

# PMP – Particle Measurement Program Informal Working Group

## Task Force 2– Brake Dust Sampling and Measurement

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Meeting #30 – Thursday 06 MAY 2021 15:00 – 16:00 CEST

### Minutes of Meeting – Final Version

**1. Participants:** As in the file *“30th TF2 Meeting Attendance”* uploaded in TEAMS.

**2. Background:** This is the fourth meeting related to the mass measurement approach. TG introduced the meeting and provided a brief update on the scheduling of the upcoming meetings. The target is to complete the presentations’ round at the next TF2 Meeting (31<sup>st</sup> TF2). TG will then summarize the discussions and prepare a first version of the recommendations for the mass measurement. The PM discussion is expected to be finalized by the end of May.

**3. Mass Discussion:** AJ presented LINK-EU’s experience with PM measurement. The presentation focused on LINK-EU’s approach as well as on the differences with the LINK-US setup. The LINK-EU setup is based on a performance dyno and comes with differences in the sampling line compared to the LINK-US setup. Both cyclones and impactors are employed for the brake PM mass measurement. High-level specifications for both instruments are provided in Slides 6-8 of the attached presentation *“Brake Particulate emissions - LINK-EU Test System”*. Filters handling and storage follows the EN12341 specifications. Special considerations need to be taken for filter loading particularly for PM<sub>10</sub> and when multiple tests are scheduled.

AM commented that filter overloading might become an issue when high gas concentrations are present. This is not expected for brake emissions. AJ clarified that concerns are more related to full testing procedures which include also the bedding-in. It is not likely that a single emissions test can impose such problems. A discussion on Slide 12 of the attached presentation took place. RV pointed that differences of 40 µg and 60 µg might be too high considering the overall PM loading of the filters. AJ clarified that these numbers have been adopted from EN12341 and were not adjusted for brake emissions measurement. TG requested the labs to provide data on blank filters with the aim of defining possible threshold values to discard filters. The possible effect of bouncing phenomena in case of the impactors was also discussed. AJ explained that grease was applied to prevent these phenomena. FR expressed his concerns particularly for long cycles which might lead to high mass loadings. Finally, AJ mentioned that mass emission results from cyclones and impactors will be compared to each other and shared with the group at a later stage. LINK-US and LINK-EU consolidated recommendations on mass measurement will follow within the next couple of weeks.

KK presented BMW’s experience with PM measurement. The presentation included information on BMW’s setup, PM mass measurement instrumentation, and filters weighting procedure. Additionally, some preliminary PM results as well as some open topics for discussion were introduced. BMW applies both cyclones and impactors for brake PM mass measurement. Specifications for both instruments are provided in Slides 4-6 of the attached presentation *“Brake Particulate emissions - BMW Test System”*. TX40 filters are used in both instruments. Weighing procedure is performed according to UNECE Regulation No. 83. PM mass emissions are averaged over 3 WLTP-Brake cycles following a BMW specific bedding procedure (i.e. 10 repetitions of Trip #10 instead of 5 full WLTP-Brake Cycle). Slide 9 provides an overview of the PM mass emissions of two front brakes. PM<sub>10</sub>

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measured with the cyclone seems to be up to 20% lower compared to the values measured with the impactor. PM<sub>10</sub> emissions are close to 10-12 mg/km for a front brake application of a SUV. PM<sub>2.5</sub> is measured to be approximately one third of the overall PM<sub>10</sub> emissions. Finally, KK introduced some topics for consideration including the loading during soak times, the high influence of filter handling on the results, and the availability of the necessary instrumentation for PM mass measurement.

KK clarified that no standard was followed for the flow determination. It was clarified that the impactor is installed in the duct which has a diameter of 170 mm. A discussion regarding the difference in the determined mass between the cyclone and the impactor took place. KK mentioned that losses in the sampling line prior to the cyclone might be a reason for the reduced PM emissions compared to the impactor. On the other hand, it was mentioned that impactors might overestimate PM mass. A discussion on the presented emission levels followed. TG commented that it is the first time such figures are presented – at least for typical passenger cars European brakes. These figures correspond to as high as 30 mg/km at vehicle level. KK mentioned that BMW typically measures 10 mg/km per brake for their front axle applications and 5 mg/km for their rear axle applications. SG confirmed such emission levels for some AUDI applications, too. A request to collect PM mass emissions data within TF2 was made. TG explained that TF2 focuses on the method development and such a discussion shall take place at the PMP. RV agreed to this proposal. Additionally, existing data can be submitted to the AGVES group. MM commented that for this exercise to be meaningful it would be nice first to finalize the method development and then start collecting PM emissions data.

**4. Next Meetings:** The next meeting will take place on Wednesday 12.05.2021. Brembo will present their point of view on the topic of PM measurements.