Commission Regulation (EU) No 582/2011 of 25 May 2011 implementing and amending Regulation (EC) No 595/2009 of the European Parliament and of the Council with respect to emissions from heavy duty vehicles (Euro VI) and amending Annexes I and III to Directive 2007/46/EC of the European Parliament and of the Council (Text with EEA relevance)

ANNEX III

VERIFYING EXHAUST EMISSIONS

1.   INTRODUCTION

1.1.   This Annex sets out the test procedure for verifying exhaust emissions.

2.   GENERAL REQUIREMENTS

2.1.   The general requirements for conducting the tests and interpreting the results shall be those set out in Annex 4B to UN/ECE Regulation No 49 with the exceptions set out in points 2.2 to 2.6.

2.2.   The appropriate reference fuels as described in Annex IX to this Regulation shall be used for testing.

2.3.   If the emissions are measured in the raw exhaust gas, Table 5 in Section 8.4.2.3 of Annex 4B to UN/ECE Regulation No 49 of shall be replaced with the following table:

Table 1

Raw exhaust gas *u* values and component densities

Fuel	ρ_e	**Gas**					
		NO$_x$	**CO**	**HC**	**CO$_2$**	**O$_2$**	**CH$_4$**
		ρ_{gas} **[kg/m^3]**					
		2,053	**1,25**	[a]	**1,9636**	**1,4277**	**0,716**
		u_{gas}[b]					
Diesel (B7)	1,2943	0,001586	0,000966	0,000482	0,001517	0,001103	0,000553
Ethanol (ED95)	1,2768	0,001609	0,00098	0,00078	0,001539	0,001119	0,000561
CNG[c]	1,2661	0,001621	0,000987	0,000528[d]	0,001551	0,001128	0,000565
Propane	1,2805	0,001603	0,000976	0,000512	0,001533	0,001115	0,000559
Butane	1,2832	0,0016	0,000974	0,000505	0,00153	0,001113	0,000558
LPG[e]	1,2811	0,001602	0,000976	0,00051	0,001533	0,001115	0,000559

a	depending on fuel.
b	at λ = 2, dry air, 273 K, 101,3 kPa.
c	*u* accurate within 0,2 % for mass composition of: C = 66 - 76 %; H = 22 - 25 %; N = 0 - 12 %.
d	NMHC on the basis of CH$_{2,93}$ (for total HC the u_{gas} coefficient of CH$_4$ shall be used).
e	*u* accurate within 0,2 % for mass composition of: C$_3$ = 70 - 90 %; C$_4$ = 10 - 30 %.

2.4.   If the emissions are measured in the dilute exhaust gas, Table 6 in Section 8.5.2.3.1 of Annex 4B to UN/ECE Regulation No 49 shall be replaced with the following table:

Commission Regulation (EU) No 582/2011 of 25 May 2011 implementing and amending Regulation...
ANNEX III
Document Generated: 2024-02-15

3

Table 2

Dilute exhaust gas *u* values and component densities

Fuel	ρ_{de}	Gas					
		NO_x	CO	HC	CO_2	O_2	CH_4
		ρ_{gas} [kg/m^3]					
		2,053	1,25	[a]	1,9636	1,4277	0,716
		u_{gas}[b]					
Diesel (B7)	1,293	0,001588	0,000967	0,000483	0,001519	0,001104	0,000553
Ethanol (ED95)	1,293	0,001588	0,000967	0,00077	0,001519	0,001104	0,000553
CNG[c]	1,293	0,001588	0,000967	0,000517[d]	0,001519	0,001104	0,000553
Propane	1,293	0,001588	0,000967	0,000507	0,001519	0,001104	0,000553
Butane	1,293	0,001588	0,000967	0,000501	0,001519	0,001104	0,000553
LPG[e]	1,293	0,001588	0,000967	0,000505	0,001519	0,001104	0,000553

a   depending on fuel.

b   at $\lambda = 2$, dry air, 273 K, 101,3 kPa.

c   *u* accurate within 0,2 % for mass composition of: C = 66 - 76 %; H = 22 - 25 %; N = 0 - 12 %.

d   NMHC on the basis of $CH_{2,93}$ (for total HC the u_{gas} coefficient of CH_4 shall be used).

e   *u* accurate within 0,2 % for mass composition of: C_3 = 70 - 90 %; C_4 = 10 - 30 %.

2.5.   Ammonia (NH_3) shall be determined in accordance with Appendix 1 to this Annex.

2.6.   The emissions from positive-ignition engines fuelled with petrol or E85 shall be determined in accordance with Appendix 2 to this Annex.

Appendix 1

Procedure for the measurement of ammonia

1.   This Appendix describes the procedure for measurement of ammonia (NH_3). For non-linear analysers, the use of linearising circuits shall be permitted.

2.   Two measurement principles are specified for NH_3 measurement and either principle may be used provided it meets the criteria specified in point 2.1 or 2.2, respectively. Gas dryers shall not be permitted for NH_3 measurement.

2.1. **Laser Diode Spectrometer (LDS)**

2.1.1. *Measurement principle*

The LDS employs the single line spectroscopy principle. The NH_3 absorption line is chosen in the near infrared spectral range and scanned by a single-mode diode laser.

2.1.2. *Installation*

The analyser shall be installed either directly in the exhaust pipe (in-situ) or within an analyser cabinet using extractive sampling in accordance with the instrument manufacturers instructions. If installed in an analyser cabinet, the sample path (sampling line, pre-filter(s) and valves) shall be made of stainless steel or PTFE and shall be heated to 463 ± 10 K (190 ± 10 °C) in order to minimise NH_3 losses and sampling artefacts. In addition, the sampling line shall be as short as practically possible.

Influence from exhaust temperature and pressure, installation environment and vibrations on the measurement shall be minimised, or compensation techniques be used.

If applicable, sheath air used in conjunction with in-situ measurement for protection of the instrument, shall not affect the concentration of any exhaust component measured downstream of the device, or sampling of other exhaust components shall be made upstream of the device.

2.1.3. *Cross interference*

The spectral resolution of the laser shall be within $0,5$ cm^{-1} in order to minimise cross interference from other gases present in the exhaust gas.

2.2. **Fourier Transform Infrared (hereinafter 'FTIR') analyser**

2.2.1. *Measurement principle*

The FTIR employs the broad waveband infrared spectroscopy principle. It allows simultaneous measurement of exhaust components whose standardised spectra are available in the instrument. The absorption spectrum (intensity/wavelength) is calculated from the measured interferogram (intensity/time) by means of the Fourier transform method.

2.2.2. *Installation and sampling*

The FTIR shall be installed in accordance with the instrument manufacturer's instructions. The NH_3 wavelength shall be selected for evaluation. The sample path (sampling line, pre-filter(s) and valves) shall be made of stainless steel or PTFE and shall be heated to 463 ± 10 K (190 ± 10 °C) in order to minimise NH_3 losses and sampling artefacts. In addition, the sampling line shall be as short as practically possible.

2.2.3.   *Cross interference*

The spectral resolution of the NH_3 wavelength shall be within 0,5 cm^{-1} in order to minimise cross interference from other gases present in the exhaust gas.

3.   EMISSIONS TEST PROCEDURE AND EVALUATION

3.1.   **Checking the analysers**

Prior to the emissions test, the analyser range shall be selected. Emission analysers with automatic or manual range switching shall be permitted. During the test cycle, the range of the analysers shall not be switched.

Zero and span response shall be determined, if the provisions of point 3.4.2 do not apply for the instrument. For the span response, a NH_3 gas that meets the specifications of point 4.2.7 shall be used. The use of reference cells that contain NH_3 span gas is permitted.

3.2.   **Collection of emission relevant data**

At the start of the test sequence, the NH_3 data collection shall be started, simultaneously. The NH_3 concentration shall be measured continuously and stored with at least 1 Hz on a computer system.

3.3.   **Operations after test**

At the completion of the test, sampling shall continue until system response times have elapsed. Determination of analyser's drift according to point 3.4.1 shall only be required if the information in point 3.4.2 is not available.

3.4.   **Analyser drift**

3.4.1   As soon as practical but no later than 30 minutes after the test cycle is complete or during the soak period, the zero and span responses of the analyser shall be determined. The difference between the pre-test and post-test results shall be less than 2 % of full scale.

3.4.2.   Determination of analyser drift is not required in the following situations:

(a)   if the zero and span drift specified by the instrument manufacturer in points 4.2.3 and 4.2.4 meets the requirements of point 3.4.1;

(b)   the time interval for zero and span drift specified by the instrument manufacturer in points 4.2.3 and 4.2.4 exceeds the duration of the test.

3.5.   **Data evaluation**

The average NH_3 concentration (ppm/test) shall be determined by integrating the instantaneous values over the cycle. The following equation shall be applied:

$$c_{NH3} = \frac{1}{n} \sum_{i=1}^{i=n} c_{NH3,i}$$

in ppm/test)

where:

     $c_{NH3,i}$ is the instantaneous NH_3 concentration in the exhaust gas, ppm,

     n is the number of measurements.

For the WHTC, the final test result shall be determined with the following equation:

$$c_{NH3} = (0{,}14 \times c_{NH3,cold}) + (0{,}86 \times c_{NH3,hot})$$

where:

$c_{NH3,cold}$	is the average NH_3 concentration of the cold start test, ppm,
$c_{NH3,hot}$	is the average NH_3 concentration of the hot start test, ppm.

4.   ANALYSER SPECIFICATION AND VERIFICATION

4.1.   **Linearity requirements**

The analyser shall comply with the linearity requirements specified in Table 7 of Annex 4B to UN/ECE Regulation No 49. The linearity verification in accordance with Section 9.2.1 of Annex 4B to UN/ECE Regulation No 49, shall be performed at least every 12 months or whenever a system repair or change is made that could influence calibration. With the prior approval of the approval authority, less than 10 reference points are permitted, if an equivalent accuracy can be demonstrated.

For the linearity verification, a NH_3 gas that meets the specifications of point 4.2.7 shall be used. The use of reference cells that contain NH_3 span gas shall be permitted.

Instruments, whose signals are used for compensation algorithms, shall meet the linearity requirements specified in Table 7 of Annex 4B to the UN/ECE Regulation No 49. Linearity verification shall be done as required by internal audit procedures, by the instrument manufacturer or in accordance with ISO 9000 requirements.

4.2.   **Analyser specifications**

The analyser shall have a measuring range and response time appropriate for the accuracy required to measure the concentration of NH_3 under transient and steady state conditions.

4.2.1.   *Minimum detection limit*

The analyser shall have a minimum detection limit of < 2 ppm under all conditions of testing.

4.2.2.   *Accuracy*

The accuracy, defined as the deviation of the analyser reading from the reference value, shall not exceed ± 3 % of the reading or ± 2 ppm, whichever is larger.

4.2.3.   *Zero drift*

The drift of the zero response and the related time interval shall be specified by the instrument manufacturer.

4.2.4.   *Span drift*

The drift of the span response and the related time interval shall be specified by the instrument manufacturer.

4.2.5.   *System response time*

The system response time shall be ≤ 20 s.

4.2.6.   *Rise time*

The rise time of the analyser shall be ≤ 5 s.

Commission Regulation (EU) No 582/2011 of 25 May 2011 implementing and amending Regulation...
ANNEX III
Document Generated: 2024-02-15

7

4.2.7. *NH_3 calibration gas*

A gas mixture with the following chemical composition shall be available:

NH_3 and purified nitrogen.

The true concentration of the calibration gas shall be within ± 3 % of the nominal value. The concentration of NH_3 shall be given on a volume basis (volume per cent or volume ppm).

The expiration date of the calibration gases stated by the manufacturer shall be recorded.

5.   ALTERNATIVE SYSTEMS

Other systems or analysers may be approved by the approval authority, if it is found that they yield equivalent results in accordance with Section 5.1.1 of Annex 4B to UN/ECE Regulation No 49.

'Results' shall refer to average cycle specific NH_3 concentrations.

Appendix 2

Determination of emissions from positive-ignition engines fuelled with petrol or E85

1.   This Appendix describes the procedure for measurement of gaseous and particulate emissions from positive-ignition engines.

2.1.   The tests shall be conducted and evaluated as set out in Annex 4B to UN/ECE Regulation No 49 with the exceptions set out in points 2.1.1 to 2.2.

2.1.1. *Calculation of mass emission (raw exhaust gas)*

The mass of the pollutants (g/test) shall be determined in accordance with Section 8.4.2.3 or 8.4.2.4 of Annex 4B to UN/ECE Regulation No 49 with the *u* values from Table 3.

TABLE 3

Raw exhaust gas *u* values and component densities

Fuel	ρ_e	Gas					
		NO_x	CO	HC	CO_2	O_2	CH_4
		ρ_{gas} [kg/m^3]					
		2,053	**1,25**	**a**	**1,9636**	**1,4277**	**0,716**
		u_{gas} ^b					
Petrol (E10)	1,2931	0,001587	0,000966	0,000499	0,001518	0,001104	0,000553
Ethanol (E85)	1,2797	0,001604	0,000977	0,00073	0,001534	0,001116	0,000559

a depending on fuel.

b at $\lambda = 2$, dry air, 273 K, 101,3 kPa.

2.1.2. *Calculation of mass emission (dilute exhaust gas)*

The mass of the pollutants (g/test) shall be determined in accordance with Section 8.5.2.3 of Annex 4B to UN/ECE Regulation No 49 with the *u* values from Table 4.

TABLE 4

Dilute exhaust gas *u* values and component densities

Fuel	ρ_e	Gas					
		NO_x	CO	HC	CO_2	O_2	CH_4
		ρ_{gas} [kg/m^3]					
		2,053	**1,25**	**a**	**1,9636**	**1,4277**	**0,716**
		u_{gas} ^b					
Petrol (E10)	1,293	0,001588	0,000967	0,000499	0,001519	0,001104	0,000554

a depending on fuel.

b at $\lambda = 2$, dry air, 273 K, 101,3 kPa.

| Ethanol (E85) | 1,293 | 0,001588 | 0,000967 | 0,000722 | 0,001519 | 0,001104 | 0,000554 |

| a | depending on fuel. |

| b | at $\lambda = 2$, dry air, 273 K, 101,3 kPa. |

For systems with flow compensation, the u_{gas} values given in Table 4, shall be inserted into equation 62 of Section 8.5.2.3.3 of Annex 4B to UN/ECE Regulation No 49.

2.1.2.1. *Background correction*

The emissions shall be background corrected according to the requirements of Section 8.5.2.3.2 of Annex 4B to UN/ECE Regulation No 49. If the fuel composition is not known, the following stoichiometric factors may be used:

F_S (E10) = 13,3
F_S (E85) = 11,5

2.2.   For the dilute testing of positive-ignition engines, it is permitted to use analyser systems that meet the general requirements and calibration procedures of Un/ECE Regulation No 83. In this case, the provisions of Section 9 and Appendix 3 of Annex 4B to UN/ECE Regulation No 49 shall not apply.

However, the test procedures in Section 7 of Annex 4B to UN/ECE Regulation No 49 and the emission calculations provided in Section 2.1 of this Appendix and in Section 8 of Annex 4B to UN/ECE Regulation No 49 shall apply.