of tailpipe emissions shall be performed after a cold start with each fuel:

- (i) reference petrol,
- (ii) reference G20 fuel,
- (iii) reference G25 fuel.

The emissions of CO, HC, NO_x and HC + NO_x are calculated according Regulation No. 83. 4/.

6.2.2.5.1.2. The test vehicle(s) equipped with the retrofit system, and with the reference petrol shall comply with the limit values according to the type approval of the vehicle(s) including the deterioration factors applied during the type approval of the vehicle(s).

This condition is deemed to be met if the emissions values for each pollutant or combination of pollutants obtained in each test with reference petrol are less than the limits.

However, one of the three test values obtained may exceed, by not more than 10 per cent, the limit prescribed, provided that the arithmetical mean of the three values is below this limit.

Where the prescribed limits are exceeded for more than one pollutant or combination of pollutants, it is immaterial whether this occurs in the same test or different tests.

6.2.2.5.1.3. The requirements regarding emissions of the vehicle(s) equipped with the retrofit system, and with the two reference gases, shall be deemed to be fulfilled if the results meet the following conditions for each regulated pollutant (CO, HC + NO_x) or (CO, HC, NO_x) according to the requirements the petrol parent vehicle had to comply with at the date of its approval:

- (1) $(MA + MB)/2 < 0.85S + 0.4G$
- (2) $MA \text{ and } MB < G$

where:

- MA: mean value of the emissions of one pollutant (CO/HC/NO_x) 4/ or the sum of two pollutants (HC + NO_x) obtained from the three Type I tests with the retrofit system and with G₂₀,
- MB: mean value of the emissions of one pollutant (CO/HC/NO_x) 4/ of the sum of two pollutants (HC + NO_x) obtained from the three Type I tests with the retrofit system and with G₂₅,
- S: mean value of the emissions of one pollutant (CO/HC/NO_x) 4/ or the sum of two pollutants (HC + NO_x) obtained from the three Type I tests with the reference petrol,
- G: limit value of the emissions of one pollutant (CO/HC/NO_x) 4/ or the sum of two pollutants (HC + NO_x) according to the type approval of the vehicle(s) divided by the deterioration factors.

6.2.2.5.1.4. Notwithstanding the provisions of paragraphs 6.2.2.5.1.1. to 6.2.2.5.1.3., for non intrusive retrofit system as defined in paragraph 2.1.5., the Type I test shall be carried out only with each CNG reference fuel.

6.2.2.5.1.4.1. Subject to the requirements of paragraph 6.2.2.5.1.4.2. the tests shall be repeated three times.

The test vehicle(s) with each reference CNG shall comply with the limits values according to the type approval of the vehicle(s) including the deterioration factors applied during the type approval of the vehicle(s).

6.2.2.5.1.4.2. The number of emission tests to be performed on one CNG reference fuel can be reduced in the conditions hereinafter defined:

- only one test is performed if the result obtained for each pollutant or for the combined emission of two pollutants subject to limitation is less than or equal to 0.7 the emission limit (i.e. $M1 \leq 0.70 G$);
- only two tests are performed if, for each pollutant or for the combined emission of two pollutants subject to limitation the following requirements are met:

$$M1 \leq 0.85 G \text{ and } M1 + M2 \leq 1.70 G \text{ and } M2 \leq G$$

where:

- M1: value of the emission of one pollutant obtained from the first test of the Type I performed;
- M2: value of the emission of one pollutant obtained from the second test of the Type I performed;
- G: limit value of the emissions of one pollutant (CO/HC/NO_x) or the sum of two pollutants (HC + NO_x) according to the type approval of the vehicle(s) divided by the deterioration factors.

6.2.2.5.2. Specific requirements on the Type II test (carbon monoxide emission test at idling speed) for vehicles having a maximum mass exceeding 3,500 kg:

6.2.2.5.2.1. One CNG retrofit system sample, as described in paragraph 2. of this Regulation, installed into the parent vehicle, as described in paragraph 2. of this Regulation, shall be submitted to the type II test procedures described in Regulation No. 83.

6.2.2.5.2.2. Notwithstanding the provisions of Annex 5 of Regulation No. 83, 05 series of amendments, the Type II test shall be performed at the request of the system manufacturer with only one CNG reference fuel chosen at the discretion of the type-approval technical service responsible for the test.

6.2.2.5.3. Calculation of the CO₂ emissions and fuel consumption (for M1 and N1 category of vehicles)

6.2.2.5.3.1. The emissions of CO₂ are calculated according to Regulation No. 101 for each parent vehicle, if applicable.

The mean of CO₂ emissions shall be calculated as follows:

$$\text{CO}_{2\text{CNG}} = 1/n \cdot \sum_{i=1}^n (\text{CO}_{2\text{G20}i} + \text{CO}_{2\text{G25}i}) / 2$$
$$\text{CO}_{2\text{petrol}} = 1/n \cdot \sum_{i=1}^n \text{CO}_{2\text{petrol}.i}$$

where:

- i: number of parent vehicles (i = 1 to n)
CO_{2G20}: mean value of the emissions of CO₂ obtained from the three Type I tests with the retrofit system and with CNG G20 for vehicle No. i,
CO_{2G25}: mean value of the emissions of CO₂ obtained from the three Type I tests with the retrofit system and with CNG G25 for vehicle No. i;
CO_{2petrol.i}: mean value of the emissions of CO₂ obtained from the three Type I tests with reference petrol for vehicle No. i.

6.2.2.5.3.2. The mean fuel consumption shall be calculated in the same way as for the mean of CO₂ emissions, as defined in paragraph 6.2.2.5.3.1.

6.2.2.5.3.3. The ratios of CO₂ emissions and fuel consumption shall be calculated as follows:

$$K_{\text{CO}_2} = \text{CO}_{2\text{CNG}} / \text{CO}_{2\text{petrol}}$$

$$K_{\text{Cons}} = \text{Cons}_{\text{CNG}} / \text{Cons}_{\text{petrol}}$$

for each vehicle of the family, the official values of CO₂ emissions and fuel consumption are multiplied by the above ratios.

6.2.2.5.3.4. Notwithstanding the provisions of paragraph 6.2.2.5.3.1., for non intrusive system, as defined in paragraph 2.1.5. of this Regulation, the value of the petrol CO₂ emission may be the official CO₂ emission value of the vehicle(s) No. i. "

Paragraph 6.2.2.5. (former), renumber as paragraph 6.2.2.6.

Paragraph 6.2.3.1., amend to read:

"6.2.3.1. to the test procedures of paragraph 6.2.3.2. or 6.2.3.3. The measured power with CNG shall be lower than that measured with petrol + 5 per cent."

Paragraph 6.2.3.2., amend to read:

"6.2.3.2. Chassis dynamometer method:

The maximum power at the wheels is measured on a chassis dynamometer on each parent vehicle with the following fuels:

- (i) reference petrol,
- (ii) reference fuel G20 or G25,

The mean of power measurements shall be calculated as follows:

....."

Insert a new paragraph 6.2.3.4., to read:

"6.2.3.4. Notwithstanding the provisions of paragraph 6.2.3.1., with regard to the way to calculate the mean of maximum power on petrol in paragraphs 6.2.3.2. and 6.2.3.3., for non intrusive system, as defined in paragraph 2.1.5. of this Regulation, the value of maximum power on petrol of the vehicle(s) No. i may be the official value."

Insert new paragraphs 6.2.4. to 6.2.4.4.2.4., to read:

"6.2.4. OBD requirements and tests for vehicles retrofitted with CNG retrofit system.

6.2.4.1. For the purposes of this paragraph, the following definitions apply:

6.2.4.1.1. "original emission-related component" means any component in the air inlet, exhaust or evaporative system which supplies an input to or receives an output from the petrol controller;

6.2.4.1.2. "CNG emission-related component" means any component in the air inlet exhaust or evaporative system which supplies an input to or receives an output from the CNG controller.

6.2.4.2. In the case that there is a need, to fit properly the CNG retrofit system in the vehicle, it is allowed to simulate the right operation of the original emission-related components which are not in use on CNG mode.

6.2.4.3. The CNG retrofit system, as described in paragraph 2. of this Regulation, installed into the parent vehicle(s), shall comply with the requirements and tests of Annex 11 of Regulation No. 83, 05 series of amendments on both petrol and CNG modes.

6.2.4.4. Specific OBD requirements and tests for "master-slave" retrofit system:

6.2.4.4.1. Notwithstanding the requirements of paragraph 6.2.4.3., a "Master-slave" retrofit system shall fulfil the following requirements:

- (a) the petrol ECU shall remain activated for engine management in both petrol and CNG modes
- (b) during petrol operations the petrol OBD system shall remain the only on-board diagnostic system of the vehicle
- (c) during CNG operations the petrol OBD system shall continue to monitor the original emission related components with the exception of those which are not in use
- (d) during CNG operations the CNG ECU shall only monitor for the CNG emission-related components as well as their electrical connections;

6.2.4.4.2. Notwithstanding the requirements of paragraph 6.2.4.3., the CNG retrofit system shall be submitted to the following tests, which, in the case of Type I tests, shall be performed according to Annex 11, Appendix 1, of Regulation No. 83, 05 series of amendments.

6.2.4.4.2.1. The following tests shall be carried out on one parent vehicle, equipped with the CNG retrofit system:

- the CNG ECU shall follow the petrol ECU on fuel strategies (e.g. injection and ignition strategies (e.g. spark plug advance)). This can be demonstrated by a monitoring (diagnostic) programme, while modifying the signal of one of the petrol system's sensors with an impact on the injection time and on ignition spark plug advance
- during a Type I test on petrol the original MI shall activate due to the electrical disconnection of any original emission-related component.
- during a Type I test on CNG the original MI shall activate due to the electrical disconnection of any original emission-related component, which is in use during CNG operations.

6.2.4.4.2.2. The following tests shall be carried out on the parent vehicle(s), equipped with the CNG retrofit system, only on CNG operating mode:

- (a) during a Type I test, electrical disconnection of one CNG emission-related component;
- (b) during a Type I, test replacement of one CNG emission-related component with a deteriorated and defective one or electronic simulation of such a failure.

The original MI or automatic switch from CNG mode to petrol mode shall activate before the end of the tests under any of the conditions above.

- 6.2.4.4.2.3. Fault codes due to malfunctions of the CNG emission-related components and their electrical connections shall be stored in the CNG ECU.
- 6.2.4.4.2.4. The system manufacturer shall provide specific instructions as to read out the CNG fault codes referred to in paragraph 6.2.4.4.2.3."

Paragraph 7.1., amend to read:

"7.1. Installation manual for the retrofit installation on the vehicle"

Paragraphs 7.1.3.3. to 7.1.3.5., amend to read:

- "7.1.3.3. The installation manual is part of the retrofit system and shall therefore be provided for each conversion kit.
- 7.1.3.4. The installation manual must be written in the language of the country to which the conversion retrofit will be delivered, or at least in English.
- 7.1.3.5. The installation manual can be divided in two parts:
- Part I: (i) Part containing the description of the sample of retrofit installed on the parent vehicle(s), and submitted to the tests and inspections of the Authority that grants the type approval.
- (ii) Part containing the list of components indicated by the retrofit manufacturer as alternatives.
- Part II: (i) Part containing specific installation instructions, for vehicles belonging to the family of the parent vehicle(s)."

Paragraphs 7.1.3.6. and 7.1.3.7., amend to read:

- "7.1.3.6. Part I of the installation manual has to be submitted to the authority that grants the type approval.
- 7.1.3.7. Part II of the installation manual has to be filed by the retrofit system manufacturer for a time to be determined in accordance with the authority that grants the type approval."

Paragraphs 7.1.4. to 7.1.4.2., amend to read:

- "7.1.4. Contents of Part I, section (i) of installation manual
- 7.1.4.1. Retrofit system description
- 7.1.4.1.1. Operational principles of the retrofit system
- 7.1.4.1.2. Operational principles of each component of the retrofit system"

Paragraphs 7.1.4.1.3. to 7.1.4.2.4., should be deleted.

Paragraphs 7.1.5. to 7.1.9.1. (former), renumber as paragraphs 7.1.4.2. to 7.1.4.6.1.

Insert new paragraphs 7.1.5. and 7.1.5.2.3., to read:

- "7.1.5. Contents of Part II of installation manual
- 7.1.5.1. Retrofit system identification
 - 7.1.5.1.1. Retrofit system approval number
 - 7.1.5.1.2. Vehicle manufacturer
 - 7.1.5.1.3. Vehicle category
 - 7.1.5.1.4. Vehicle type
 - 7.1.5.1.5. Engine type
 - 7.1.5.1.6. Engine displacement
 - 7.1.5.1.7. Transmission type
 - 7.1.5.1.8. Vehicle model
 - 7.1.5.1.9. Type of conversion retrofit (LPG or CNG)
 - 7.1.5.1.10. Assembly instruction number
 - 7.1.5.1.11. General scheme of the retrofit system containing the following information of each component:
 - (a) identification number
 - (b) manufacturer's code
 - (c) type approval, if it exists
 - (d) for the containers: capacity/manufacturer/type/date of expiry or replacement date, if it exists
 - 7.1.5.1.12. Description (including drawings, if applicable) of the fitting devices of the container installation on the vehicle.
- 7.1.5.2. Installation instructions

- 7.1.5.2.1. Assembly instructions of all components together with diagrams or photographs showing clearly the layout of the single components within the engine compartment.
- 7.1.5.2.2. Diagram or photograph showing the exact position where the installer shall place the retrofit system type approval plate (contained in the conversion kit).
- 7.1.5.2.3. Clear wiring diagram of the electrical system containing the mechanical components to which the wires shall be connected."

Paragraph 7.2., amend to read:

"7.2. End-user manual"

Paragraphs 7.2.4.5. to 7.2.4.7. (former), renumber as paragraphs 7.2.2.5. to 7.2.2.7.

Paragraph 7.2.5. (former), renumber as paragraph 7.2.3. and amend to read:

"7.2.3. Contents of the end-user manual"

Paragraphs 7.2.5.1. to 7.2.5.5.7. (former), renumber as paragraphs 7.2.3.1. to 7.2.3.5.7.

Paragraph 8.1., amend to read:

"8.1. Every modification of the installation of the specific equipment for the use of LPG or CNG in the propulsion system of the vehicle shall be notified to"

Annex 1A, (COMMUNICATION)

Item 11.1., amend to read:

"11.1. Emission requirements:
Has the retrofit system demonstrated to be "non intrusive": yes/no 2/
Regulation No. 83, series of amendments 3/
Regulation No. 49, series of amendments 3/"

Insert a new item 11.2., to read:

"11.2. OBD requirements:
Has the retrofit system demonstrated to be "master-slave": yes/no 2/ "

Annex 1A, Addendum,

Item 1., amend to read:

"1. Vehicles on which the retrofit equipment has been tested:

Vehicle No.	1	2	n
Make:			
Type:			
Category:			
Emission limits:			
Power:			
Pollution control system type:			

Item 3., amend to read:

"3. Vehicle type(s) for which the retrofit equipment type is qualified:

Fuel		Petrol (or diesel) <u>1/</u>					LPG				
Vehicle type	Engine type	Power (kW)	CO (g/km)	HC (g/km)	NOx (g/km)	CO ₂ <u>2/</u> (g/km)	Power (kW)	CO (g/km)	HC (g/km)	NOx (g/km)	CO ₂ <u>2/</u> (g/km)

1/ strike out what does not apply.

2/ Applicable to vehicles of categories M₁ and N₁ vehicle only."

Annex 1B

Item 11.1., amend to read:

"11.1. Emission requirements:
Has the retrofit system demonstrated to be "non intrusive": yes/no 2/
Regulation No. 83, series of amendments 3/
Regulation No. 49, series of amendments 3/"

Insert a new item 11.2., to read:

"11.2. OBD requirements:
Has the retrofit system demonstrated to be "master-slave": yes/no 2/ "

Annex 1B, Addendum

Item 1., amend to read:

"1. Vehicles on which the retrofit equipment has been tested:

Vehicle No.	1	2	n
Make:			
Type:			
Category:			
Emission limits:			
Power:			
Pollution control system type:			

Item 3., amend to read:

"3. Vehicle type(s) for which the retrofit equipment type is qualified:

Fuel		Petrol (or diesel) 1/					CNG				
Vehicle type	Engine type	Power (kW)	CO (g/km)	HC (g/km)	NOx (g/km)	CO ₂ 2/ (g/km)	Power (kW)	CO (g/km)	HC (g/km)	NOx (g/km)	CO ₂ 2/ (g/km)

1/ strike out what does not apply.

2/ Applicable to vehicles of categories M₁ and N₁ only."

Annex 2A, the example of the plate, delete "Date:" from the figure.

Annex 2B, the example of the plate, delete "Date:" from the figure.

Annex 3A,

Insert new items 2.4. and 2.5., to read:

"2.4. "Non intrusive" system: yes/no 1/

2.5. "Master-slave" system: yes/no 1/"

Items 2.4. to 2.20.1. (former), renumber as items 2.6. to 2.22.1.

Annex 3B

Insert new items 2.4. and 2.5., to read:

"2.4. "Non intrusive" system: yes/no 1/

2.5. "Master-slave" system: yes/no 1/"

Items 2.4. to 2.19.1. (former), renumber as 2.6. to 2.21.1.

Annex 4, paragraphs 3.1. and 4.1., amend the references "7.1.5." and "7.1.6." to read "7.1.4.2." and "7.1.4.3.".
