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PROPOSAL FOR DRAFT 04 SERIES OF AMENDMENTS TO REGULATION No. 49

(Emissions of C.I., NG and P.I. (LPG) engines)

Addendum 1

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

Note: The text reproduced below contains amendments prepared by the expert from OICA, following the adoption of the original proposal by GRPE at its forty-third session. It modifies the original proposal (TRANS/WP.29/2002/37) and it is transmitted for consideration to WP.29 and to AC.1 (TRANS/WP.29/GRPE/43, paras. 10 and 11). The modifications are in **bold text**. Also in bold text are references to **paragraphs to be amended**, if these were not addressed in document TRANS/WP.29/2002/37; inside these paragraphs the **bold text** indicates modifications with respect to the 03 series of amendments to Regulation No. 49.

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Paragraph 2.7., amend to read:

"2.7. **"**gaseous pollutants" means carbon monoxide, hydrocarbons (assuming a ratio of $CH_{1.85}$ for diesel, $CH_{2.525}$ for LPG and **an assumed molecule $CH_3O_{0.5}$ for ethanol-fuelled diesel engines), non-methane hydrocarbons (assuming a ratio of $CH_{1.85}$ for diesel fuel, $CH_{2.525}$ for LPG and $CH_{2.93}$ for NG),** methane (assuming a ratio of CH_4 for NG) and oxides of nitrogen, the last-named being expressed in nitrogen dioxide (NO_2) equivalent;

"particulate pollutants" means any material collected on a specified filter medium after diluting the exhaust with clean filtered air so that the temperature does not exceed 325 K (52°C);"

Paragraph 4.1.3., amend to read:

"4.1.3. In the case of an engine fuelled with natural gas which is self-adaptive for the range of H-gases on the one hand and the range of L-gases on the other hand, and which switches between the H-range and the L-range by means of a switch, the parent engine must be tested **at each position of the switch on the reference fuel relevant for the respective position** as specified in annex 6 for each range. The fuels are GR (fuel 1) and G23 (fuel 3) for the H-range of gases and G25 (fuel 2) and G23 (fuel 3) for the L-range of gases. The parent engine must meet the requirements of this Regulation at both positions of the switch without any readjustment to the fuelling between the two tests at **the respective position** of the switch. However, one adaptation run over one ETC cycle without measurement is permitted after the change of the fuel. Before testing the parent engine must be run-in using the procedure given in paragraph 3 of appendix 2 to annex 4."

Insert new tables concerning approval of NG-fuelled and LPG-fuelled engines, after paragraph 4.2.2.3., to read as follows (Note: in the tables and their titles **bold** is not used to mark new text.):

"APPROVAL OF NG-FUELLED ENGINES

	Para. 4.1. **Granting of a universal fuel approval**	**Number of test runs**	**Calculation of "r"**	**Para. 4.2.** **Granting of a fuel restricted approval**	**Number of test runs**	**Calculation of "r"**
refer to para. 4.1.2. NG-engine adaptable to any fuel composition	**GR (1) and G25 (2)** at manufacturer's request engine may be tested on an additional market fuel (3), **if S_λ = 0.89 – 1.19**	**2** (max. 3)	$r = \frac{\text{fuel 2 (G25)}}{\text{fuel 1 (GR)}}$ **and, if tested with an <u>additional fuel</u>** $ra = \frac{\text{fuel 2 (G25)}}{\text{fuel 3 (market fuel)}}$ **and** $rb = \frac{\text{fuel 1 (GR)}}{\text{fuel 3 (G23 or market fuel)}}$			
refer to para. 4.1.3. NG-engine which is self adaptive by a switch	**GR (1) and G23 (3) for H** <u>and</u> **G25 (2) and G23 (3) for L** at manufacturer's request engine may be tested on a market fuel (3) instead of **G23, if S_λ = 0.89 – 1.19**	**2 for the H-range**, and **2 for the L-range** at respective position of switch **4**	$rb = \frac{\text{fuel 1 (GR)}}{\text{fuel 3 (G23 or market fuel)}}$ **and** $ra = \frac{\text{fuel 2 (G25)}}{\text{fuel 3 (G23 or market fuel)}}$			
refer to para. 4.2.1. NG-engine laid out for operation on either H-range gas or L-range gas				**GR (1) and G23 (3) for H** <u>or</u> **G25 (2) and G23 (3) for L** at manufacturer's request engine may be tested on a market fuel (3) instead of **G23, if S_λ = 0.89 – 1.19**	**2 for the H-range** or **2 for the L-range** **2**	$rb = \frac{\text{fuel 1 (GR)}}{\text{fuel 3 (G23 or market fuel)}}$ **for the H-range** **<u>or</u>** $ra = \frac{\text{fuel 2 (G25)}}{\text{fuel 3 (G23 or market fuel)}}$ **for the L-range**
refer to para. 4.2.2. NG-engine laid out for operation on one specific fuel composition				**GR (1) and G25 (2),** fine-tuning between the tests allowed at manufacturer's request engine may be tested on **GR (1) and G23 (3) for H** or **G25 (2) and G23 (3) for L**	**2** or **2 for the H-range** or **2 for the L-range** **2**	

APPROVAL OF LPG-FUELLED ENGINES

	Para. 4.1. **Granting of a universal fuel approval**	**Number of test runs**	**Calculation of "r"**	**Para. 4.2.** **Granting of a fuel restricted approval**	**Number of test runs**	**Calculation of "r"**
refer to para. 4.1.5 LPG-engine adaptable to any fuel composition	**fuel A and fuel B**	**2**	$r = \frac{\text{fuel B}}{\text{fuel A}}$			
refer to para. 4.2.2 LPG-engine laid out for operation on one specific fuel composition				**fuel A and fuel B**, fine-tuning between the tests allowed	**2**	

"

Annex 4,

Paragraph 1.3., amend to read:

"1.3. Measurement principle

The emissions to be measured from the exhaust of the engine include the gaseous components (carbon monoxide, total hydrocarbons for diesel engines on the ESC test only; non-methane hydrocarbons for diesel and gas engines on the ETC test only; methane for gas engines on the ETC test only and oxides of nitrogen), the particulates (diesel engines, **gas engines at stage C only**) and smoke (diesel engines on the ELR test only). Additionally, carbon dioxide is often used as a tracer gas for determining the dilution ratio of partial and full flow dilution systems. Good engineering practice recommends the general measurement of carbon dioxide as an excellent tool for the detection of measurement problems during the test run."

Annex 4 - Appendix 1, paragraph 1.2., amend to read:

"1.2. Determination of dynamometer settings

The torque curve at full load must be determined by experimentation to calculate the torque values for the specified test modes under net conditions, as specified in annex 1, appendix 1, paragraph 8.2. The power absorbed by engine-driven equipment, if applicable, must be taken into account. The dynamometer setting for each test mode **except idle** must be calculated using the formula:
......"

Annex 4 - Appendix 2,

Paragraph 3.1., amend to read:

"3.1. Preparation of the sampling filters (**if applicable**)

At least one hour ...."

Paragraph 3.4., amend to read:

"3.4. Starting the particulate sampling system (**if applicable**)

The particulate sampling ....."

Paragraph 3.8.3., amend to read:

"3.8.3. Particulate sampling (**if applicable**)

At the start of the engine ....."

Paragraph 4.3.1., amend to read:

"4.3.1. Systems with constant mass flow

For systems with heat exchanger, the mass of the pollutants (g/test) must be determined from the following equations:

(1) NO_x mass = 0.001587 * NOx conc * $K_{H,D}$ * M_{TOTW} (diesel engines)

(2) NO_x mass = 0.001587 * NOx conc * $K_{H,G}$ * M_{TOTW} (gas engines)

(3) CO mass = 0.000966 * CO conc * M_{TOTW}

(4) HC mass = 0.000479 * HC conc * M_{TOTW}' (diesel engines)

(5) HC mass = 0.000502 * HC conc * M_{TOTW}' (LPG fuelled engines)

(6) HC mass = 0.000552 * HC conc * M_{TOTW}' (NG fuelled engines)

(7) NMHC mass = 0.000479 * NMHC conc * M_{TOTW}' (diesel engines)

(8) NMHC mass = 0.000502 * NMHC conc * M_{TOTW}' (LPG fuelled engines)

(**9**) NMHC mass = 0.000516 * NMHC conc * M_{TOTW}' (NG fuelled engines)

(**10**) CH_4 mass = 0.000552 * CH_4 conc * M_{TOTW} (NG fuelled engines)

where:

NO_x conc, CO conc, HC conc, 1/ NMHC conc, **CH_4 conc** = average background corrected concentrations over the cycle from integration (mandatory for NO_x and HC) or bag measurement, ppm

M_{TOTW} = total mass of diluted exhaust gas over the cycle as determined in paragraph 4.1., kg

$K_{H,D}$ = humidity correction factor for diesel engines as determined in paragraph 4.2., **based on cycle averaged intake air humidity**

$K_{H,G}$ = humidity correction factor for gas engines as determined in paragraph 4.2., **based on cycle averaged intake air humidity**

Concentrations measured on a dry basis must be converted to a wet basis in accordance with annex 4, appendix 1, paragraph 4.2.

The determination of $NMHC_{conc}$ **and $CH_{4\ conc}$** depends on the method used (see annex 4, appendix 4, paragraph 3.3.4.). **Both concentrations must be determined as follows, whereby CH_4 is subtracted from HC for the determination of $NMHC_{conc}$:**

(a) GC method

$$NMHC_{conc} = HC_{conc} - CH_{4\ conc}$$

$$\mathbf{CH_{4\ conc} = as\ measured}$$

(b) NMC method

$$NMHC_{conc} = \frac{HC(w/o\,Cutter) * (1 - CE_M) - HC(w/Cutter)}{CE_E - CE_M}$$

$$\mathbf{CH_{4,conc} = \frac{HC(w/\,Cutter) - HC(w/o\ Cutter) \times (1 - CE_E)}{CE_E - CE_M}}$$

1/ Based on C1 equivalent

where:

HC(w/ Cutter) = HC concentration with the sample gas flowing through the NMC

HC(w/o Cutter) = HC concentration with the sample gas bypassing the NMC

CE_M = methane efficiency as determined per annex 4, appendix 5, paragraph 1.8.4.1.

CE_E = ethane efficiency as determined per annex 4, appendix 5, paragraph 1.8.4.2."

Paragraph 4.3.1.1., amend to read (calculation of the dilution factor for NG-fuelled gas engines deleted)**:**

"4.3.1.1. Determination of the background corrected concentrations

The average background concentration of the gaseous pollutants in the dilution air must be subtracted from measured concentrations to get the net concentrations of the pollutants. The average values of the background concentrations can be determined by the sample bag method or by continuous measurement with integration. The following formula must be used.

$$conc = conc_e - conc_d * (1 - (1/DF))$$

where:

$conc$ = concentration of the respective pollutant in the diluted exhaust gas, corrected by the amount of the respective pollutant contained in the dilution air, ppm

$conc_e$ = concentration of the respective pollutant measured in the diluted exhaust gas, ppm

$conc_d$ = concentration of the respective pollutant measured in the dilution air, ppm

DF = dilution factor

The dilution factor **shall** be calculated as follows:

$$DF = \frac{F_S}{CO_{2,conce} + (HC_{conce} + CO_{conce}) * 10^{-4}}$$

where:

$CO_{2,conce}$ = concentration of CO_2 in the diluted exhaust gas, % vol

HC_{conce} = concentration of HC in the diluted exhaust gas, ppm C1

CO_{conce} = concentration of CO in the diluted exhaust gas, ppm

F_S = stoichiometric factor

Concentrations measured on dry basis must be converted to a wet basis in accordance with annex 4, appendix 1, paragraph 4.2.

The stoichiometric factor must be calculated as follows:

$$F_s = 100 * \frac{x}{x + \frac{y}{2} + 3.76 * \left(x + \frac{y}{4}\right)}$$

where:

x,y = fuel composition C_xH_y

Alternatively, if the fuel composition is not known, the following stoichiometric factors may be used:

F_S (diesel) = 13.4
F_S (LPG) = 11.6
F_S (NG) = 9.5"

<u>Paragraph 4.3.2.</u>, amend to read:

"4.3.2. Systems with flow compensation

For systems without heat exchanger, the mass of the pollutants (g/test) must be determined by calculating the instantaneous mass emissions and integrating the instantaneous values over the cycle. Also, the background correction must be applied directly to the instantaneous concentration value. The following formulae must be applied:

(1) $NO_{x\ mass}$ =

$$\sum_{i=1}^{n} \left(M_{TOTW,i} \times NOx_{conce,i} \times 0.001587 \times K_{H,D}\right) - \left(M_{TOTW} \times NOx_{concd} \times (1 - 1/DF) \times 0.001587 \times K_{H,D}\right)$$

(diesel engines)

(2) $NO_{x\ mass}$ =

$$\sum_{i=1}^{n} \left(M_{TOTW,i} \times NOx_{conce,i} \times 0.001587 \times K_{H,G}\right) - \left(M_{TOTW} \times NOx_{concd} \times (1 - 1/DF) \times 0.001587 \times K_{H,G}\right)$$

(gas engines)

(3) $$CO_{mass} = \sum_{i=1}^{n} \left(M_{TOTW,i} \times CO_{conce,i} \times 0.000966\right) - \left(M_{TOTW} \times CO_{concd} \times (1 - 1/DF) \times 0.000966\right)$$

(4) $$HC_{mass} = \sum_{i=1}^{n} \left(M_{TOTW,i} \times HC_{conce,i} \times 0.000479\right) - \left(M_{TOTW} \times HC_{concd} \times (1 - 1/DF) \times 0.000479\right)$$

(diesel engines)

(5) $$HC_{mass} = \sum_{i=1}^{n} \left(M_{TOTW,i} \times HC_{conce,i} \times 0.000502\right) - \left(M_{TOTW} \times HC_{concd} \times (1 - 1/DF) \times 0.000502\right)$$

(LPG engines)

(6) $$\mathbf{HC_{mass}} = \sum_{i=1}^{n} \left(\mathbf{M_{TOTW,i}} \times \mathbf{HC_{conce,i}} \times \mathbf{0.000552}\right) - \left(\mathbf{M_{TOTW}} \times \mathbf{HC_{concd}} \times (\mathbf{1 - 1/DF}) \times \mathbf{0.000552}\right)$$

(NG engines)

(7) $\mathbf{NMHC_{mass}}$ **=**

$$\sum_{i=1}^{n} \left(\mathbf{M_{TOTW,i}} \times \mathbf{NMHC_{conce,i}} \times \mathbf{0.000479}\right) - \left(\mathbf{M_{TOTW}} \times \mathbf{NMHC_{concd}} \times (\mathbf{1 - 1/DF}) \times \mathbf{0.000479}\right)$$

(diesel engines)

(8) $\mathbf{NMHC_{mass}}$ =

$$\sum_{i=1}^{n}\left(\mathbf{M_{TOTW,i}} \times \mathbf{NMHC_{conce,i}} \times \mathbf{0.000502}\right) - \left(\mathbf{M_{TOTW}} \times \mathbf{NMHC_{concd}} \times \left(\mathbf{1 - 1/DF}\right) \times \mathbf{0.000502}\right)$$

(LPG engines)

(**9**) $NMHC_{mass}$ =

$$\sum_{i=1}^{n}\left(M_{TOTW,i} \times NMHC_{conce,i} \times 0.000516\right) - \left(M_{TOTW} \times NMHC_{concd} \times \left(1 - 1/DF\right) \times 0.000516\right)$$

(NG engines)

(**10**) $$CH_{4\ mass} = \sum_{i=1}^{n}\left(M_{TOTW,i} \times CH_{4\ conce,i} \times 0.000552\right) - \left(M_{TOTW} \times CH_{4\ concd} * \left(1 - 1/DF\right) \times 0.000552\right)$$

(NG engines)

where:

$conc_e$ = concentration of the respective pollutant measured in the diluted exhaust gas, ppm

$conc_d$ = concentration of the respective pollutant measured in the dilution air, ppm

$M_{TOTW,I}$ = instantaneous mass of the diluted exhaust gas (see paragraph 4.1.), kg

M_{TOTW} = total mass of diluted exhaust gas over the cycle (see paragraph 4.1.), kg

$K_{H,D}$ = humidity correction factor for diesel engines as determined in paragraph 4.2., **based on cycle averaged intake air humidity**

$K_{H,G}$ = humidity correction factor for gas engines as determined in paragraph 4.2., **based on cycle averaged intake air humidity**

DF = dilution factor as determined in paragraph 4.3.1.1."

<u>Paragraph 4.4.</u>, amend to read:

"4.4. Calculation of the specific emissions

The emissions (g/kWh) must be calculated for **the** individual components, **as required according to paragraphs 5.2.1. and 5.2.2. for the respective engine technology,** in the following way:

$\overline{NO_x} = NOx_{mass}/W_{act}$ (diesel and gas engines)

$\overline{CO} = CO_{mass}/W_{act}$ (diesel and gas engines)

$\overline{HC} = HC_{mass}/W_{act}$ (**diesel and gas engines**)

$\overline{NMHC} = NMHC_{mass}/W_{act}$ (**diesel and gas engines**)

$\overline{CH_4} = CH_{4mass}/W_{act}$ (NG fuelled gas engines)

where:

W_{act} = actual cycle work as determined in paragraph 3.9.2., kWh."

Paragraph 5., amend to read:

"5. CALCULATION OF THE PARTICULATE EMISSION (**IF APPLICABLE**)"

Annex 4 - Appendix 5, paragraph 1.8.2., amend to read:

"1.8.2. Hydrocarbon response factors

The analyser must be calibrated using propane in air and purified synthetic air, according to paragraph 1.5.

Response factors must be determined when introducing an analyser into service and after major service intervals. The response factor (R_f) for a particular hydrocarbon species is the ratio of the FID C1 reading to the gas concentration in the cylinder expressed by ppm C1.

The concentration of the test gas must be at a level to give a response of approximately 80 per cent of full scale. The concentration must be known to an accuracy of ± 2 per cent in reference to a gravimetric standard expressed in volume. In addition, the gas cylinder must be preconditioned for 24 hours at a temperature of 298 K ± 5 K (25°C ± 5°C).

The test gases to be used and the recommended relative response factor ranges are as follows:

Methane and purified synthetic air	$1.00 \leq R_f \leq 1.15$	**(diesel and LPG engines)**
Methane and purified synthetic air	$\mathbf{1.00 \leq R_f \leq 1.07}$	**(NG engines)**
Propylene and purified synthetic air	$0.90 \leq R_f \leq 1.1$	
Toluene and purified synthetic air	$0.90 \leq R_f \leq 1.10$	

These values are relative to the response factor (R_f) of 1.00 for propane and purified synthetic air."

Annex 8,

Paragraph 3.1, amend to read:

"3.1. Gaseous emissions (diesel engine)

Assume the following test results for a PDP-CVS system

V_0	(m^3/rev)	0.1776
N_p	(rev)	23073
p_B	(kPa)	98.0
p_1	(kPa)	2.3
T	(K)	322.5
H_a	(g/kg)	12.8
$NO_{x\ conce}$	(ppm)	53.7
$NO_{x\ concd}$	(ppm)	0.4
CO_{conce}	(ppm)	38.9
CO_{concd}	(ppm)	1.0
HC_{conce}	(ppm) **without cutter**	9.00
HC_{concd}	(ppm) **without cutter**	3.02
HC_{conce}	**(ppm) with cutter**	**1.20**
HC_{concd}	**(ppm) with cutter**	**0.65**
$CO_{2,conce}$	(%)	0.723
W_{act}	(kWh)	62.72

Calculation of the diluted exhaust gas flow (annex 4, appendix 2, paragraph 4.1.):

$$M_{TOTW} = 1.293 * 0.1776 * 23073 * (98.0 - 2.3) * 273 / (101.3 * 322.5) = 4237.2 \text{ kg}$$

Calculation of the NO_x correction factor (annex 4, appendix 2, paragraph 4.2.):

$$K_{H,D} = \frac{1}{1-0.0182\times(12.8-10.71)} = 1.039$$

Calculation of the NMHC concentration by NMC method (annex 4, appendix 2, paragraph 4.3.1.), assuming a methane efficiency of 0.04 and an ethane efficiency of 0.98:

$$\mathbf{NMHC_{conce}} = \frac{9.0\times(1-0.04)-1.2}{0.98-0.04} = 7.91 \text{ ppm}$$

$$\mathbf{NMHC_{concd}} = \frac{3.02\times(1-0.04)-0.65}{0.98-0.04} = 2.39 \text{ ppm}$$

Calculation of the background corrected concentrations (annex 4, appendix 2, paragraph 4.3.1.1.):

Assuming a diesel fuel of the composition $C_1H_{1.8}$

$$F_s = 100 * \frac{1}{1+(1.8/2)+(3.76*(1+(1.8/4)))} = 13.6$$

$$DF = \frac{13.6}{0.723+(9.00+38.9)*10^{-4}} = 18.69$$

$NO_{x\ conc}$ = 53.7 - 0.4 * (1 - (1/18.69)) = 53.3 ppm

CO_{conc} = 38.9 - 1.0 * (1 - (1/18.69)) = 37.9 ppm

HC_{conc} = 9.00 - 3.02 * (1 - (1/18.69)) = 6.14 ppm

$NMHC_{conc}$ = 7.91 - 2.39 * (1 - (1/18.69)) = 5.65 ppm

Calculation of the emissions mass flow (annex 4, appendix 2, paragraph 4.3.1.):

$NO_{x\ mass}$ = 0.001587 * 53.3 * 1.039 * 4237.2 = 372.391 g

CO_{mass} = 0.000966 * 37.9 * 4237.2 = 155.129 g

HC_{mass} = 0.000479 * 6.14 * 4237.2 = 12.462 g

$NMHC_{mass}$ = 0.000479 * 5.65 * 4237.2 = 11.467 g

Calculation of the specific emissions (annex 4, appendix 2, paragraph 4.4.):

$\overline{NO_x}$ = 372.391 / 62.72 = 5.94 g/kWh

$\overline{CO}$ = 155.129 / 62.72 = 2.47 g/kWh

$\overline{HC}$ = 12.462 / 62.72 = 0.199 g/kWh

$\overline{NMHC}$ = 11.467 / 62.72 = 0.183 g/kWh "

Paragraph 3.3., amend to read (deleting also words "with double dilution" in the first sentence)**:**

"3.3. Gaseous emissions (CNG engine)

Assume the following test results for a PDP-CVS system

M_{TOTW}	(kg)	4237.2
H_a	(g/kg)	12.8
$NO_{x\ conce}$	(ppm)	17.2
$NO_{x\ concd}$	(ppm)	0.4
$CO_{\ conce}$	(ppm)	44.3
$CO_{\ concd}$	(ppm)	1.0
$HC_{\ conce}$	(ppm) **without cutter**	27.0
$HC_{\ concd}$	(ppm) **without cutter**	**2.02**
$HC_{\ conce}$	**(ppm) with cutter**	**18.0**
$HC_{\ concd}$	**(ppm) with cutter**	**0.65**
$CH_{4\ conce}$	(ppm)	18.0
$CH_{4\ concd}$	(ppm)	**1.1**
$CO_{2,conce}$	(%)	0.723
W_{act}	(kWh)	62.72

Calculation of the NOx correction factor (annex 4, appendix 2, paragraph 4.2.):

$$K_{H,G} = \frac{1}{1-0.0329\times(12.8-10.71)} = 1.074$$

Calculation of the NMHC concentration (annex 4, appendix 2, paragraph 4.3.1.):

a) GC method

$$NMHC_{conce} = 27.0 - 18.0 = 9.0 \text{ ppm}$$

b) NMC method

Assuming a methane efficiency of 0.04 and an ethane efficiency of 0.98 (see annex 4, appendix 5, paragraph 1.8.4.)

$$NMHC_{conce} = \frac{27.0\times(1-0.04)-18.0}{0.98-0.04} = 8.4 \text{ ppm}$$

$$\mathbf{NMHC_{concd} = \frac{2.02\times(1-0.04)-0.65}{0.98-0.04} = 1.37 \text{ ppm}}$$

Calculation of the background corrected concentrations (annex 4, appendix 2, paragraph 4.3.1.1.):

Assuming a 100 % methane fuel of the composition C_1H_4

$$F_S = 100 \times \frac{1}{1+(4/2)+(3.76\times(1+(4/4)))} = 9.5$$

$$DF = \frac{9.5}{0.723+(27.0+44.3)\times 10^{-4}} = 13.01$$

For NMHC with GC method, the background concentration is the difference between HC_{concd} and $CH_{4\ concd}$

$NO_{x\ conc}$ = 17.2 - 0.4 * (1 - (1/13.01)) = 16.8 ppm

CO_{conc} = 44.3 - 1.0 * (1 - (1/13.01)) = 43.4 ppm

$NMHC_{conc}$ = 8.4 - 1.37 * (1 - (1/13.01)) = 7.13 ppm (NMC method)

$NMHC_{conc}$ = 9.0 - 0.92 * (1 - (1/13.01)) = 8.15 ppm (GC method)

$CH_{4\ conc}$ = 18.0 - 1.1 * (1 - (1/13.01)) = 17.0 ppm (GC method)

Calculation of the emissions mass flow (annex 4, appendix 2, paragraph 4.3.1.):

$NO_{x\ mass}$ = 0.001587 * 16.8 * 1.074 * 4237.2 =121.330 g

CO_{mass} = 0.000966 * 43.4 * 4237.2 = 177.642 g

$NMHC_{mass}$ = 0.000516 * 7.13 * 4237.2 = 15.589 g (NMC method)

$NMHC_{mass}$ = 0.000516 * 8.15 * 4237.2 = 17.819 g (GC method)

$CH_{4\ mass}$ = 0.000552 * 17.0 * 4237.2 = 39.762 g (GC method)

Calculation of the specific emissions (annex 4, appendix 2, paragraph 4.4.):

$\overline{NO_x}$ = 121.330/62.72 = 1.93 g/kWh

$\overline{CO}$ = 177.642/62.72 = 2.83 g/kWh

$\overline{NMHC}$ = 15.589/62.72 = 0.249 g/kWh (NMC method)

$\overline{NMHC}$ = 17.819/62.72 = 0.284 g/kWh (GC Method)

$\overline{CH_4}$ = 39.762/62.72 = 0.634 g/kWh (GC method)"

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