

# PMP – Particle Measurement Program Informal Working Group

## Task Force 2– Brake Dust Sampling and Measurement

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### Definition of a common bedding-in procedure

**Experience shows that appropriate bedding-in is very important when emission tests are performed.** On one hand, the bedding-in procedure shall be long enough to ensure the stabilization of the friction couple behaviour. On the other hand, there needs to be a compromise taking into account that a reasonable testing time shall be ensured. Furthermore, the definition of certain parameter(s) as stabilization “markers” will result in different bedding procedures for different types of pads (i.e. different number of cycles to reach the target parameter). This would go directly against any standardization effort for the bedding procedure.

- Possibility to shorten the bedding procedure? Data from GM show that PN behaviour is still stabilizing by the 4<sup>th</sup> WLTP cycle repeat. At least 4-5 cycles would be needed. Horiba reports that in some cases even more cycles are required. TUI reports that considerably more than 5 cycles are necessary to achieve a reproducible emission level for drum brakes. **Therefore, JRC’s recommendation is to apply 5 WLTP-based novel cycles for disc/pad couples and define the necessary number of cycles for drum brakes after the RR exercise (when more data for drum brakes might be available).** Additionally, **JRC invites the labs to run an experimental campaign with the aim of comparing the bedding-in of a certain disc/pad couple with the application of 5 WLTP-based novel cycles (5 x 15826 sec = 22 h) against the application of 10-12 trips #10 of the cycle (10-12 x 5272 sec = 14.6-17.6 h).** According to TUI, a reduction of the bedding time by increasing the friction energy or the brake pressure should be avoided, as the conditioning can have a direct effect on the emission behaviour of the subsequent cycles. However, trip #10 remains a part of the real-world cycle and cannot be considered as an artificial increase of the friction energy.
- What recommendations are given for the bedding procedure and the purging between the cycles during the bedding procedure? **JRC suggests that the 5 WLTP-based novel cycles run consecutively without any interruption. It is recommended not to apply soak times between trips while running the bedding procedure. However, it is recommended that the 2<sup>nd</sup> to 5<sup>th</sup> repetition commence with IBT of 100°C (1<sup>st</sup> repetition will commence under ambient temperature). No additional purging between the cycles is required. All other parameters shall be the same as of emissions testing. PN emissions during the bedding-in procedure can be recorded but shall not be used for any reporting purposes as concentrations might be artificially increased.**
- Do we need different bedding procedures or criteria for different brake materials (ECE/NAO)? GM study showed generally similar stabilization behaviour between pad types. AUDI studies demonstrate different behaviours in some cases. There is also the issue of not having an objective definition of different pad materials, thus opening the door for different interpretations among labs. Finally, we need to keep the procedure as “global” as possible for standardization purposes. **Therefore, JRC’s recommendation is to apply one common procedure for all different brake materials. Differentiation might be required for drum brakes.**
- Criteria when the bedding is finished? What metric should be used (PN, PM,  $\mu$ )? **JRC suggests concluding bedding-in with the execution of 5 and X WLTP-based novel cycles for pads/discs and drum brakes, respectively.** No additional criteria shall be applied.

HORIBA suggests using integrated PN values for the bedding. GM reports that Mu levels are not sufficient to predict emission behavior stability. TUI suggests the following sequence: 1. Determination of mass and thickness (new disc and pads); 2. Application of 1 WLTP-based novel cycle before adjusting cooling air flowrate; 3. Application of at least 4 WLTP-based novel

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cycles before running emission tests; 4. Evaluation of the bedding procedure using PN values (PN EFs; e.g. < 30%; the PN is determined by 10/23nm CPC, which is used for the main emissions tests) of the four WLTP novel cycles according to step 3. If the predefined limits are exceeded, additional cycles (WLTP novel cycles) shall be carried out without removing disc and pads. If the limits are met, the bedding-in process is complete.