

## **Terms of reference and rules of procedure for the Informal Working Group on the Particle Measurement Programme**

### **1 Background**

- 1.1 Since the inception of the Particle Measurement Programme (PMP) group, the activities focused on development of an alternative metric with increased sensitivity compared to the existing Particulate Matter (PM) mass measurement system for Heavy Duty (HD) and Light Duty (LD) engines/vehicles (M and N category vehicles) were continued.
- 1.2 This phase concluded with the developed and adoption into UN Regulations Nos. 83 (emissions of  $M_1$  and  $N_1$  vehicles) (R83) and 49 (emissions of compression ignition and positive ignition (LPG and CNG) engines) (R49) of a particle number (PN) counting method for ultrafine solid particles, together with enhancements to the PM measurement procedure for R83. Initially the PN protocol was applied for diesel engines/vehicles only in the 06 series of amendments of R83 (R83.06) and R49 (R49.06) and subsequently has been extended to cover vehicles using spark ignition direct injection engines in R83.06.
- 1.3 The European Union (EU) and Switzerland requested in 2013 further investigation of particle number emissions from spark ignition engines relating to particle size (reduction of the 50% counting efficiency specification  $d_{50}$ ) and to emissions under rich operation conditions. As follow-up of this request, the PMP IWG has monitored particle emissions from a large variety of LD engine technologies. The attention has been mainly focussed on the difference between the number of particles measured with the existing PMP methodology ( $d_{50}=23$  nm) and with systems with lower  $d_{50}$ s. The fraction of particles emitted by the monitored engines not captured/counted by the existing PMP methodology is extremely variable and it depends very much on the engine technology and on the  $d_{50}$  considered. However, the  $d_{50}=23$  nm seems to be not a major issue as far as current engine technologies to which the PN limit is applicable are concerned (i.e. diesel and G-DI), since high emitters are still unequivocally detected. Therefore it appears that there is no urgent need to modify the  $d_{50}$  to lower values. Moreover, the PMP IWG also concluded that in any case it would be extremely challenging, especially for the very high uncertainty, to develop a reliable particle counting methodology with a  $d_{50}$  well below 10 nm. It is foreseeable that the PN measuring uncertainty is worsened and instrument specific differences will increase compared to the existing method. Further activity to investigate the possibility to modify the existing PMP methodology  $d_{50}$  from 23 to about 10 nm is still considered useful in order to cover potential future needs.
- 1.4 It was also requested to consider whether there is a need to extend particle measurement procedures to additional sources such as brake wear and the interaction between tyres and road. The first step consisted of a literature survey having the objective of summarizing the current knowledge on the physical/chemical nature, mass, number and size distribution of non-exhaust particle emissions. One of the main issues identified during the literature survey is the large variety of methodologies and test conditions used in the published studies. This may explain why often these studies lead to very different or even contradicting conclusions. The group therefore agreed that a suggested common test procedure for sampling and investigating brake wear particles would be beneficial for future research purposes as well as for the development of low emitting brake systems. On the other hand, measuring particle emissions generated by the interaction between tyres and road is much more challenging, due to the difficulty of distinguishing the contributions from tyres, material deposited on the road and the road itself. Nevertheless the group proposes to continue monitoring all information relevant to tyre/road wear particles.

## 2 Terms of Reference

- 2.1 The group should prepare the update and integration of test procedure updates into UN Regulations Nos. 83, 49 and 96 (diesel emission (agricultural tractors)) as appropriate.
- 2.2 The group may consider, at a later stage, the transposition of the developed procedures into the UN Global Technical Regulation (UN GTR) No. 4 and the expected forthcoming UN GTR covering the Worldwide harmonized Light vehicles Test Procedure (WLTP) and Test Cycle (WLTC).

## 3 Timeline

- 3.1 The work of the group on Particle Measurement Programme should be completed by June 2019. A prolongation and extension of the mandate of the group, in relation to the development and validation of new test procedures, e.g. in relation to PN measurement systems compatible with PEMS, tyre/brake wear if necessary, should be considered in due time by GRPE.

## 4 Scope and work items

### A. Exhaust particle emissions

#### 4.1 PM mass exhaust measurement

Note:

- (a) HD and Non-Road Mobile Machinery (NRMM) PM measurement excluded from PMP TOR as have recently been extensively revised in the respective UN GTRs. It is not foreseen that further major technical adaptation is required in the near term.
- (b) LD could also be excluded on a similar basis owing to recent revisions into the WLTP draft UN GTR. It is not foreseen that further major technical adaptation is required in the near term.

#### 4.2 PN exhaust measurement

- 4.2.1 Existing scope of PN measurements to be adapted to technical progress, as appropriate.
  - (a) LD Compression Ignition (CI) vehicles.
  - (b) HD CI engines/vehicles.
  - (c) LD Positive Ignition (PI) direct injection engine vehicles.
  - (d) HD PI direct injection engines/vehicles.
- 4.2.2 Extension of scope
  - (a) Investigate particle number emissions from vehicles equipped with PI direct injection during regeneration when vehicles with such technology are available on the market.
  - (b) Engine dyno raw exhaust PN measurements for HD for use at Type Approval.

#### 4.3 PN measurement equipment – HD and LD

##### 4.3.1 Existing PMP PN measurement equipment d50 reduction.

- (a) Determine what modifications are required to modify the d50 of the existing PN measurement methodology from 23 nm to about 10 nm. Assess the impact of such modifications on particle number emissions/repeatability/reproducibility. .

Objective: NRMM/HD/LD common measurement system.

- (b) Determine whether LD diesel regeneration measurements can be accurately, reliably, in a repeatable way and reproducibly made using the new cut-off size.
- (c) Develop Type Approval Raw exhaust PN measurement method suitable for engine dyno HD and NRMM.

#### 4.4 Calibration Guidelines

##### 4.4.1 Update of existing calibration guidelines.

- (a) Review and update of the calibration guidance documents relating to the Particle Number Counting (PNC) and VPR (Volatile Particle Remover), taking into account of:
  - (i) technical progress;
  - (ii) the work of European Metrology Research Programme (EMRP) ENV-02;
  - (iii) ISO 27891;
  - (iv) VPR Round Robin (RR): fundamental calibration of the condensation particle counter (CPC) and recommendations on LD aerosols.
- (b) Compilation of relevant calibration literature and review for inclusion of best practices.
- (c) Review and update of the calibration guidelines for CPC and VPR if the lower particle size d50 cutoff of the PMP of 23 nm is reduced.

## **B. Non-exhaust particle emissions**

#### 4.5 Brake Wear Particulate Matter (PM) measurement

##### 4.5.1 Development of a suggested common test procedure for sampling and assessing brake wear particles both in terms of mass and number

- (a) Selection or development of a test cycle appropriate for the investigation of Brake Wear Particles
- (b) Investigation and selection of the appropriate methodologies for particles generation and sampling. Definition of the appropriate test rig configuration
- (c) Investigation and selection of the appropriate instrumentation for the measurement and characterization of brake wear particles

#### 4.6. Tyre/Road Wear Particulate Matter (PM) measurement

- (a) Continue monitoring on-going projects and published data regarding the physical nature and size distribution of particle emissions from tyre/road wear
- (b) Provide a report to GRPE for consideration in Jan 2019 on the investigation status and recommended next steps

The informal group on Particle Measurement Programme should complete the tasks described in this section by June 2019. A prolongation and extension of the mandate of the group, in relation to the above tasks should be considered in due time by GRPE.

### 5. Rules of procedure

- 5.1. The informal group is open to all participants of GRPE. A limitation of the number of participants from any country or organisation to participate in the informal group is actually not foreseen.
- 5.2. A Chair and a Secretary will manage the informal group.
- 5.3. The working language of the informal group will be English.
- 5.4. All documents and/or proposals shall be submitted to the Secretary of the group in a suitable electronic format, preferably in line with the UNECE guidelines in advance of the meetings. The group may refuse to discuss any item or proposal which has not been circulated 5 working days in advance of the scheduled meeting.
- 5.5. The informal group shall meet regularly at the GRPE meetings in Geneva. Additional meetings will be organised upon demand.
- 5.6. An agenda and related documents will be circulated to all members of the informal group in advance of all scheduled meetings.
- 5.7. The work process will be developed by consensus. When consensus cannot be reached, the Chair of the informal group shall present the different points of view to GRPE. The Chair may seek guidance from GRPE as appropriate.
- 5.8. The progress of the informal group will be routinely reported to GRPE orally or as an informal document by the Chair or the Secretary.
- 5.9. All working documents shall be distributed in digital format. The specific PMP section on the UNECE website shall continue to be utilised.