



Brake Emission Workshop GRPE Jan 2021

A contribution of car industry



Status

- The automotive Industry has well supported the development of a measurement procedure
 - Definition of Test Bench
 - Definition of Particle Measurement Method
 - Definition of Brake Cycle based on WLTP-Data

Current Status of work enables for Particle Measurement of Foundation Brakes on a test bench under specified (dynamic) braking conditions



Questions for a possible regulatory approach

- Several fundamental questions need to be answered
 - Shall we focus on component tests or vehicle tests?
 - Focus on M1/N1 or also M2/N2, M3/N3?
 - Which „Groupe de Rapporteurs“ will have the lead for the development of a regulatory approach?
 - How to account for new vehicle technologies – especially electrified vehicles?
 - How to account for technologies that reduce brake emissions, but are not covered yet by the test bench approach?
 - How to regulate components or spare parts?
 - How could a regulatory scheme look like? (limit value, fleet approach, classification,...)
 - How to derive reasonable limit values?

Investigation of compatibility, repeatability, reproducibility etc. still necessary
- Round Robin / Timing not scheduled yet
- Only passenger cars
- Electrified powertrains and brake system



Scope of Regulation

- Concentration on those vehicle classes with highest impact
 - Definition of Test Bench
 - Investigations necessary on distribution of brake emissions across vehicle classes
 - Taking into account the human exposure and urban circumstances (densely populated areas, congested driving conditions, low speed, vehicle distribution)
 - How to handle the trade-off between road safety and emissions
 - Which vehicle class is the main contributor?
 - Do heavy duty brakes play a significant role in brake emissions?

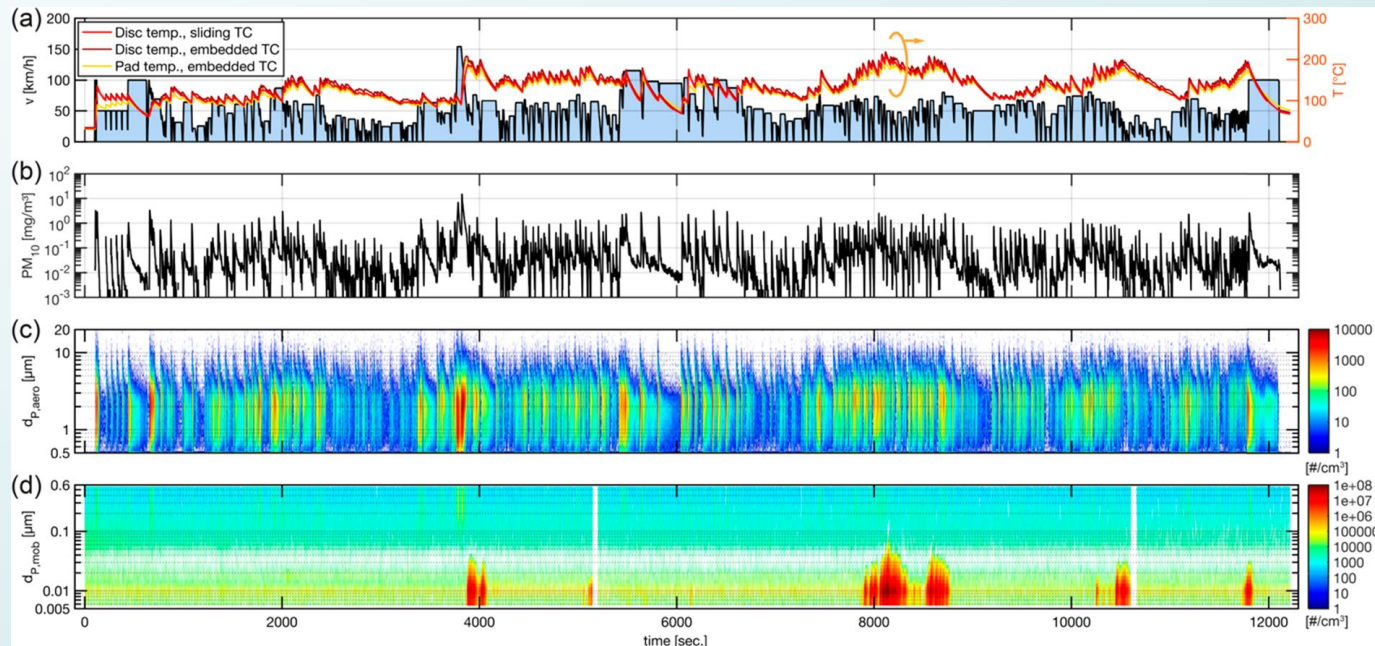
PMP should identify the main contributors in a first step!

Further investigations/measurements needed

Vehicle Types with minor emission contribution (eg. BEVs) shall be treated separately.

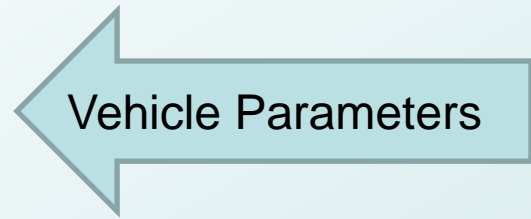
Ⓢ A future regulation should focus on bench-testing

- In Principle stable results achievable with current test set-ups
 - Brake dynamometer particle sampling approach with constant volume sampling. Minimize particle losses
 - WLTP derived realistic braking cycle close to on-road driving
 - Approach can be extended for hybrid electric vehicles, or electric vehicles
 - In principle measurement setup is applicable to Heavy-Duty vehicles





Component Test / Brake System Test



Foundation Brake

Axes / Weight Distribution

Tyre / Rim

Electric Braking

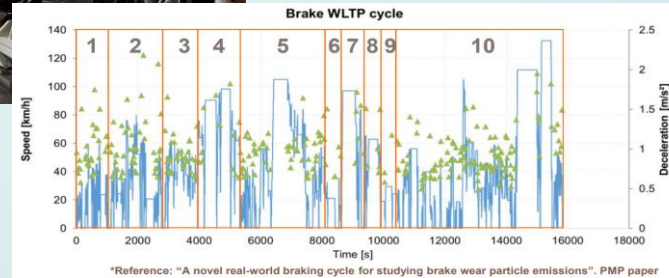
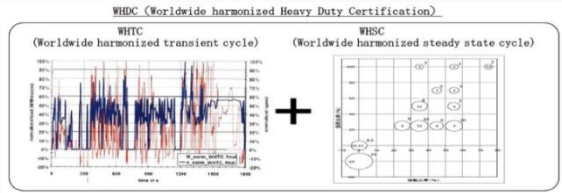
Engine Braking / Gearbox

Vehicle Load

Proposed Approach is a brake system test considering vehicle specific parameters

@ Component Test / Brake System Test

System approach but component testing? The WHTC as good example?



Method not mature but shows potential to handle different vehicle classes and approaches



How a regulatory scheme could look like

- Limit values on the basis of individual vehicles
 - Definition of Test Bench
 - Vehicle based limit preferable; Fleet value is a good approach, but too complex in a first step
 - Individual Vehicle Weight should be reflected
 - Compensation of emission reducing technologies (for example particle collecting systems)
 - Temperature is a very sensitive parameter and can influence emission behaviour
 - PMP-measurement procedure as basis for PM/PN-determination



Questions for a possible regulatory approach

- Shall we focus on component tests or vehicle tests?
- Focus on M1/N1 or also M2/N2, M3/N3/O?
- Which „Groupe de Rapporteurs“ will have the lead for the development of the approach?
- How to account for new vehicle technologies – especially electrified vehicles?
- How to account for technologies that reduce brake emissions, but are not covered yet by the test bench approach?
- How to regulate components or spare parts?
- How could a regulatory scheme look like? (limit value, fleet approach, classification,...)
- How to derive reasonable limit values?
- Focus on component test under consideration of vehicle parameters
- Not yet possible to decide, focus on main contributors. Further investigations needed.
- Brake experts have to be involved
- To be treated depending on contribution. To be investigated, based on achieved results of PMP
- To be considered as vehicle specific parameter
To be investigated
- To be discussed. (e.g trade off road safety(braking distance) vs. health (particle emissions))
- Not yet possible to decide
- Not yet possible to decide