

PMP – Particle Measurement Program Informal Working Group Task Force 2– Brake Dust Sampling and Measurement

Meeting #40 – Wednesday 20 APRIL 2022 15:00 – 17:00 CEST

Minutes of Meeting – Final Version

1. Participants: As in the file *“40th TF2 Meeting Attendance”* uploaded in TEAMS.

2. Introduction: Theo Grigoratos (TG) welcomed the TF2 members and summarized the status of the previous clauses. A clean version of Clause 1 and Clause 2 will be circulated by the end of this week. Comments on Clauses 3-5 have been received and are being elaborated. Today’s meeting is dedicated to the discussion of the bedding procedure included in Clause 6 of the protocol. The proposed text will be submitted to TEAMS and comments are requested by Friday 29.04 COB.

3. Clause 6 presentation: Katharina Kolbeck presented the BMW data focusing on the topic of alternative bedding. Different brakes were tested for their emissions following the two different alternatives (i.e. Default = 5 x WLTP-Brake cycles vs. Alternative = 10 x Trips #10 of the WLTP-Brake cycle). A high-level comparison of the two protocols shows the clear benefit of the alternative method in terms of testing time, whereas there is a clear handicap in terms of energy dissipated on the brake. No significant influence on the different temperature profiles was observed. Similarly, PM and PN emissions seem to be at similar levels without any obvious benefit when applying the default method. BMW suggested having also controls with other flows or setups.

Jarek Grochowicz pointed out that most data looked into ECE brakes and asked whether it makes sense to reduce energy dissipated particularly for brakes with NAO pads (and drum brakes) – KK replied that it is a valid concern and more data would be needed to decide. Dmytro Lugovyy asked if BMW looked at how the bedding looks like when performed with different inertia levels – KK replied that the friction energy is mainly what defines preconditioning and inertia levels do not seem to have an important influence. Bob Anderson asked for clarification on whether measurements of total emissions took place – KK confirmed that showed data was for total PN. The BMW presentation is available on TEAMS.

TG provided a presentation related to the bedding data from the ILS and concluded with a proposal for the bedding procedure. The details of the proposal and the data-supported evidence are summarized in the attached presentation *“GTR - Clause 6”*. The amended text is available in the submitted document *“PMP Brake Protocol - Clause 6 Clean”*. Two different sub-clauses have been introduced in the newly formulated Clause 6:

Clause 6.1: Describes the procedure related to the bedding procedure of front brakes – Provisions for the correct application of the bedding procedure have been introduced in more detail.

Clause 6.2.: Describes the procedure related to the bedding of rear brakes – Not much data available – Provisions for the correct application of the bedding procedure have been introduced in more detail.

Presentation: TG discussed the ILS data submitted with the default method. Most laboratories managed to complete the bedding procedure as it was defined without major issues. The average temperature the WLTP-Brake cycle seems to slightly decrease (on average by 5-10°C) when

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progressing from bedding to emission cycles – The peak temperature seems not to be affected significantly. Marcel Mathissen asked for clarification on the temperature stabilization – TG clarified that the important message is that the average temperature over the three emission cycles is very similar meaning that the brake's temperature behaviour is stabilized after the default bedding method. A discussion on the cooling adjustment method and how this will be checked against the cooling settings followed – TG clarified that only data from the 1st bedding cycle will be used to validate the cooling settings. The application of cooling sections during the bedding procedure results in similar temperatures as emission tests (5-10°C lower compared to default bedding) – The application of a 25h test at constantly lower temperatures might influence the emissions behaviour of the brake – The PM and PN emission behavior of the brakes seems to be adequately stabilized with the execution of the default bedding schedule.

TG then discussed the ILS data submitted with the drum brake. Two labs completed the bedding procedure as it was defined without issues. The average temperature of the WLTP-Brake cycle seems to significantly decrease (on average by 15-25°C) when progressing from bedding to emission cycles - the peak temperature of the drum brake seems not to be affected. The application of cooling sections during the bedding procedure results in slightly lower temperatures compared to default bedding – a similar concern that running a 25h test at constantly lower temperatures might influence the emissions behavior of the brake. The PM and PN emission behavior of the brake seems to be adequately stabilized with the execution of the default bedding schedule; however, there are very few data points to reach a solid conclusion. KK asked whether there was large variability in the PN measurements of any of the labs that tested Br4 – TG replied that both PM and PN measurement variability was very low despite the low emission levels.

TG also discussed the ILS data submitted with the alternative bedding method. After discussing some temperature stabilization issues in some tests, TG highlighted that the PM emissions behavior seems to be more stabilized when the default method is applied; however, there are only a few data points to confirm. On the other hand, it is not possible to reach a sound conclusion about the emission behavior with the two examined methods. ***TG concluded with the proposal to continue to the GTR with the default method and briefly described some specifications.*** Ravi Vedula asked about possible interruptions during bedding that could lead to temperature drop – TG replied that the tests shall resume from the point they were ceased without making temperature adjustments. A discussion about wear measurement followed – TG mentioned that it should become a mandatory part of the GTR since it provides very useful information. Dmytro Lugovyy asked for specifications regarding the measurement and the balance – these will come from the SAE J2986:2019. Michael Arndt asked about possible interruptions during wear measurement – A solution might be to report emissions per energy dissipated – TG clarified that wear will not be the primary target of the GTR, it will be used only as complementary information, meaning that failure to report it in case of proven interruption shall not lead to invalid tests.

4. Next Meeting: The next meeting will take place on Wednesday 27.04.2022 from 15.00-17.00. The topic will be Clause 7 of the TF2 protocol and the general enclosure and setup requirements.