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Subject:	ANNEXES to the Commission Regulation amending Commission Regulation (EU) 2017/xxx and Directive 2007/46/EC of the European Parliament and of the Council as regards real-driving emissions from light passenger and commercial vehicles (Euro 6)

Delegations will find attached document D048924/04 - Annexes 1 to 3.

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ANNEXES 1 to 3

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to the

Commission Regulation

amending Commission Regulation (EU) 2017/xxx and Directive 2007/46/EC of the European Parliament and of the Council as regards real-driving emissions from light passenger and commercial vehicles (Euro 6)

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ANNEX I

In Annex I to Regulation (EU) 2017/xxx, the following Appendix 3a is inserted:

"**Appendix 3a: Extended Documentation Package**

The extended documentation package shall include the following information on all AES:

(a) a declaration of the manufacturer that the vehicle does not contain any defeat device not covered by one of the exceptions in Article 5 (2) of Regulation (EC) 715/2007;

(b) a description of the engine and the emission control strategies and devices employed, whether software or hardware, and any condition(s) under which the strategies and devices will not operate as they do during testing for TA;

(c) a declaration of the software versions used to control these AES/BES, including the appropriate checksums of these software versions and instructions to the authority on how to read the checksums; the declaration shall be updated and sent to the Type Approval Authority that holds this extended documentation package each time there is a new software version that has an impact to the AES/BES;

(d) detailed technical reasoning of any AES; including explanations on why any of the exception clauses from the defeat device prohibition in Article 5(2) of Regulation (EC) No 715/2007 apply, where applicable; including hardware element(s) that need to be protected by the AES, if applicable; and/or proof of sudden and irreparable engine damage that cannot be prevented by regular maintenance and would occur in the absence of the AES along with a risk assessment estimating the risk with the AES and without it; reasoned explanation on why there is a need to use an AES for starting the engine;

(e) a description of the fuel system control logic, timing strategies and switch points during all modes of operation;

(f) a description of the hierarchical relations among the AES (i.e., when more than one AES can be active concurrently, an indication of which AES is primary in responding, the method by which strategies interact, including data flow diagrams and decision logic and how does the hierarchy assure emissions from all AES are controlled to the lowest practical level;

(g) a list of parameters which are measured and/or calculated by the AES, along with the purpose of every parameter measured and/or calculated and how each of those parameters relates to engine damage; including the method of calculation and how well these calculated parameters correlate with the true state of the parameter being controlled and any resulting tolerance or factor of safety incorporated into the analysis;

(h) a list of engine/emission control parameters which are modulated as a function of the measured or calculated parameter(s) and the range of modulation for each engine/emission control parameter; along with the relationship between engine/emission control parameters and measured or calculated parameters;

(i) an evaluation of how the AES will control real-driving emissions to the lowest practical level, including a detailed analysis of the expected increase of total regulated pollutants and CO_2 emissions by using the AES, compared to the BES.".

ANNEX II

Annex IIIA to Regulation (EU) 2017/xxx is amended as follows:

(1) point 1.2.12 is replaced by the following:
"1.2.12. "*Exhaust emissions*" means the tailpipe emissions of gaseous, solid and liquid compounds.";

(2) point 1.2.18 is replaced by the following:
"1.2.18. "*Particle number emissions*" (PN) means the total number of solid particles emitted from the vehicle exhaust quantified according to the dilution, sampling and measurement methods as specified in Annex XXI.";

(3) point 1.2.25 is replaced by the following:
"1.2.25. "*Span*" means to adjust an instrument so that it gives a proper response to a calibration standard that represents between 75 per cent and 100 per cent of the maximum value in the instrument range or expected range of use.";

(4) the following points 1.2.40 and 1.2.41 are inserted:

"1.2.40. "Off-vehicle charging hybrid electric vehicle"(OVC-HEV) means a hybrid electric vehicle that can be charged from an external source.

1.2.41. "Not off-vehicle charging hybrid electric vehicle" (NOVC-HEV) means a vehicle with at least two different energy converters and two different energy storage systems that are used for the purpose of vehicle propulsion and that cannot be charged from an external source.";

(5) in point 2.1.1, in the table, the words "to be determined" are replaced by "1 + *margin* PN with *margin* PN = 0,5";

(6) in point 2.1.2, in the table, the words "to be determined" are replaced by "1 + *margin PN* with *margin* PN = 0,5";

(7) The following paragraph is added under the tables in points 2.1.1 and 2.1.2:

"margin PN" is a parameter taking into account the additional measurement uncertainties introduced by the PEMS PN equipment, which are subject to an annual review and shall be revised as a result of the improved quality of the PEMS PN procedure or technical progress.";

(8) The last sentence in point 2.3 is amended as follows:
"If the respective PEMS test is not required by this Regulation the manufacturer may charge a reasonable fee similar to the provision in Article 7(1) of Regulation (EC) No 715/2007";

(9) point 3.1 is replaced by the following:

"3.1 The following requirements apply to PEMS tests referred to in Article 3(11)";

(10) point 3.1.0 is : replaced by the following:

"3.1.0. The requirements of point 2.1 shall be fulfilled for the urban part and the complete PEMS trip. Upon the choice of the manufacturer the conditions of at least one of the two points 3.1.0.1 or 3.1.0.2 below shall be fulfilled. OVC-HEVs shall fulfil the conditions of point 3.1.0.3. ";

(11) the following point 3.1.0.3 is inserted:

"3.1.0.3. $M_t \leq \text{NTE}_{\text{pollutant}}$ and $M_u \leq \text{NTE}_{\text{pollutant}}$ with the definitions of point 2.1 of this Annex and point 4 of Appendix 7c.";

(12) points 3.1.3.2. and 3.1.3.2.1. are replaced by the following:

"3.1.3.2. The manufacturer shall ensure that the information listed in point 3.1.3.2.1. is made available on a publicly accessible website without costs and without the need for the user to reveal his identity or sign up. The manufacturer shall keep the Commission and Type Approval Authorities informed on the location of the website.

3.1.3.2.1. The website shall allow a wildcard search of the underlying database based on one or more of the following:

Make, Type, Variant, Version, Commercial name, or Vehicle Identification Number, as defined in the Certificate of Conformity, pursuant to Annex IX of Directive (EC) 2007/46.

The information described below shall be made available for all vehicles in a search:

– the results of the PEMS tests as set out in point 6.3 of Appendix 5, point 3.9 of Appendix 6 and point 4 of Appendix 7c for all vehicle emission types in the list described in point 5.4 of Appendix 7. For NOVC-HEVs, the results of the PEMS tests as set out in point 6.3 of Appendix 5 and, if applicable, point 3.9 of Appendix 6 shall be reported. For OVC-HEVs, the results of the PEMS test as set out in point 4 of Appendix 7c shall be reported;

- the Declared Maximum RDE Values as reported in point 48.2 of the Certificate of Conformity, as described in Annex IX of Directive 2007/46/EC.";

(13) point 3.1.3.2.2 is deleted;

(14) points 4.2 and 4.3 are replaced by the following:

"4.2. The manufacturer shall demonstrate to the approval authority that the chosen vehicle, driving patterns, conditions and payloads are representative for the PEMS test family. The payload and altitude requirements, as specified in points 5.1 and 5.2, shall be used ex-ante to determine whether the conditions are acceptable for RDE testing.

4.3. The approval authority shall propose a test trip in urban, rural and motorway environments meeting the requirements of point 6. For the purpose of trip design, the urban, rural and motorway parts shall be selected based on a topographic map. The urban part of the

trip should be driven on urban roads with a speed limit of 60 km/h or less. In case the urban part of the trip needs to be driven for a limited period of time on roads with speed limit higher than 60 km/h, the vehicle shall be driven with speeds up to 60 km/h.";

(15) the following point 4.5 is inserted:

"4.5 In order to also assess emissions during trips in hot start, a certain number of vehicles per PEMS test family, specified in point 4.2.7 in Appendix 7, shall be tested without conditioning the vehicle as described in point 5.3, but with a warm engine.";

(16) point 5.2.1 is replaced by the following:

"5.2.1 The test shall be conducted under ambient conditions laid down in this section. The ambient conditions become “extended” when at least one of the temperature and altitude conditions is extended. The correction factor for extended conditions for temperature and altitude shall only be applied once. If a part of the test or the entire test is performed outside of normal or extended conditions, the test shall be invalid.";

(17) point 5.2.4 is replaced by the following:
“5.2.4. Moderate temperature conditions: Greater than or equal to 273.15 K (0°C) and lower than or equal to 303.15 K (30°C).”

(18) point 5.2.5 is replaced by the following:
“5.2.5. Extended temperature conditions: Greater than or equal to 266.15 K (-7°C) and lower than 273.15 K (0°C) or greater than 303.15 K (30°C) and lower than or equal to 308.15 K (35°C).”

(19) point 5.2.6 is replaced by the following:

"5.2.6 By way of derogation from the provisions of points 5.2.4 and 5.2.5 the lower temperature for moderate conditions shall be greater or equal to 276.15 K (3°C) and the lower temperature for extended conditions shall be greater or equal to 271.15 K (-2°C) between the start of the application of binding NTE emission limits as defined in section 2.1 and until five years and four months after the dates given in paragraphs 4 and 5 of Article 10, of Regulation (EC) No 715/2007.";

(20) point 5.3 is replaced by the following:

"5.3. Vehicle conditioning for cold engine-start testing

Before RDE testing, the vehicle shall be preconditioned in the following way:

Driven for at least 30 min, parked with doors and bonnet closed and kept in engine-off status within moderate or extended altitude and temperatures in accordance with points 5.2.2 to 5.2.6 between 6 and 56 hours. Exposure to extreme atmospheric conditions (heavy snowfall, storm, hail) and excessive amounts of dust should be avoided. Before the test start, the vehicle and equipment shall be checked for damages and the absence of warning signals, suggesting malfunctioning.";

(21) point 5.4.2 is replaced by the following:

"5.4.2 If the trip results are valid following the verifications in accordance with point 5.4.1, the methods for verifying the normality of the test conditions as laid down in Appendices 5, 6, 7a and 7b to this Annex shall be applied. For OVC-HEVs only, the validity of a trip and the normality of test conditions are verified in accordance with Appendix 7c, while Appendices 5 and 6 do not apply.";

(22) points 5.5.2. and 5.5.2.1 to 5.5.2.4 are replaced by the following:

"5.5.2. Vehicles equipped with periodically regenerating systems

5.5.2.1. “Periodically regenerating systems” shall be understood in accordance with the definition in point 3.8.1 of Annex XXI.

5.5.2.2. All results will be corrected with the K_i factors or with the K_i offsets developed by the procedures in sub-annex 6 of Annex XXI for type-approval of a vehicle type with a periodically regenerating system,

5.5.2.3 If the emissions do not fulfil the requirements of point 3.1.0, then the occurrence of regeneration shall be verified. The verification of a regeneration may be based on expert judgement through cross-correlation of several of the following signals, which may include exhaust temperature, PN, CO_2, O_2 measurements in combination with vehicle speed and acceleration.

If periodic regeneration occurred during the test, the result without the application of either the K_i -factor of the K_i offset shall be checked against the requirements of point 3.1.0. If the resulting emissions do not fulfil the requirements, then the test shall be voided and repeated once at the request of the manufacturer. The manufacturer may ensure the completion of the regeneration. The second test is considered valid even if regeneration occurs during it.

5.5.2.4 At the request of the manufacturer, even if the vehicle fulfils the requirements of point 3.1.0, the occurrence of regeneration may be verified as in point 5.5.2.3 above. If the presence of regeneration can be proved and with the agreement of the Type Approval, the final results will be shown without the application of either the K_i factor or the Ki offset.";

(23) the following points 5.5.2.5. and 5.5.2.6. are inserted:

"5.5.2.5 The manufacturer may ensure the completion of the regeneration and precondition the vehicle appropriately prior to the second test.

5.5.2.6. If regeneration occurs during the second RDE test, pollutants emitted during the repeated test shall be included in the emissions evaluation.";

(24) point 6.2 is replaced by the following:

"6.2 The trip shall always start with urban driving followed by rural and motorway driving in accordance with the shares specified in point 6.6. The urban, rural and motorway operation shall be run continuously, but may also include a trip which starts and ends at the same point. Rural operation may be interrupted by short periods of urban operation when driving through urban areas. Motorway operation may be interrupted by short periods of urban or rural operation, e.g., when passing toll stations or sections of road work.";

(25) point 6.4 is replaced by the following:

"6.4 Rural operation is characterised by vehicle speeds higher than 60 km/h and lower than or equal to 90 km/h. For N2 category vehicles that are equipped in accordance with Directive 92/6/EEC with a device limiting vehicle speed to 90 km/h, rural operation is characterised by vehicle speed higher than 60 km/h and lower than or equal to 80 km/h.";

(26) point 6.5 is replaced by the following:

"6.5 Motorway operation is characterised by speeds above 90 km/h. For N2 category vehicles that are equipped in accordance with Directive 92/6/EEC with a device limiting vehicle speed to 90 km/h, motorway operation is characterised by speed higher than 80 km/h.";

(27) points 6.8 and 6.9. are replaced by the following:

"6.8 The average speed (including stops) of the urban driving part of the trip should be between 15 and 40 km/h. Stop periods, defined by vehicle speed of less than 1 km/h, shall account for 6-30 % of the time duration of urban operation. Urban operation may contain several stop periods of 10 s or longer. However, individual stop periods shall not exceed 300 consecutive seconds; else the trip shall be voided.

6.9 The speed range of the motorway driving shall properly cover a range between 90 and at least 110 km/h. The vehicle's velocity shall be above 100 km/h for at least 5 minutes.

For M2 category vehicles that are equipped in accordance with Directive 92/6/EEC with a device limiting vehicle speed to 100 km/h, the speed range of the motorway driving shall properly cover a range between 90 and 100 km/h. The vehicle's velocity shall be above 90 km/h for at least 5 minutes.

For N2 category vehicles that are equipped in accordance with Directive 92/6/EEC with a device limiting vehicle speed to 90 km/h, the speed range of the motorway driving of shall properly cover a range between 80 and 90 km/h. The vehicle's velocity shall be above 80 km/h for at least 5 minutes.";

(28) point 6.11 is replaced by the following:

"6.11 The start and the end point of a trip shall not differ in their elevation above sea level by more than 100 m. In addition, the proportional cumulative positive altitude gain over the entire trip and over the urban part of the trip as determined in accordance with point 4.3 shall be less than 1200 m/100km and be determined in accordance with Appendix 7b.";

(29) the following point 6.13 is inserted:

"6.13 The average speed (including stops) during cold start period as defined in Appendix 4, point 4 shall be between 15 and 40 km/h. The maximum speed during the cold start period shall not exceed 60 km/h.";

(30) point 7.6 is replaced by the following:

"7.6 The idling immediately after the first ignition of the combustion engine shall be kept to the minimum possible and it shall not exceed 15 s. The vehicle stop during the entire cold start period, as defined in point 4 of Appendix 4, shall be kept to the minimum possible and it shall not exceed 90 s. If the engine stalls during the test, it may be restarted, but the sampling shall not be interrupted";

(31) point 9.4 is replaced by the following:

"9.4 After establishing the validity of a trip in accordance with point 9.2 emission results shall be calculated using the methods laid down in Appendices 5 and 6 of this Annex. Appendix 6 shall only be applied to NOVC-HEVs (as defined in point 1.2.40) if the power at the wheels has been determined by wheel hub torque measurements. For OVC-HEVs the emission results shall be calculated using the method laid down in Appendix 7c of this Annex.";

(32) point 9.6 is replaced by the following:

"9.6 The cold start is defined in accordance with point 4 of Appendix 4 of this Annex. Gaseous pollutant and particle number emissions during cold start shall be included in the normal evaluation in accordance with Appendix 5 and 6. For OVC-HEVs the emission results shall be calculated using the method laid down in Appendix 7c of this Annex.

If the vehicle was conditioned for the last three hours prior to the test at an average temperature that falls within the extended range in accordance with point 5.2, then the provisions of point 9.5 of Annex IIIA apply to the cold start period, even if the running conditions are not within the extended temperature range. The corrective factor of 1.6 shall be applied only once. The corrective factor of 1.6 applies to pollutant emissions but not to CO_2.";

(33) Appendix 1 is amended as follows:

(a) Point 3.2; rows 2-4 in Table 1 are amended as follows:

“

Parameter	Recommended unit	Source[8]
THC concentration[1,4]	ppm C_1	Analyser
CH_4 concentration[1,4]	ppm C_1	Analyser
NMHC concentration[1,4]	ppm C_1	Analyser[6]

”

(b) points 3.4.1., 3.4.2. and 3.4.3. are replaced by the following:

"3.4.1. General:

The installation of the PEMS shall follow the instructions of the PEMS manufacturer and the local health and safety regulations. The PEMS should be installed as to minimise during the test electromagnetic interferences as well as exposure to shocks, vibration, dust and variability in temperature. The installation and operation of the PEMS shall be leak-tight and minimise heat loss. The installation and operation of PEMS shall not change the nature of the exhaust gas nor unduly increase the length of the tailpipe. To avoid the generation of particles, connectors shall be thermally stable at the exhaust gas temperatures expected during the test. It is recommended not to use elastomer connectors to connect the vehicle exhaust outlet and the connecting tube. Elastomer connectors, if used, shall have no contact with the exhaust gas to avoid artefacts at high engine load.

3.4.2. Permissible backpressure

The installation and operation of the PEMS sampling probes shall not unduly increase the pressure at the exhaust outlet in a way that may influence the representativeness of the measurements. It is thus recommended that only one sampling probe is installed in the same plane. If technically feasible, any extension to facilitate the sampling or connection with the exhaust mass flow meter shall have an equivalent, or larger, cross sectional area than the exhaust pipe. If the sampling probes obstruct a significant area of the tailpipe cross-section, backpressure measurement may be requested by the Type Approval Authority.

3.4.3. Exhaust mass flow meter

Whenever used, the exhaust mass flow meter shall be attached to the vehicle's tailpipe(s) in accordance with the recommendations of the EFM manufacturer. The measurement range of the EFM shall match the range of the exhaust mass flow rate expected during the test. The installation of the EFM and any exhaust pipe adaptors or junctions shall not adversely affect the operation of the engine or exhaust after-treatment system. A minimum of four pipe diameters or 150 mm of straight tubing, whichever is larger, shall be placed at either side of the flow-sensing element. When testing a multi-cylinder engine with a branched exhaust manifold, it is recommended to position the exhaust mass flow meter downstream of where the manifolds combine and to increase the cross section of the piping such as to have an equivalent, or larger, cross sectional area from which to sample. If this is not feasible, exhaust

flow measurements with several exhaust mass flow meters may be used, if approved by the Type Approval Authorities. The wide variety of exhaust pipe configurations, dimensions and exhaust mass flow rates may require compromises, guided by good engineering judgement, when selecting and installing the EFM(s). It is permissible to install an EFM with a diameter smaller than that of the exhaust outlet or the total cross-sectional area of multiple outlets, providing it improves measurement accuracy and does not adversely affect the operation or the exhaust after-treatment as specified in point 3.4.2. It is recommended to document the EFM set-up using photographs.";

(c) point 3.5 is replaced by the following:

"3.5. Emissions sampling

Emissions sampling shall be representative and conducted at locations of well-mixed exhaust where the influence of ambient air downstream of the sampling point is minimal. If applicable, emissions shall be sampled downstream of the exhaust mass flow meter, respecting a distance of at least 150 mm to the flow sensing element. The sampling probes shall be fitted at least 200 mm or three times the inner diameter of the exhaust pipe, whichever is larger, upstream of the point at which the exhaust exits the PEMS sampling installation into the environment. If the PEMS feeds back a flow to the tail pipe, this shall occur downstream of the sampling probe in a manner that does not affect during engine operation the nature of the exhaust gas at the sampling point(s). If the length of the sampling line is changed, the system transport times shall be verified and if necessary corrected.

If the engine is equipped with an exhaust after-treatment system, the exhaust sample shall be taken downstream of the exhaust after-treatment system. When testing a vehicle with a branched exhaust manifold, the inlet of the sampling probe shall be located sufficiently far downstream so as to ensure that the sample is representative of the average exhaust emissions of all cylinders. In multi-cylinder engines, having distinct groups of manifolds, such as in a "V" engine configuration, the sampling probe shall be positioned downstream of where the manifolds combine. If this is technically not feasible, multi-point sampling at locations of well-mixed exhaust may be used, if approved by the Type Approval Authority. In this case, the number and location of sampling probes shall match as far as possible those of the exhaust mass flow meters. In case of unequal exhaust flows, proportional sampling or sampling with multiple analysers shall be considered.

If particles are measured, the exhaust shall be sampled from the centre of the exhaust stream. If several probes are used for emissions sampling, the particle sampling probe should be placed upstream of the other sampling probes. The particle sampling probe should not interfere with the sampling of gaseous pollutants. The type and specifications of the probe and its mounting shall be documented in detail.

If hydrocarbons are measured, the sampling line shall be heated to 463 ± 10 K (190 ± 10 °C). For the measurement of other gaseous components with or without cooler, the sampling line shall be kept at a minimum of 333 K (60°C) to avoid condensation and to ensure appropriate penetration efficiencies of the various gases. For low pressure sampling systems, the temperature can be lowered corresponding to the pressure decrease provided that the sampling system ensures a penetration efficiency of 95% for all regulated gaseous pollutants. If particles are sampled and not diluted at the tailpipe, the sampling line from the raw exhaust sample point to the point of dilution or particle detector shall be heated to a minimum of 373

K (100 °C). The residence time of the sample in the particle sampling line shall be less than 3 s until reaching first dilution or the particle detector.

All parts of the sampling system from the exhaust pipe up to the particle detector, which are in contact with raw or diluted exhaust gas, shall be designed to minimize deposition of particles. All parts shall be made from antistatic material to prevent electrostatic effects.";

(d) points 4.2. and 4.3. are replaced by the following:

"4.2. Starting and stabilizing the PEMS

The PEMS shall be switched on, warmed up and stabilized in accordance with the specifications of the PEMS manufacturer until key functional parameters, e.g., pressures, temperatures and flows have reached their operating set points before test start. To ensure correct functioning, the PEMS may be kept switched on or can be warmed up and stabilized during vehicle conditioning. The system shall be free of errors and critical warnings.

4.3. Preparing the sampling system

The sampling system, consisting of the sampling probe and sampling lines shall be prepared for testing by following the instruction of the PEMS manufacturer. It shall be ensured that the sampling system is clean and free of moisture condensation.";

(e) point 4.6 is amended as follows:

"4.6 Checking the analyser for measuring particle emissions

The zero level of the analyser shall be recorded by sampling HEPA filtered ambient air at an appropriate sampling point, usually at the inlet of the sampling line. The signal shall be recorded at a constant frequency of at least 1.0 Hz averaged over a period of 2 minutes; the final concentration shall be within the manufacturer’s specifications, but shall not exceed 5000 particles per cubic-centimetre.";

(f) in point 4.8., the last sentence is replaced by the following:

"The PEMS shall function free of errors and critical warnings.";

(g) Points 5.1., 5.2. and 5.3. are replaced by the following:

"5.1 Test start

Sampling, measurement and recording of parameters shall begin prior to the ‘ignition on’ of the engine. To facilitate time alignment, it is recommended to record the parameters that are subject to time alignment either by a single data recording device or with a synchronised time stamp. Before and directly after ‘ignition on’, it shall be confirmed that all necessary parameters are recorded by the data logger.

5.2 Test

Sampling, measurement and recording of parameters shall continue throughout the on-road test of the vehicle. The engine may be stopped and started, but emissions sampling and parameter recording shall continue. Any warning signals, suggesting malfunctioning of the PEMS, shall be documented and verified. If any error signal(s) appear during the test, the test shall be voided. Parameter recording shall reach a data completeness of higher than 99 %. Measurement and data recording may be interrupted for less than 1 % of the total trip duration but for no more than a consecutive period of 30 s solely in the case of unintended signal loss or for the purpose of PEMS system maintenance. Interruptions may be recorded directly by the PEMS but it is not permissible to introduce interruptions in the recorded parameter via the pre-processing, exchange or post-processing of data. If conducted, auto zeroing shall be performed against a traceable zero standard similar to the one used to zero the analyser. It is strongly recommended to initiate PEMS system maintenance during periods of zero vehicle speed.

5.3 Test end

The end of the test is reached when the vehicle has completed the trip and the ignition is turned off. Excessive idling of the engine after the completion of the trip shall be avoided. The data recording shall continue until the response time of the sampling systems has elapsed.";

(h) in point 6.1, table 2 is replaced by the following:

"Pollutant	Absolute Zero response drift	Absolute Span response drift [(1)]
CO_2	≤2000 ppm per test	≤2% of reading or ≤2000 ppm per test, whichever is larger
CO	≤75 ppm per test	≤2% of reading or ≤75 ppm per test, whichever is larger
NO_X	≤5 ppm per test	≤2% of reading or ≤5 ppm per test, whichever is larger
CH_4	≤10 ppmC_1 per test	≤2% of reading or ≤10 ppmC_1 per test, whichever is larger
THC	≤10 ppmC_1 per test	≤2% of reading or ≤10 ppmC_1 per test, whichever is larger

[(1)] If the zero drift is within the permissible range, it is permissible to zero the analyser prior to verifying the span drift.";

(i) point 6.2 is replaced by the following:

"6.2 Checking the analyser for measuring particle emissions

The zero level of the analyser shall be recorded in accordance with point 4.6.";

(34) Appendix 2 is amended as follows:

(a) in point 2, the following parameter is added between E_{CO2} and E_E:

"$E(d_p)$ - PEMS-PN analyser efficiency";

(b) in point 3.1., the first sentence is replaced by the following:

"The accuracy and linearity of analysers, flow-measuring instruments, sensors and signals, shall be traceable to international or national standards.";

(c) in point 3.2., Table 1 is replaced by the following:

"Measurement parameter/instrument	$\lvert\chi_{min} \times (a_1 - 1) + a_0\rvert$	Slope a_1	Standard error SEE	Coefficient of determination r^2
Fuel flow rate(1)	≤1% max	0.98 - 1.02	≤2%	≥0.990
Air flow rate(1)	≤1% max	0.98 - 1.02	≤2%	≥0.990
Exhaust mass flow rate	≤2% max	0.97 - 1.03	≤3%	≥0.990
Gas analysers	≤0.5% max	0.99 - 1.01	≤1%	≥0.998
Torque(2)	≤1% max	0.98-1.02	≤2%	≥0.990
PN analysers(3)	≤5% max	0.85-1.15(4)	≤10%	≥0.950

(1) optional to determine exhaust mass flow

(2) optional parameter

(3) The linearity check shall be verified with soot-like particles, as these are defined in point 6.2

(4) To be updated based on error propagation and traceability charts.";

(d) point 3.3 is replaced by the following:

"3.3. Frequency of linearity verification

The linearity requirements pursuant to point 3.2 shall be verified:

(a) for each gas analyser at least every twelve months or whenever a system repair or component change or modification is made that could influence the calibration;

(b) for other relevant instruments, such as PN analysers, exhaust mass flow meters and traceably calibrated sensors, whenever damage is observed, as required by

internal audit procedures or by the instrument manufacturer but no longer than one year before the actual test.

The linearity requirements pursuant to point 3.2 for sensors or ECU signals that are not directly traceable shall be performed with a traceably calibrated measurement device on the chassis dynamometer once for each PEMS-vehicle setup.";

(e) in point 4.2.6., table 2 is replaced by the following:

"Pollutant	Absolute Zero response drift	Absolute Span response drift
CO_2	≤1000 ppm over 4 h	≤2% of reading or ≤1000 ppm over 4 h, whichever is larger
CO	≤50 ppm over 4 h	≤2% of reading or ≤50 ppm over 4 h, whichever is larger
PN	5000 particles per cubic centimetre over 4h	According to manufacturer specifications
NO_X	≤5 ppm over 4 h	≤2% of reading or 5 ppm over 4h, whichever is larger
CH_4	≤10 ppmC_1	≤2% of reading or ≤10 ppmC_1 over 4 h, whichever is larger
THC	≤10 ppmC_1	≤2% of reading or ≤10 ppmC_1 over 4 h, whichever is larger";

(f) point 6 is replaced by the following:

"6. Analysers for measuring (solid) particle emissions";

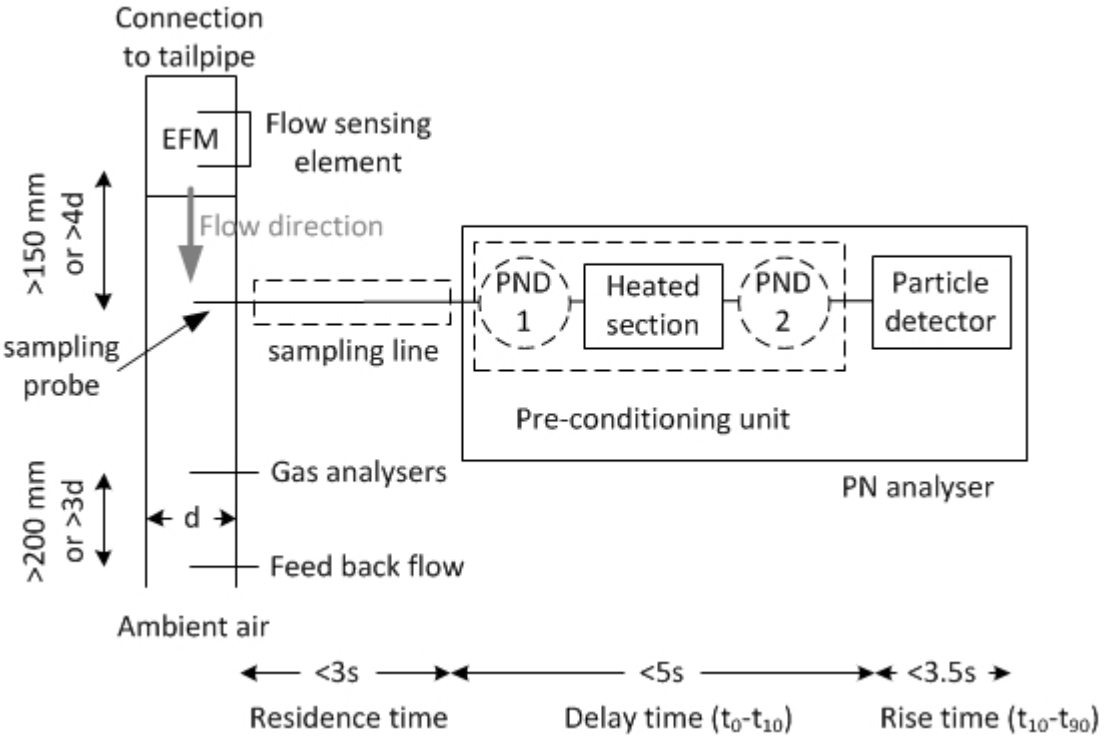
(g) the following points 6.1. to 6.4. are inserted:

"6.1. General

The PN analyser shall consist of a pre-conditioning unit and a particle detector that counts with 50% efficiency from approximately 23 nm. It is permissible that the particle detector also pre-conditions the aerosol. The sensitivity of the analysers to shocks, vibration, aging, variability in temperature and air pressure as well as electromagnetic interferences and other impacts related to vehicle and analyser operation shall be limited as far as possible and shall be clearly stated by the equipment manufacturer in its support material. The PN analyser shall only be used within its manufacturer's declared parameters of operation.

Figure 1

Example of a PN analyser setup: Dotted lines depict optional parts. EFM = Exhaust mass Flow Meter, d = inner diameter, PND = Particle Number Diluter.



The PN analyser shall be connected to the sampling point via a sampling probe which extracts a sample from the centreline of the tailpipe tube. As specified in point 3.5 of Appendix 1, if particles are not diluted at the tailpipe, the sampling line shall be heated to a minimum temperature of 373 K (100 °C) until the point of first dilution of the PN analyser or the particle detector of the analyser. The residence time in the sampling line shall be less than 3 s.

All parts in contact with the sampled exhaust gas shall be always kept at a temperature that avoids condensation of any compound in the device. This can be achieved, e.g. by heating at a higher temperature and diluting the sample or oxidizing the (semi)volatile species.

The PN analyser shall include a heated section at wall temperature ≥573K. The unit shall control the heated stages to constant nominal operating temperatures, within a tolerance of ±10 K and provide an indication of whether or not heated stages are at their correct operating temperatures. Lower temperatures are acceptable as long as the volatile particle removal efficiency fulfils the specifications of 6.4.

Pressure, temperature and other sensors shall monitor the proper operation of the instrument during operation and trigger a warning or message in case of malfunction.

The delay time of the PN analyser shall be ≤5 s.

The PN analyser (and/or particle detector) shall have a rise time of ≤3.5 s.

Particle concentration measurements shall be reported normalised to 273 K and 101.3 kPa. If necessary, the pressure and/or temperature at the inlet of the detector shall be measured and reported for the purposes of normalizing the particle concentration.

PN systems that comply with the calibration requirements of the UNECE Regulations 83 or 49 or GTR 15 automatically comply with the calibration requirements of this Annex.

6.2 Efficiency requirements

The complete PN analyser system including the sampling line shall fulfil the efficiency requirements of Table 3a.

Table 3a

PN analyser (including the sampling line) system efficiency requirements

d_p [nm]	Sub-23	23	30	50	70	100	200
$E(d_p)$ PN analyser	To be determined	0.2 – 0.6	0.3 – 1.2	0.6 – 1.3	0.7 – 1.3	0.7 – 1.3	0.5– 2.0

Efficiency $E(d_p)$ is defined as the ratio in the readings of the PN analyser system to a reference Condensation Particle Counter (CPC)'s ($d_{50\%}$=10nm or lower, checked for linearity and calibrated with an electrometer) or an Electrometer's number concentration measuring in parallel monodisperse aerosol of mobility diameter d_p and normalized at the same temperature and pressure conditions.
The efficiency requirements will need to be adapted, in order to make sure that the efficiency of the PN analysers remains consistent with the margin PN. The material should be thermally stable soot-like (e.g. spark discharged graphite or diffusion flame soot with thermal pre-treatment). If the efficiency curve is measured with a different aerosol (e.g. NaCl), the correlation to the soot-like curve must be provided as a chart, which compares the efficiencies obtained using both test aerosols. The differences in the counting efficiencies have to be taken into account by adjusting the measured efficiencies based on the provided chart to give soot-like aerosol efficiencies. The correction for multiply charged particles should be applied and documented but shall not exceed 10%. These efficiencies refer to the PN analysers with the sampling line. The PN analyser can also be calibrated in parts (i.e. the pre-conditioning unit separately from the particle detector) as long as it is proven that PN analyser and the sampling line together fulfil the requirements of Table 3a. The measured signal from the detector shall be >2 times the limit of detection (here defined as the zero level plus 3 standard deviations).

6.3 Linearity requirements

The PN analyser including the sampling line shall fulfil the linearity requirements of point 3.2 in Appendix 2 using monodisperse or polydisperse soot-like particles. The particle size (mobility diameter or count median diameter) should be larger than 45 nm. The reference instrument shall be an Electrometer or a Condensation Particle Counter (CPC) with d_{50}=10 nm or lower, verified for linearity. Alternatively, a particle number system compliant with UNECE Regulation 83.

In addition the differences of the PN analyser from the reference instrument at all points checked (except the zero point) shall be within 15% of their mean value. At least 5 points equally distributed (plus the zero) shall be checked. The maximum checked concentration shall be the maximum allowed concentration of the PN analyser.

If the PN analyser is calibrated in parts, then the linearity can be checked only for the PN detector, but the efficiencies of the rest parts and the sampling line have to be considered in the slope calculation.

6.4 Volatile removal efficiency

The system shall achieve >99% removal of ≥30 nm tetracontane ($CH_3(CH_2)_{38}CH_3$) particles with an inlet concentration of ≥10,000 particles per cubic-centimetre at the minimum dilution.

The system shall also achieve a >99% removal efficiency of polydisperse alcane (decane or higher) or emery oil with count median diameter >50 nm and mass >1 mg/m^3.

The volatile removal efficiency with tetracontane and/or polydisperse alcane or oil have to be proven only once for the instrument family. The instrument manufacturer though has to provide the maintenance or replacement interval that ensures that the removal efficiency does not drop below the technical requirements. If such information is not provided, the volatile removal efficiency has to be checked yearly for each instrument.";

(35) in Appendix 3, in point 3.3., Table 1 is replaced by the following:

"Table 1

Permissible tolerances

Parameter [Unit]	Permissible absolute tolerance
Distance [km](1)	250 m of the laboratory reference
THC(2) [mg/km]	15 mg/km or 15% of the laboratory reference, whichever is larger
CH_4(2) [mg/km]	15 mg/km or 15% of the laboratory reference, whichever is larger
NMHC(2) [mg/km]	20 mg/km or 20% of the laboratory reference, whichever is larger
PN(2) [#/km]	$1 \cdot 10^{11}$ p/km or 50% of the laboratory reference[1] whichever is larger
CO(2) [mg/km]	150 mg/km or 15% of the laboratory reference, whichever is larger
CO_2 [g/km]	10 g/km or 10% of the laboratory reference, whichever is larger
NO_x(2) [mg/km]	15 mg/km or 15% of the laboratory reference, whichever is larger

[1] PMP system

(1) only applicable if vehicle speed is determined by the ECU; to meet the permissible tolerance it is permitted to adjust the ECU vehicle speed measurements based on the outcome of the validation test

(2) parameter only mandatory if measurement required by point 2.1 of this Annex.";

(36) Appendix 4 is amended as follows:

(a) point 4 is amended is replaced with the following:

"4. Cold start

Cold start is the period from the first start of the combustion engine until the point when the combustion engine has run cumulatively for 5 min. If the coolant temperature is determined, the cold start period ends once the coolant has reached 343 K (70 °C) for the first time but no later than the point at which the combustion engine has run cumulatively for 5 min after initial engine start.";

(b) point 5 is replaced by the following:

“5. Emission measurements during stop of the combustion engine

Any instantaneous emissions or exhaust flow measurements obtained while the combustion engine is deactivated shall be recorded. In a separate step, the recorded values shall afterward be set to zero by the data post processing. The combustion engine shall be considered as deactivated if two of the following criteria apply: the recorded engine speed is <50 rpm; the exhaust mass flow rate is measured at <3 kg/h; the measured exhaust mass flow rate drops to <15% of the typical steady-state exhaust mass flow rate at idling.”;

(c) point 12 is replaced by the following:

"12. Calculating the instantaneous particle number emissions

The instantaneous particle number emissions [particles/s] shall be determined by multiplying the instantaneous concentration of the pollutant under consideration [particles/cm^3] with the instantaneous exhaust mass flow rate [kg/s], both corrected and aligned for the transformation time. If applicable, negative instantaneous emission values shall enter all subsequent data evaluations. All significant digits of intermediate results shall enter the calculation of the instantaneous emissions. The following equation shall apply:

$$PN,i = c_{PN,i} q_{mew,i} / \rho_e$$

where:

PN,i is the particle number flux [particles/s]

$c_{PN,i}$ is the measured particle number concentration [#/m^3] normalized at 0°C

$q_{mew,i}$ is the measured exhaust mass flow rate [kg/s]

ρ_e is the density of the exhaust gas [kg/m^3] at 0°C (Table 1)";

(d) in point 1 following the title "Verification of trip dynamic conditions and calculation of the final RDE emissions result with method 1 (Moving Averaging Window)", the words "Step 1. Segmentation of the data and exclusion of cold start emissions (section 4 in Appendix 4);" are replaced by the words "Step 1. Segmentation of the data;";

(e) in point 3.1 following the title "Verification of trip dynamic conditions and calculation of the final RDE emissions result with method 1 (Moving Averaging Window)", the last sentence of the first paragraph is amended as follows:

"The calculation described in the present point shall be run from the first point (forward).";

(f) in point 3.1 following the title "Verification of trip dynamic conditions and calculation of the final RDE emissions result with method 1 (Moving Averaging Window)", in the second paragraph, the second and fourth indents are deleted;

(g) in point 3.2. following the title "Verification of trip dynamic conditions and calculation of the final RDE emissions result with method 1 (Moving Averaging Window)", the following paragraph is added:

"In case a NOVC-HEV is tested, the window calculation shall start at the point of ignition on and include driving events during which no CO_2 is emitted.";

(h) in point 5. following the title "Verification of trip dynamic conditions and calculation of the final RDE emissions result with method 1 (Moving Averaging Window)", the following paragraph is inserted:

"For N2 category vehicles that are equipped in accordance with Directive 92/6/EEC with a device limiting vehicle speed to 90 km/h, the share of motorway windows in the complete test shall be at least 5 %.";

(i) in point 5.3. following the title "Verification of trip dynamic conditions and calculation of the final RDE emissions result with method 1 (Moving Averaging Window)", the following paragraph is added:

"When testing a NOVC-HEV and only if the specified minimum requirement of 50% is not met, the upper positive tolerance tol_1 may be increased by steps of 1 percentage point until the 50% of normal windows target is reached. When using this approach, tol_1 shall never exceed 50%.";

(j) in point 6.1. following the title "Verification of trip dynamic conditions and calculation of the final RDE emissions result with method 1 (Moving Averaging Window)", the following paragraph is added:

"For all averaging windows including cold start data points, as defined in point 4 of Appendix 4, the weighting function is set to 1.".

(37) Appendix 6 is amended as follows:

(a) in point 3.1., the following paragraph is added:

"The provisions of this Appendix 6 shall only be applicable for NOVC-HEVs (as defined in point 1.2.40) if the power at the wheels has been determined by wheel hub torque measurements.";

(b) Point 3.2 is replaced by the following

"3.2 Calculation of the moving averages of the instantaneous test data

Three second moving averages shall be calculated from all relevant instantaneous test data to reduce influences of possibly imperfect time alignment between emission mass flow and wheel power. The moving average values shall be computed in a 1 Hz frequency:

$$\boldsymbol{m}_{gas,3s,k} = \frac{\sum_{i=k}^{k+2} \boldsymbol{m}_{gas,i}}{\mathbf{3}}$$

$$\boldsymbol{P}_{w,3s,k} = \frac{\sum_{i=k}^{k+2} \boldsymbol{P}_{w,i}}{\mathbf{3}}$$

$$\boldsymbol{v}_{3s,k} = \frac{\sum_{i=k}^{k+2} \boldsymbol{v}_{i}}{\mathbf{3}}$$

Where k .....time step for moving average values

i .....time step from instantaneous test data ";

(c) In point 3.3., table 1-1 is replaced by the following:

"Table 1-1

Speed ranges for the allocation of test data to urban, rural and motorway conditions in the power binning method

Vehicle category		Urban	Rural(1)	Motorway(1)
M1, M2, N1	v_i [km/h]	0 to ≤ 60	>60 to ≤ 90	>90
N2	v_i [km/h]	0 to ≤ 60	>60 to ≤ 80	>80

(1)not used in the actual regulatory evaluation of urban driving";

(d) in point 3.4.2., the equations following the words "Corresponding results (see Table 2, Table 3):" are replaced by the following:

"P_{drive} = 70[km/h]/3.6*(79.19+0.73[N/(km/h)]*70[km/h]+0.03[N/(km/h)²]*(70[km/h])²+1470[kg]*0.45[m/s²])*0.001

P_{drive} = 18.25 kW";

(e) in point 3.5., the first paragraph is deleted;

(f) point 3.6 is replaced by the following:

"3.6 Check of power class coverage and of normality of power distribution

For a valid test a sufficient number of measured emission values have to be allocated to the relevant power classes. This demand is checked by the number of 3 second average values (counts) allocated to each power class:

- a minimum coverage of 5 counts is demanded for the total trip in each wheel power class up to class No. 6. or up to the class containing 90% of the rated power whatever gives the lower class number. If the counts in a wheel power class above number 6 are less than 5, the average class emission value ($m_{gas,3s,k}$) and the average class velocity ($v_{3s,k}$) shall be set to zero.

- a minimum coverage of 5 counts is required for the urban part of the trip in each wheel power class up to class No. 5 or up to the class containing 90% of the rated power whatever gives the lower class number. If the counts in the urban part of the trip in a wheel power class above number 5 are less than 5, the average class emission value ($m_{gas,3s,k}$) and the average class velocity ($v_{3s,k}$) shall be set to zero.";

(g) in point 4, the text following figure 2 is replaced by the following:

"The actual wheel power shall be calculated from the measured CO_2 mass flow as follows:

$$P_{w,i} = \frac{CO2_i - D_{WLTC}}{k_{WLTC}}$$

With CO_2 in [g/h]

$P_{w,j}$ in [kW]

The above equation can be used to provide P_{Wi} for the classification of the measured emissions as described in point 3 with following additional conditions in the calculation:

(I) if $v_i \leq$ 1km/h and if $CO2_i \leq D_{WLTC}$ then $P_{w,i} = 0$

(II) if $v_i >$ 1 km/h and if $CO2_i < 0.5$ X D_{WLTC} then $P_{w,i} = P_{drag}$ ";

(38) Appendix 7 is amended as follows:

(a) points 3 to 3.1.2. are replaced by the following:

"3. PEMS TEST FAMILY BUILDING

A PEMS test family shall comprise finished vehicles with similar emission characteristics. Vehicle emission types may be included in a PEMS test family only as long as the completed vehicles within a PEMS test family are identical with respect to the characteristics in points 3.1. and 3.2.

3.1. Administrative criteria

3.1.1. The approval authority issuing the emission type approval in accordance with Regulation (EC) 715/2007 ('authority')

3.1.2. The manufacturer having received the emission type approval in accordance with Regulation (EC) 715/2007.";

(b) point 4.2.7 is replaced by the following:

"4.2.7. At least one vehicle in the PEMS family shall be tested in hot start testing.";

(c) the following point 4.2.8. is inserted:

"4.2.8. Notwithstanding the provisions in points 4.2.1 to 4.2.6, at least the following number of vehicle emission types of a given PEMS test family shall be selected for testing:

Number N of vehicle emission types in a PEMS test family	**Minimum number NT of vehicle emission types selected for PEMS cold start testing**	**Minimum number NT of vehicle emission types selected for PEMS hot start testing**
1	1	1(**)
From 2 to 4	2	1
from 5 to 7	3	1
from 8 to 10	4	1
from 11 to 49	NT = 3 + 0,1 x N (*)	2
more than 49	NT = 0,15 x N (*)	3

(*) NT shall be rounded to the next higher integer number.

(**) when there is only one vehicle emission type in a PEMS test family, it shall be tested in both hot and cold start conditions.";

(39) the following Appendix 7c is inserted:

"Appendix 7c

Verification of trip conditions and calculation of the final RDE emissions result for OVC-HEVs

1. INTRODUCTION

This Appendix describes the verification of trip conditions and the calculation of the final RDE emissions result for OVC-HEVs. The method proposed in the Appendix will undergo review in order to find a more complete one.

2. SYMBOLS, PARAMETERS AND UNITS

M_t is the weighted distance-specific mass of gaseous pollutants [mg/km] or particle number [#/km], respectively emitted over the complete trip

m_t is the mass of gaseous pollutant [g] or particle number [#] emissions, respectively emitted over the complete trip

$m_{t,CO2}$ is the mass of CO_2 [g] emitted over the complete trip

M_u is the weighted distance-specific mass of gaseous pollutants [mg/km] or particle number [#/km], respectively emitted over the urban part of the trip

m_u is the mass of gaseous pollutant or the particle number emissions, respectively emitted over the urban part of the trip [mg]

$m_{u,CO2}$ is the mass of CO_2 [g] emitted over the urban part of the trip

$M_{WLTC,CO2}$ is the distance-specific mass of CO_2 [g/km] for a test in charge sustaining mode over the WLTC

3. General Requirements

The gaseous and particle pollutant emissions of OVC-HEVs shall be evaluated in two steps. First, the trip conditions shall be evaluated in accordance with point 4. Second, the final RDE emissions result is calculated in accordance with point 5. It is recommended to start the trip in charge-sustaining battery status to ensure that the third requirement of point 4 is fulfilled. The battery shall not be charged externally during the trip.

4. Verification of trip conditions

It shall be verified in a simple three-step procedure that:

1. the trip complies with the general requirements, boundary conditions, trip and operational requirements, and the specifications for lubricating oil, fuel and reagents defined in points 4 to 8 of this Annex IIIa;
2. the trip complies with the trip conditions defined in Appendices 7a and 7b of this Annex IIIa.
3. the combustion engine has been working for a minimum cumulative distance of 12 km under urban conditions.

If the at least one of the requirements is not fulfilled, the trip shall be declared invalid and repeated until the trip conditions are valid.

5. Calculation of the Final RDE emissions Result

For valid trips, the final RDE result is calculated based on a simple evaluation of the ratios between the cumulative gaseous and particle pollutant emissions and the cumulative CO_2 emissions in three steps:

1. Determine the total gaseous pollutant and particle number emissions [mg;#] for the complete trip as m_t and over the urban part of the trip as m_u.

2. Determine the total mass of CO_2 [g] emitted over the complete RDE trip as $m_{t,CO2}$ and over the urban part of the trip as $m_{u,CO2}$.

3. Determine the distance-specific mass of CO_2 $M_{WLTC,CO2}$ [g/km] in charge-sustaining mode for the individual vehicles (declared value for the individual vehicle) as described in the xxx/2016; Type I test, including cold start.

4. Calculate the final RDE emissions result as:

$M_t = \frac{m_t}{m_{t,CO2}} \cdot M_{WLTC,CO2}$ for the complete trip;

$M_u = \frac{m_u}{m_{u,CO2}} \cdot M_{WLTC,CO2}$ for the urban part of the trip.".

(40) Appendix 8 is amended as follows:

a. Point 3.1 is amended as follows:

“3.1 General

Emission values as well as any other relevant parameters shall be reported and exchanged as csv-formatted data file. Parameter values shall be separated by a comma, ASCII-Code #h2C. Sub-parameter values shall be separated by a colon, ASCII-Code #h3B. The decimal marker of numerical values shall be a point, ASCII-Code #h2E. Lines shall be terminated by carriage return, ASCII-Code #h0D. No thousands separators shall be used.”;

b. point 3.3; the first sentences in the second paragraph is amended as follows:

“The vehicle manufacturer shall record the available results of the data evaluation methods in separate files.”.

ANNEX III

Part I of Annex IX to Directive 2007/46/EC is amended as follows:

(a) A new point 48.2 is introduced after point 48.1 in the side 2 of the Certificate of Conformity (CoC) of M1 vehicles as follows:

"48.2 Declared maximum RDE values (if applicable)

Complete RDE trip: NOx: ……, Particles (number): ……..

Urban RDE trip: NOx: ……, Particles (number): ……..";

(b) A new point 48.2 is introduced after point 48.1 in the side 2 of the Certificate of Conformity (CoC) of M2 vehicles as follows:

"48.2 Declared maximum RDE values (if applicable)

Complete RDE trip: NOx: ……, Particles (number): ……..

Urban RDE trip: NOx: ……, Particles (number): ……..";

(c) A new point 48.2 is introduced after point 48.1 in the side 2 of the Certificate of Conformity (CoC) of N1 vehicles as follows:

"48.2 Declared maximum RDE values (if applicable)

Complete RDE trip: NOx: ……, Particles (number): ……..

Urban RDE trip: NOx: ……, Particles (number): ……..";

(d) A new point 48.2 is introduced after point 48.1 in the side 2 of the Certificate of Conformity (CoC) of N2 vehicles as follows:

"48.2 Declared maximum RDE values (if applicable)

Complete RDE trip: NOx: ……, Particles (number): ……..

Urban RDE trip: NOx: ……, Particles (number): ……..".