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Progress on the development of new UN GTRs and of amendments to established UN GTRs

Proposal for a draft UN GTR on brake particulate emissions

Request for authorization to develop a new UN GTR on brake particulate emissions

Submitted by the Working Party on Pollution and Energy*

The text reproduced below was adopted by the Working Party on Pollution and Energy (GRPE) at its eighty-third session (ECE/TRANS/WP.29/GRPE/83, para. 36.). It is based on GRPE-83-11, as amended by Annex XII of the report. It is submitted to the World Forum for Harmonization of Vehicle Regulations (WP.29) and to the Administrative Committee (AC.3) for consideration at their November 2021 sessions.

* In accordance with the programme of work of the Inland Transport Committee for 2021 as outlined in proposed programme budget for 2021 (A/75/6 (part V sect. 20) para 20.51), the World Forum will develop, harmonize and update UN Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.



I. Mandate and objectives

1. In 2013, following the submission of informal documents by the Russian Federation, UNECE WP.29 agreed with the GRPE decision to assign the follow-up of the issues concerning the emissions of particles from tyre and brake wear to the Informal Working Group on Particle Measurement Programme (IWG on PMP).
2. The main objective of the Informal Working Group on Particle Measurement Programme (IWG on PMP) was to investigate whether there is a need to extend particle measurement procedures to additional sources such as brake wear and the interaction between tyres and road.
3. Under continued work by the Informal Working Group on Particle Measurement Programme (IWG on PMP), the main objective of this proposal is to seek authorization for the IWG on PMP to begin a new mandate, specifically to develop a new UN GTR on the topic of brake PM and PN emissions of LDV's brake systems.

II. Introduction

4. Since the beginning of the Informal Working Group on Particle Measurement Programme (IWG on PMP), the activities focused on the development of an alternative metric to the Particulate Matter (PM) mass measurement system for Heavy Duty (HD) and Light Duty (LD) engines/vehicles (M and N category vehicles). This phase concluded with the development and adoption of the UN Regulation No. 83 (Emissions of M_1 and N_1 vehicles) (R83) and the UN Regulation No. 49 (Emissions of compression ignition and positive ignition (LPG and CNG) engines) (R49) of a particle number (PN) counting method for ultrafine solid particles and the 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 UN Regulation No. 83 (R83.06) and UN Regulation No. 49 (R49.06), and subsequently has been extended to cover vehicles using spark ignition direct injection engines in R83.06. In 2013, the European Union (EU) and Switzerland requested further investigation of PN 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. At the same time, 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.
5. In June 2013, the first mandate of the IWG on PMP with reference to non-exhaust emissions was approved by AC.3. The IWG on PMP aimed to accomplish the following objectives, which were successfully completed by June 2016:
 - (a) Conduct a literature survey with the objective of summarizing the current knowledge on the physical/chemical nature, mass, number and size distribution of non-exhaust particle emissions;
 - (b) Identify and report the main knowledge gaps and the needs for future research and consideration. This objective was materialized as a report submitted to the 69th GRPE session (Informal Document GRPE-69-23);
 - (c) Establish a group of experts on the field of non-exhaust emissions as well as a mechanism for sharing information and on-going research on topics related to non-exhaust emissions and the environment;
 - (d) Analyse the WLTP database with the aim of defining normal and extreme driving conditions and gather information on existing methodologies for sampling and measuring non-exhaust emissions;
 - (e) Introduce the discussion regarding the selection of the most suitable testing approach for brake emissions and define the pros and cons of different available options (brake test rig, full vehicle chassis dynamometer, full vehicle on-road, etc.).
6. Subsequently, a second mandate for the IWG on PMP with specific reference to non-exhaust emissions was approved in June 2016 by AC.3. The IWG on PMP was mandated to

develop a suggested common test procedure for sampling and assessing brake wear particles both in terms of mass and number. The aim of the suggested methodology would be to provide the necessary tool for rendering future studies on brake emissions comparable to each other. During the reporting period of the 2016 mandate the following items were addressed:

- (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;
- (c) Investigation and selection of the appropriate instrumentation for the measurement and characterization of brake wear particles.

7. After completing a thorough analysis regarding the suitability of existing brake cycles the IWG on PMP decided to proceed with the development of a novel test cycle appropriate for the investigation of Brake Wear Particles. For that reason, the IWG on PMP decided to create a dedicated Task Force (TF1) to accelerate the development (October 2016). In September 2017, the IWG on PMP decided to create a dedicated Task Force (TF2) with the aim of addressing items (b) and (c). The TF2 decided to merge items (b) and (c) and initiated its activities in October 2017.

8. During the reporting period (2016-2019), the IWG on PMP aimed to accomplish the following objectives:

- (a) Selection of the brake test rig methodology for the generation and sampling of brake wear particles;
- (b) Agreement on the method's target measurement parameters. TF2 agreed unanimously that both PM (PM₁₀ and PM_{2.5}) and PN (>10 nm) emissions shall be addressed;
- (c) Development and publication of the WLTP-Brake cycle. The cycle is based on real-world data extracted from the WLTP database and is considered representative of real-world applications;
- (d) Validation of the WLTP-Brake cycle through a Round Robin exercise which was completed in 8 different laboratories in Europe and the United States;
- (e) Thorough analysis of the existing methods and setups for the sampling and measurement of brake particle emissions. Agreement on the need of defining a set of minimum specifications and requirements for sampling and measurement of brake particle emissions.

9. The mandate for the IWG on PMP with reference to non-exhaust emissions was further extended in June 2019 by AC.3. The revised mandate included an additional item compared to 2016, which foresaw the validation of the proposed methodology for the measurement and characterization of brake wear particles. During the reporting period (2019-2020), the IWG on PMP aimed to accomplish the following objectives:

- (a) AC.3 approved the informal document GRPE-81-12 (June 2020). The GRPE-81-12 informed and updated the GRPE of the work of the IWG on PMP Task Force 1 (TF1) on the development of the novel WLTP-Brake Cycle and its application on the measurement and characterization of brake emissions at brake dynamometer level;
- (b) A first discussion on how to address future technologies took place at the IWG on PMP level following the request of several GRPE stakeholders;

10. The mandate for the IWG on PMP with reference to non-exhaust emissions was further extended in June 2020 by AC.3. Following the discussion at the IWG on PMP level, the revised mandate included the extension of the proposed methodology to future technologies. In June 2020, several GRPE Contracting Parties urged the IWG on PMP to start considering a possible use of the proposed method as a regulatory tool. For that reason, the IWG on PMP was requested to start looking to the necessary changes/adaptations with the aim of extending the method to all existing technologies and other vehicle categories.

11. During the 81st GRPE session it was proposed to hold a workshop involving Stakeholders and Contracting Parties with the aim of discussing the possible approaches to

regulate brake wear particle emissions. The workshop took place in January 2021 and its focus was to pave the way to a future regulatory process. The main topics discussed during the workshop include:

- (a) The ideal scheme for regulating brake emissions from conventional ICE Light-Duty vehicles;
- (b) How to handle non-conventional Light-Duty vehicles (i.e. HEVs, EVs) in a future regulatory approach;
- (c) HD vehicle brake emissions and possible approaches.

12. As a follow up of the workshop the interested Contracting Parties and the IWG on PMP recommend that a UN GTR on brake PM and PN emissions from all types of LDV's brake systems is developed under a new mandate.

III. Areas of work

13. The representatives of the European Union, UK and Japan seek AC.3 the authorization to develop a new UN GTR on brake PM and PN emissions from all types of LDV's brake systems as follows:

- (a) Validation of the developed novel test cycle for the investigation of Brake Wear Particles;
- (b) Investigation and selection of the appropriate instrumentation and sampling methodology for the measurement and characterization of brake wear particles;
- (c) Definition of the minimum requirements for brake wear particles sampling;
- (d) Validation of the proposed approach for the measurement and characterization of brake wear particles through an Interlaboratory study;
- (e) Inclusion of regenerative braking;
- (f) Preparation of the PMP Brake protocol for sampling and measuring brake wear PM and PN emissions.

At a second phase, the following items might be addressed:

- (a) Definition of a real-world cycle/s for use in the laboratory;
- (b) Adaptation of the proposed methodology to include future technologies;
- (c) Adaptation of the proposed methodology to address brake emissions from heavy-duty vehicles.

IV. Existing regulations

14. Brake PM and PN emissions from LDV's are currently not regulated by any UN GTR or regional Regulations. The contracting parties sponsoring this activity consider a UN GTR governing brake emissions for these vehicles as necessary in order to regulate emissions of brakes.

V. Timeline

15. The timelines proposed below for the new mandate are target timelines. The plan will be regularly reviewed and updated to reflect progress and feasibility of the timeline.

- (a) June 2021: timeline and framework for mandate request are presented in GRPE;
 - (b) June 2021: Request for authorization submitted to AC.3;
 - (c) June 2021: TF2 finalizes the discussion on the definition of the minimum requirements for brake wear particles generation and sampling;
 - (d) June 2021: TF2 finalizes the selection of the appropriate instrumentation and sampling methodology for the measurement and characterization of brake wear particles;
 - (e) June 2021 – September 2021: IWG on PMP organizes the Round Robin exercise with the aim of collecting information and data on the proposed approach for the measurement and characterization of brake wear particles;
 - (f) September 2021 – December 2021: IWG on PMP executes the Round Robin exercise with the aim of collecting information and data on the proposed approach for the measurement and characterization of brake wear particles;
 - (g) December 2021 – February 2022: Collection of the results and data processing from the Round Robin exercise;
 - (h) March 2022 – April 2022: Preparation of the PMP Brake protocol for sampling and measuring brake wear PM and PN emissions;
 - (i) June 2022: Submission of informal document with draft GTR
 - (j) October 2022: Submission of working document with draft GTR for January 2023 GRPE
 - (k) 2023-2025: Development of items in second phase.
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