



# PARTICLE MEASUREMENT PROGRAMME

PMP-IWG

## **BRAKE PARTICLE EMISSIONS**

**INTERLABORATORY STUDY – BACKGROUND**

**Theo Grigoratos**

# INTERLABORATORY STUDY - OBJECTIVES

- ✓ Verify the feasibility and applicability of the defined specifications for sampling and measuring brake emission particles (TF2 Output);
- ✓ Provide recommendations to the TF2 on further improving and/or extending the set of the defined specifications;
- ✓ Examine the repeatability and reproducibility of PM and PN emission measurements with the application of the defined specifications;
- ✓ Examine the repeatability and reproducibility of test conditions (i.e. speed, torque, temperature) with the application of the defined specifications;
- ✓ Propose alternatives that can improve the efficiency of some of the methods and specifications proposed (i.e. bedding procedure)

# TASK FORCE 3 – SQUAD

## Organization – Management

T. Grigoratos (JRC)

## Steering Committee\*

C. Agudelo (LINK), B. Giechaskiel (JRC), S. Gramstat (AUDI), J. Grochowicz (FORD), H. Kaminski (IUTA), T. Mamakos (AVL), M. Mathissen (FORD), H. Niemann (TUD), R. Vedula (LINK), J. Von-Wild (BMW)

Participating Labs: AUDI (S. Gramstat), AVL (T. Mamakos, M. Arndt), BMW (K. Kolbeck, J. Von-Wild), BREMBO (M. Federici), DRIV (M. Morbach, C. Koelsch), FORD (R. Vogt, J. Grochowicz, M. Mathissen), HORIBA (G. Kanae Filler, D. Lugovyy), IDIADA (A. Perez, J. Olive), ITT (A. Sin, S. Balestra), JARI (H. Hagino), LINK-EU (A. Hortet, C. Schmidt), LINK-US (C. Agudelo, R. Vedula), NIER (H. Chong), TMD (P. Nyhof), TU DARMSTADT (H. Niemann, H. Kaminski), TU ILMENAU (D. Hesse, C. Hamatschek), UTAC (P. Jouy, E. Collot)

**OEM Brake providers: AUDI (S. Gramstat), BMW (K. Kolbeck), FORD (J. Grochowicz), STELLANTIS (O. Bausch, D. Ehrlich), VW (J. Niediek)**

\*The role of the SC has been ***1. Support the preparations of the ILS; 2. Handle questions and feedback to TF3 colleagues related to various aspects during the testing campaign; 3. Assist with data quality check and processing; 4. Handle possible publications in peer-reviewed journals and conferences***

# TESTED BRAKES – MAIN CHARACTERISTICS

	OEM / Model	Axle [F/R]	Vehicle Test Mass [kg]	Nominal Dyno WL [kg]	Applied Dyno WL [kg]	Nominal Inertia [kg/m <sup>2</sup> ]	Applied Inertia [kg/m <sup>2</sup> ]	Disc or Drum	Pad Type	WL/DM [-]
Br1a	Ford Focus	Front	1600	572.8	498.3	56.7	49.3	Disc	ECE	88.1
Br1b	Ford Focus	Front	1600	572.8	498.3	56.7	49.3	Disc	NAO	88.1
Br2	Audi S4	Front	1668	567	493.2	58.4	50.8	Disc	ECE	44.6
Br3	BMW X7	Front	2623	878.5	764.3	128.9	112.1	Disc	ECE	50.7
Br4	Opel Corsa	Rear	1253	187.8	163.4	18.5	16.1	Drum	N/A	44.7
Br5a	VW Crafter	Front Nominal	2500	837.5	728.6	99.7	86.7	Disc	ECE	90.1
Br5b	VW Crafter	Front 90% Pay Load	3390	1135.7	988	135.2	117.6	Disc	ECE	122.1

**Mandatory**      **Optional**

# FINAL TESTING STATUS

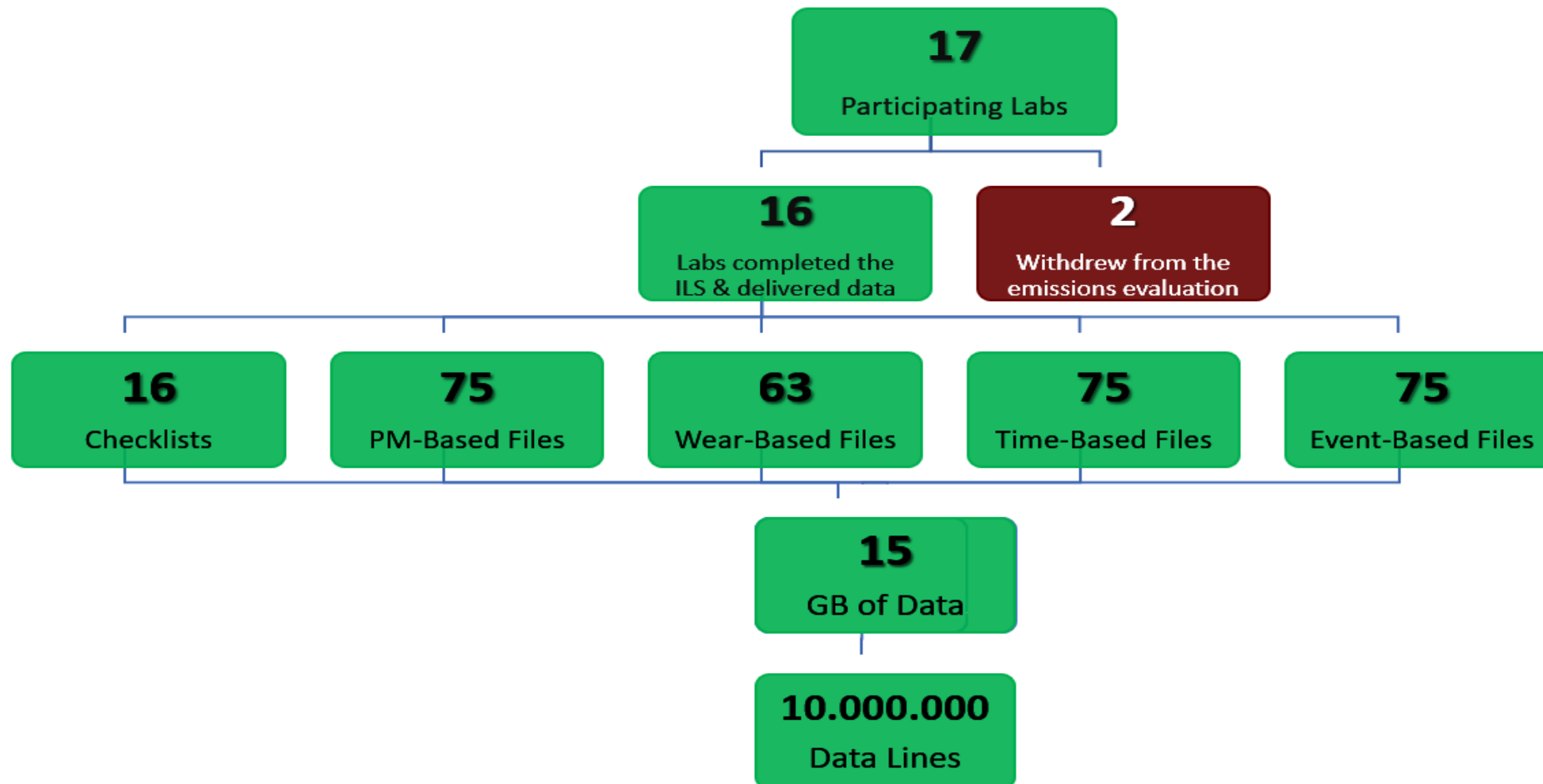
Mandatory /Optional	M1 - Br1a	M2 - Br1b	M3 - Br2	O1 - Br3	O2 - Br4	O3 - Br5a	O4 - Br5b	O5 - Repeatability	O6 - Alt. Bedding
Lab-B	✓	✓	✓	✓				✓	✓
Lab-C	✓	✓	✓	✓					
Lab-D	✓	✓	✓		✓				
Lab-F	✓	✓	✓	✓	✓	✓	✓		
Lab-G	✓	✓	✓			✓	✓		
Lab-H	✓	✓	✓						
Lab-J	✓	✓	✓						
Lab-K	✓	✓	✓					✓	
Lab-L	✓	✓	✓	✓				✓	✓
Lab-M	✓	✓	✓	✓	✓	✓	✓	✓	
Lab-N	✓	✓	✓	✓	✓	✓	✓		✓
Lab-P	✓	✓	✓						
Lab-Q	✓	✓	✓					✓	
Lab-R	✓	✓	✓						
Lab-S	✓	✓	✓	✓					
Lab-T	✓	✓	✓		✓				
Lab-X	✓	✓	✓			✓	✓		

**75**  
Completed tests  
**89%**

Not Completed    Completed

# COMPLETED TESTS AND COLLECTED FILES

71 full tests (Bedding + Emissions) were completed – Lab-L performed Repeatability and Alternative Bedding tests with more than one brakes resulting in a total of 75 completed tests



# COMPLETED TESTS AND COLLECTED FILES

The quality check revealed errors in the submitted files. A revision procedure in collaboration with the Labs followed:

- ✓ Checklist files (R. Vedula, C. Agudelo) – These provide a detailed description of the setup capabilities and the fulfillment of the main specs – Revised once with additional info and explanations from Labs;
- ✓ Time-Based files (A. Mamakos, H. Niemann) – These provide 1Hz data for 25 parameters including PN emissions – Serious alignment and other issues – Revised twice to be brought to a comparable format;
- ✓ Event-Based files (J. Wild, H. Kaminski) – Information on the individual brake events of the WLTP-Brake cycle is provided – Contained cooling sections and zero-negative values – Revised twice to be brought to a comparable format;
- ✓ PM-Mass Files (M. Mathissen, B. Giechaskiel) – These provide data for PM measurement related parameters including the actual PM10 and PM2.5 EFs – Files were revised once to correct erroneous data and be brought to a comparable format
- ✓ Wear Files (M. Mathissen, T. Grigoratos) – They provide information on the total brake wear throughout the testing procedure (Bedding + Emissions) – Labs C, R, S did not submit wear data – Not revised

# Thank you



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