Date: 13/09/2016

DRAFT changes for RDE3 reflecting the RDE-LDV expert group discussions

Annex IIIA to Regulation (EC) No 692/2008 is amended as follows:

(1) a new point 1.2.39 is introduced

'1.2.39. For the purposes of this Annex, "*OVC-HEV*" (off-vehicle charging hybrid electric vehicle) means a hybrid electric vehicle that can be charged from an external source.

(2) a new point 1.2.40 is introduced

'1.2.40. For the purposes of this Annex, "*HV*" (hybrid vehicle" 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.

(3) point 2.1.1 is amended as follows:

' 2.1.1 Final Conformity Factors

The conformity factor $CF_{pollutant}$ for the respective pollutant is specified as follows:

Pollutant	Mass of oxides of nitrogen (NOx)	Number of particles (PN)	Mass of carbon monoxide (CO)(1)	Mass of total hydrocarbons (THC)	Combined mass of total hydrocarbons and oxides of nitrogen (THC + NOx)
$CF_{pollutant}$	1 + *margin* with *Margin NOx* = 0,5	1 + *margin* with *Margin PN* = 0.5	-	-	-

(1) CO emissions shall be measured and recorded at RDE tests.

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

(4) point 2.1.2 is amended as follows:

'2.1.2 Temporary Conformity Factors

By way of exception to the provisions of point 2.1.1, during a period of 5 years and 4 months following the dates specified in Article 10(4) and (5) of Regulation (EC) 715/2007 and upon request of the manufacturer, the following temporary conformity factors may apply:

Pollutant	Mass of oxides of nitrogen (NOx)	Number of particles (PN)	Mass of carbon monoxide (CO)(1)	Mass of total hydrocarbons (THC)	Combined mass of total hydrocarbons and oxides of nitrogen (THC + NOx)
$CF_{pollutant}$	2,1	1.5	-	-	-

(1) CO emissions shall be measured and recorded at RDE tests.

The application of temporary conformity factors shall be recorded in the certificate of conformity of the vehicle.'

(5) point 3.1.0 is amended as follows:

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. A more complete solution will be found for the evaluation of such vehicles.

(6) A new point 3.1.0.3 is added as follows:

$M_t \leq$ NTEpollutant and $M_u \leq$ NTEpollutant with the definitions of point 2.1 of this Annex and point 4 of Appendix 7c.

(7) Point 3.1.3.2.2. is amended as follows

By entering the unique identification number of a PEMS test family:

- the full information as required by point 5.1 of Appendix 7,
- the lists described in points 5.3 and 5.4 of Appendix 7;
- 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 HVs, the results of the PEMS tests as set out in point 6.3 of Appendix 5 shall be reported. For OVC-HEVs, the results of the PEMS test as set out in point 4 of Appendix 7c shall be reported.

(8) point 4.3 is amended as follows:

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 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 in roads with speed limit higher than 60 km/h, then the vehicle shall be driven with speeds up to 60 km/h.

(9) point 4.5 is introduced:

In order to also assess emissions during hot start trips, at least one vehicle per PEMS family shall be measured with a hot engine. In such a case, the requirements of point 5.3 on vehicle conditioning for cold engine-start testing shall not be met.

(10) point 5.3 is amended as follows:

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 key-off-engine-off status within moderate or extended altitude and temperatures according to points 5.2.2 to 5.2.6 between 6 and 56 hours. Exposure to extreme atmospheric conditions (heavy snowfall, storm, etc..) 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.

(11) point 5.4.2 is amended as follows:

If the trip results are valid following the verifications according to 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 according to Appendix 7c, while Appendices 5 and 6 do not apply.

(12) point 6.2 is amended as follows:

The trip sequence shall always start with urban driving followed by rural and motorway driving according to 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.

(13) Point 6.3 is amended as follows:

Rural operation is characterised by vehicle speeds higher than 60 and lower than or equal to 90 km/h. For N2 category vehicles that are equipped according to 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.

(14) point 6.5 is amended as follows:

Motorway operation is characterised by speeds above 90 km/h. For N2 category vehicles that are equipped according to 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.

(15) Point 6.8 is amended as follows:

‘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 as 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.

(16) Point 6.9 is amended as follows:

‘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 according to 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 80 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 according to 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 70 and 90 km/h. The vehicle's velocity shall be above 80 km/h for at least 5 minutes. '

(17) Point 6.11 is amended as follows:

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 according to point 4.3 shall be less than 1200 m/100km and be determined according to Appendix 7b.

(18) point 6.13 is added:

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.

(19) point 7.6 is amended as follows:

The idling immediately after the first ignition of the combustion engine shall not exceed 30 s. The vehicle stop during the entire cold start period, as defined in point 4 of Appendix 4, shall not exceed 90 s. If the engine stalls during the test, it may be restarted, but the sampling shall not be interrupted.

(20) point 9.4 is amended as follows:

After establishing the validity of a trip according to Point 9.2 emission results shall be calculated using the methods laid down in Appendices 5 and 6 of this Annex. For OVC-HEVs the emission results shall be calculated using the method laid down in Appendix 7c of this Annex.

(21) point 9.6 is amended as follows:

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 according to 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 in an average temperature that falls within the extended range according to point 5.2, then the provisions of point 9.5 of the main text of Annex IIIA apply only to the cold start period, even if the running conditions are not within the extended range. The corrective factor of 1.6 applies only once.

(22) Appendix 1 is amended as follows:

a. point 3.4.1 is amended as follows:

'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.

b. point 3.4.2 is amended as follows:

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.

c. point 3.4.3 is amended as follows:

Whenever used, the exhaust mass flow meter shall be attached to the vehicle's tailpipe(s) according to 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.

d. point 3.5 is amended as follows:

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 centreline 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.

e. point 4.2 is amended as follows:

The PEMS shall be switched on, warmed up and stabilized according to 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.

f. point 4.3 is amended as follows:

The sampling system, consisting of the sampling probe, sampling lines and the analysers, 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.

g. point 4.6 is amended as follows:

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.

h. Point 4.8 added:

The PEMS shall function free of critical warning signals and error indication.

i. Point 5.1 is amended as follows:

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.

j. Point 5.2 is amended as follows:

'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. ';

k. Point 5.3 is amended as follows:

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.

l. Point 5.5.2 is amended as follows:

5.5.2. Vehicles equipped with periodically regenerating systems

5.5.2.1. "Periodically regenerating systems" shall be understood according to the definition in Article 2(6) of Regulation 692(2008).

5.5.2.2. All results will be multiplied with the Ki factors developed by the procedures in section 3 of Annex 13 of UN/ECE Regulation No 83 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 either an appropriate ECU signal, or by applying 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 the ki-factor shall be checked against the requirements of point 3.1.0. If the emissions do not fulfil the requirements, then the test shall be voided and repeated once at the request of the manufacturer.

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 multiplication with the ki factor.

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 repetition of the RDE test, pollutants emitted during the repeated test shall be included in the emissions evaluation.

m. Table 1 in point 6.1 is amended as follows

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.

n. point 6.2 is amended as follows:

The zero level of the analyser shall be recorded according to point 4.6 above.

(23) Appendix 2 is amended as follows:

a. point 3.1 is amended as follows:

The accuracy and linearity of analysers, flow-measuring instruments, sensors and signals, shall be traceable to international or national standards. Any sensors or signals that are not directly traceable, e.g., simplified flow-measuring instruments shall be calibrated alternatively against chassis dynamometer laboratory equipment that has been calibrated against international or national standards.

b. Table 1 in point 3.2 is amended as follows:

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% max	≥0.990
Air flow rate[(1)]	≤1% max	0.98 - 1.02	≤2% max	≥0.990
Exhaust mass flow rate	≤2% max	0.97 - 1.03	≤2% max	≥0.990
Gas analysers	≤0.5% max	0.99 - 1.01	≤1% max	≥0.998
Torque[(2)]	≤1% max	0.98-1.02	≤2% max	≥0.990
PN analysers[(3)]	≤5% max	0.90-1.10	≤10% max	≥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.

c. point 3.3 is amended as follows:

The linearity requirements according to point 3.2 shall be verified:

(a) for each gas analyser at least every six 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 according 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.

d. Table 2 in point 4.2.6 is amended as follows:

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	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

e. point 6 is amended as follows:

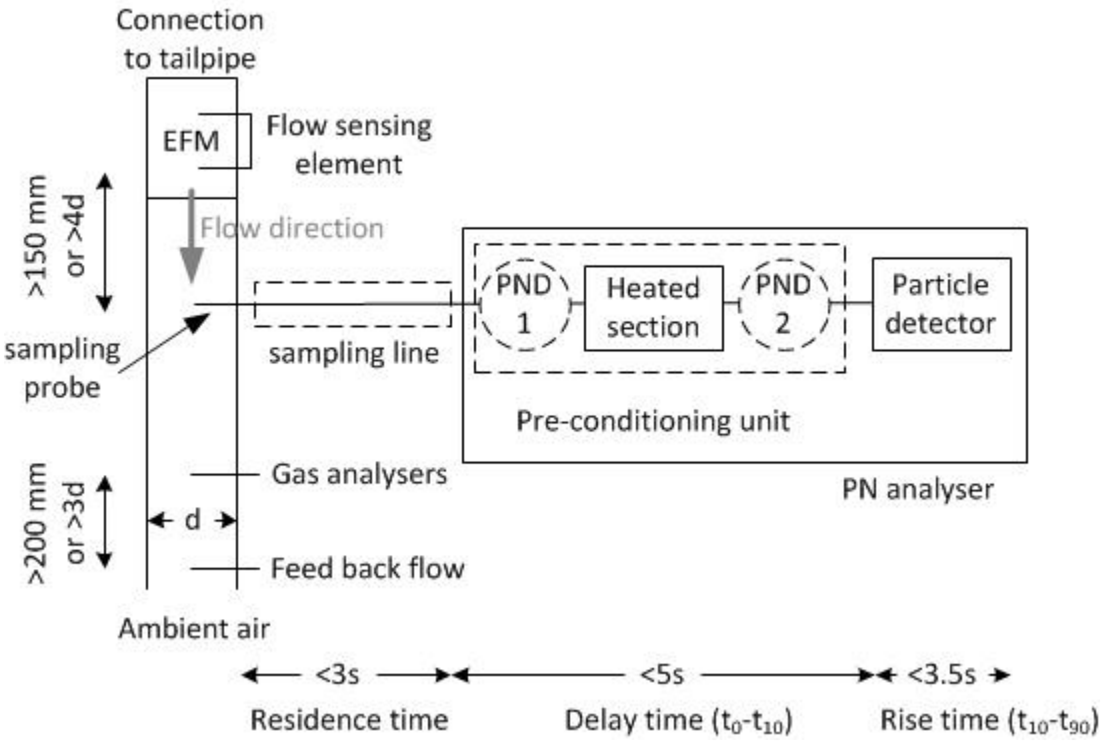
6 ANALYSERS FOR MEASURING (SOLID) PARTICLE EMISSIONS

6.1 General

The PN analyser shall consist of a pre-conditioning unit and a particle detector. 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 measurements normalised to 273 K.

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 4.

Table 4

PN analyser (including the sampling line) system efficiency requirements

d_p **[nm]**	**23**	**30**	**50**	**70**	**100**	**200**
$E(d_p)$ PN analyser[1]	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 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 multiply charged fraction should be <10% and any 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 4. 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 soot-like particles. The particle size should be at the plateau region of the analyser or a size that gives 100% efficiency. The reference instrument shall be an Electrometer or a Condensation Particle Counter (CPC) with d_{50}=10 nm or lower, verified for linearity. Alternatively, for the verification of linearity, polydisperse aerosol with a count median diameter of 50-60 nm (geometric standard deviation 1.6 ± 0.2) can be used, using as reference a particle number system compliant with UNECE Regulation 83.

In addition the PN analyser shall have an accuracy ±10% at all points checked (except the zero point). 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.

[1] To be adapted along with the margin review process

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.

f. The first paragraph of point 8 is amended as follows:

Any sensor and auxiliary equipment used to determine, e.g., temperature, atmospheric pressure, ambient humidity, vehicle speed, fuel flow or intake air flow shall not alter or unduly affect the performance of the vehicle's engine and exhaust after-treatment system. The accuracy of sensors and auxiliary equipment shall fulfil the requirements of Table 5. Compliance with the requirements of Table 5 shall be demonstrated at intervals specified by the instrument manufacturer, as required by internal audit procedures or in accordance with ISO 9000.

(24) Table 1 in Appendix 3 is amended as follows:

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[2] 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) 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.

[2] PMP system

(25) Appendix 4 is amended as follows:

a. Point 4 is amended as follows:

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 for 5 min after initial engine start.

b. point 12 is amended as follows:

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 be applied:

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

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)

(26) Appendix 5 is amended as follows:

a. point 1 is amended as follows:

The Moving Averaging Window method provides an insight on the real-driving emissions (RDE) occurring during the test at a given scale. The test is divided in sub-sections (windows) and the subsequent statistical treatment aims at identifying which windows are suitable to assess the vehicle RDE performance.

The "normality" of the windows is conducted by comparing their CO_2 distance-specific emissions[3] with a reference curve. The test is complete when the test includes a sufficient number of normal windows, covering different speed areas (urban, rural, motorway).

Step 1. Segmentation of the data;

Step 2. Calculation of emissions by sub-sets or "windows" (section 3.1);

Step 3. Identification of normal windows; (section 4)

Step 4. Verification of test completeness and normality (section 5);

Step 5. Calculation of emissions using the normal windows (section 6).

[3] For hybrids, the total energy consumption shall be converted to CO_2. The rules for this conversion will be introduced in a second step.

b. the first and second paragraphs of point 3.1 are amended as follows:

The instantaneous emissions calculated according to Appendix 4 shall be integrated using a moving averaging window method, based on the reference CO_2 mass. The principle of the calculation is as follows: The mass emissions are not calculated for the complete data set, but for sub-sets of the complete data set, the length of these sub-sets being determined so as to match the CO_2 mass emitted by the vehicle over the reference laboratory cycle. The moving average calculations are conducted with a time increment Δt corresponding to the data sampling frequency. These sub-sets used to average the emissions data are referred to as "averaging windows". The calculation described in the present point may be run from the last point (backwards) or from the first point (forward).

The following data shall not be considered for the calculation of the CO_2 mass, the emissions and the distance of the averaging windows:

– The periodic verification of the instruments and/or after the zero drift verifications;

– Vehicle ground speed < 1 km/h;

The mass (or particle number) emissions $M_{gas,j}$ shall be determined by integrating the instantaneous emissions in g/s (or #/s for PN) calculated as specified in Appendix 4.

c. Point 3.2 is amended as follows:

The following shall be calculated for each window determined in accordance with point 3.1.,

- The distance-specific emissions $M_{gas,d,j}$ for all the pollutants specified in this annex;

- The distance-specific CO_2 emissions $M_{CO2,d,j}$;

- The average vehicle speed $\bar{v}_j$

In case an HV is tested, the window calculation shall start at the point of ignition on and include driving events during which no CO_2 is emitted.

a. point 5.2 is amended as follows:

The test shall be complete when it comprises at least 15% of urban, rural and motorway windows, out of the total number of windows. For N2 category vehicles that are equipped according to 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 %.

b. The first two paragraphs of Point 5.3 are amended as follows:

The test shall be normal when at least 50% of the urban, rural and motorway windows are within the primary tolerance defined for the characteristic curve.

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%.

(27) Appendix 6, Point 3.5 is amended as follows:

Each moving average value calculated according to point 3.2 shall be sorted into the de-normalized wheel power class into which the actual 3 second moving average wheel power $P_{w,3s,k}$ fits. The de-normalised wheel power class limits have to be calculated according to point 3.3.

The classification shall be done for all three second moving averages of the entire valid trip data including also all urban trip parts. Additionally all moving averages classified to urban according to the velocity limits defined in table 1-1 shall be classified into one set of urban power classes independently of the time when the moving average appeared in the trip.

Then the average of all three second moving average values within a wheel power class shall be calculated for each wheel power class per parameter. The equations are described below and shall be applied once for the urban data set and once for the total data set.

Classification of the 3-second moving average values into power class j (j = 1 to 9):

$$if \quad P_{C,j\ lower\ bound} < P_{w,3s,k} \leq P_{C,j\ upper\ bound}$$

then: class index for emissions and velocity = j

The number of 3-second moving average values shall be counted for each power class:

$$if \quad P_{C,j\ lower\ bound} < P_{w,3s,k} \leq P_{C,j\ upper\ bound}$$

then: $counts_j = n + 1$ ($counts_j$ is counting the number of 3 second moving average emission values in a power class to check later the minimum coverage demands)

(28) 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 according to point 4. Second, the final RDE emissions result is calculated according to 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.