PARTICLE MEASUREMENT PROGRAMME

PMP-IWG

TASK FORCE 2 – BRAKE EMISSIONS

CLAUSE 6 OF THE TF2 PROTOCOL

Bedding Procedure

CLAUSE 6 – OVERVIEW

ILS data, the GRPE-81-12, and the TF2 protocol have been used to analyze Clause 6. Minor modifications to the initial proposal have been introduced:

- ✓ 6.1 – Describes the procedure related to the bedding procedure of front brakes – Data from the ILS have been analyzed – Provisions for the correct application of the bedding procedure have been introduced in more detail – The alternative proposal has been examined – Compliance criteria for the correct execution of the cycle have been introduced in Clause 1;

- ✓ 6.2. – Describes the procedure related to the bedding of rear brakes – Not much data available – Data from the drum brake tested at the ILS have been analyzed – Provisions for the correct application of the bedding procedure have been introduced in more detail – Compliance criteria for the correct execution of the cycle have been introduced in Clause 1;

CLAUSE 6 – BEDDING PROCEDURE OVERVIEW

During the ILS, each Lab had to perform 5 bedding WLTP-Brake cycles followed by 3 emissions WLTP-Brake cycles to complete a standard or a repeatability test. On the other hand, for an alternative bedding test the Labs had to perform 10 Trips #10 followed by 3 emissions WLTP-Brake cycles

- ✓ ***Standard Tests:*** 174 standard emission WLTP-Brake cycles were completed with all brakes – 277 bedding WLTP-Brake cycles were completed (Approximately 1385 h of testing);
- ✓ ***Repeatability Tests:*** 16 repeatability emission WLTP-Brake cycles were completed with Br1a, Br2, and Br3 – 30 bedding WLTP-Brake cycles were completed;
- ✓ ***Alternative Bedding:*** 16 alternative bedding emission WLTP-Brake cycles were completed with Br1a, Br1b, Br2, and Br3 – 60 bedding Trips #10 were completed;
- ✓ Not all bedding cycles were completed successfully – Some labs faced problems during the bedding, whereas in most cases labs reported problems only when registering the bedding data

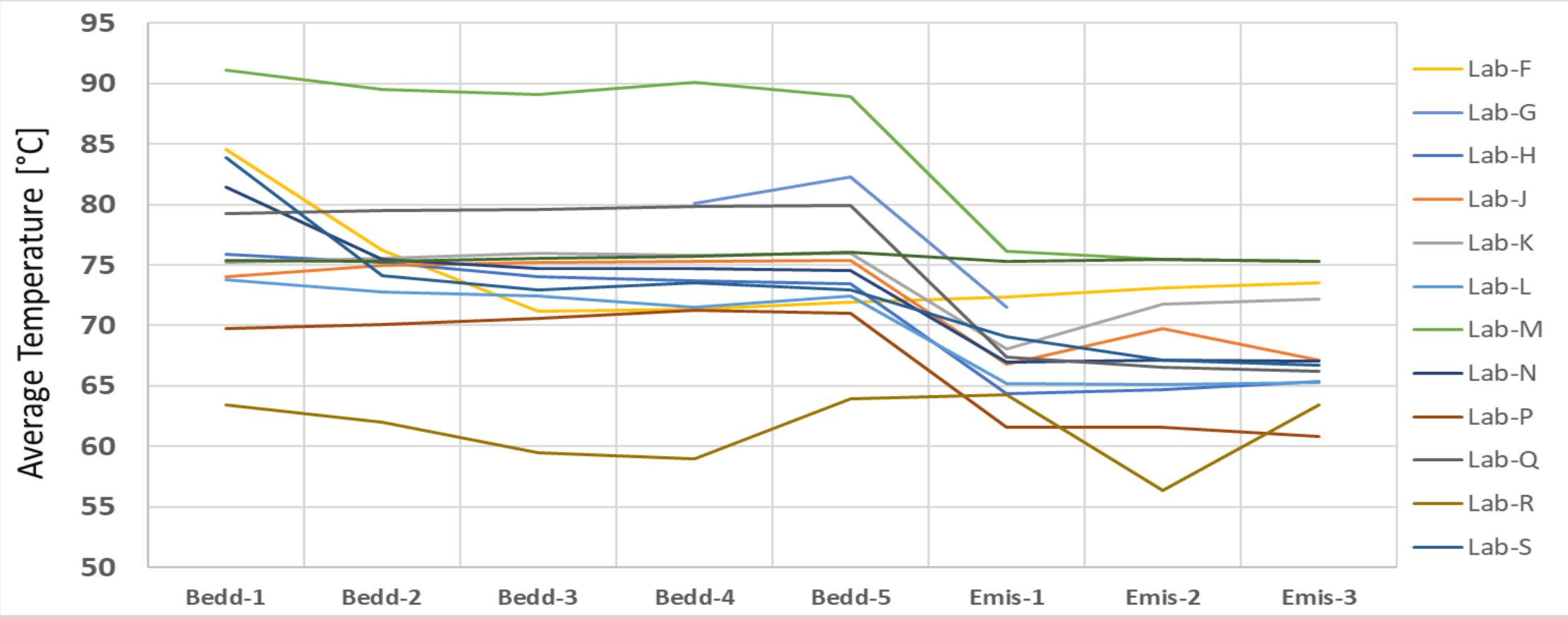
66
Tests with complete Bedding
88%

9
Tests with incomplete Bedding
12%

DEFAULT BEDDING PROCEDURE

DEFAULT BEDDING – AVG TEMPERATURE

- ✓ The average temperature of each WLTP-Brake cycle seems to slightly decrease (on average by 5-10°C) when progressing from bedding to emission cycles mostly due to no cooling sections in bedding cycles (Br1a)
- ✓ Bedding cycles come with higher average temperature fluctuations compared to emission cycles which seem more stabilized



DEFAULT BEDDING – AVG TEMPERATURE

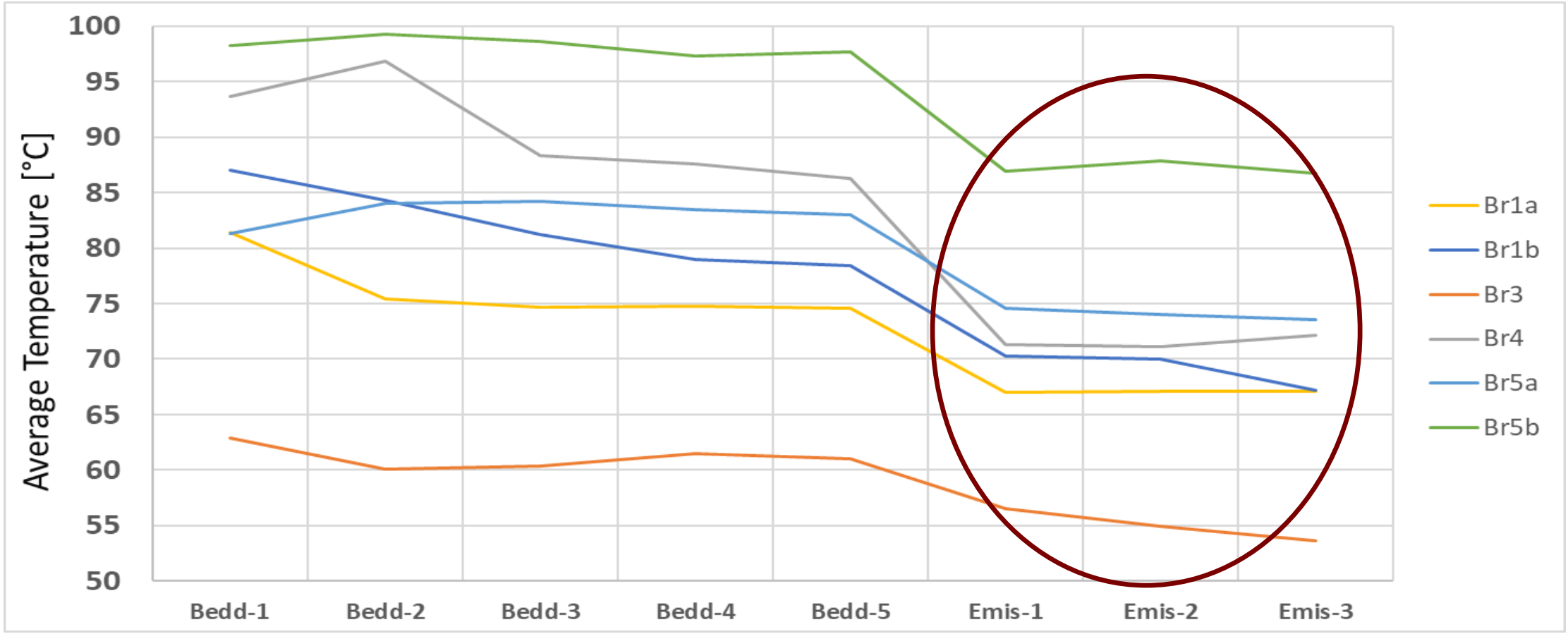
The average brake temperature during the five bedding WLTP-Brake cycles is close to 75°C – The corresponding temperature during the three emission cycles is close to 68°C and ***IS STABILIZED*** – Trend is not confirmed for Labs R and T – Lab F also exhibits a stabilized behavior already from Bed-2:

AVG Temp.	Bed-1 [C°]	Bed-2 [C°]	Bed-3 [C°]	Bed-4 [C°]	Bed-5 [C°]	Emis-1 [C°]	Emis-2 [C°]	Emis-3 [C°]
Lab-F	84.6	76.3	71.1	71.4	72.0	72.4	73.1	73.6
Lab-G	78.5	N/A	N/A	80.1	82.3	71.5	N/A	71.8
Lab-H	75.9	75.2	74.0	73.7	73.5	64.4	64.7	65.4
Lab-J	74.1	75.0	75.2	75.3	75.3	66.8	69.7	67.1
Lab-K	75.2	75.5	75.9	75.8	76.0	68.0	71.8	72.2
Lab-L	73.8	72.8	72.4	71.6	72.4	65.2	65.1	65.3
Lab-M	91.1	89.5	89.1	90.1	88.9	76.1	75.5	75.3
Lab-N	81.4	75.4	74.7	74.7	74.6	67.0	67.1	67.1
Lab-P	69.7	70.1	70.6	71.3	71.0	61.6	61.5	60.9
Lab-Q	79.3	79.5	79.6	79.9	79.9	67.4	66.5	66.2
Lab-R	63.5	62.0	59.5	58.9	64.0	64.3	56.4	63.5
Lab-S	83.9	74.1	72.9	73.6	73.0	69.1	67.2	66.7
Lab-T	75.4	75.3	75.6	75.8	76.0	75.3	75.5	75.3
AVG	**77.4**	**75.1**	**74.2**	**74.8**	**75.3**	**68.4**	**67.8**	**68.5**
StDev	7.0	6.3	6.8	6.9	6.0	4.4	5.7	4.6

Average Behavior | Different Trend

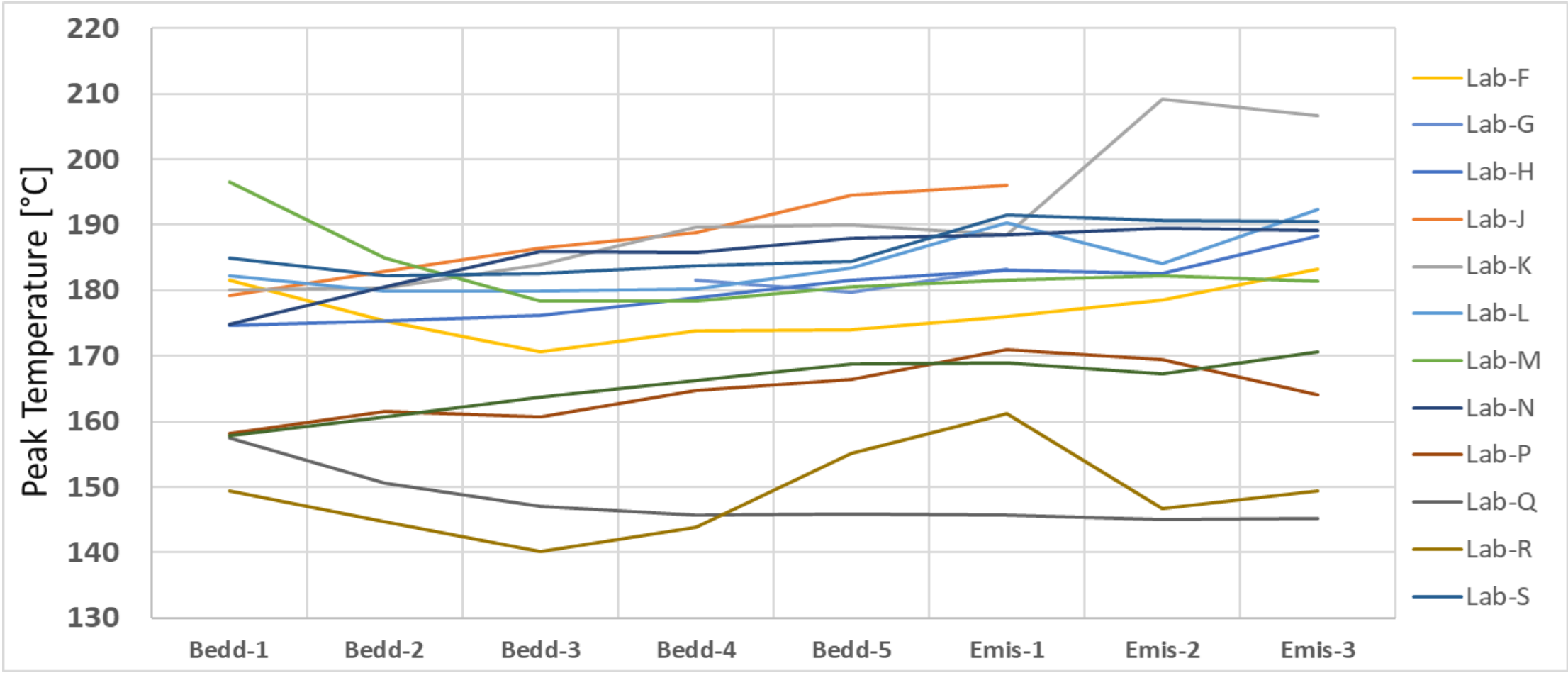
DEFAULT BEDDING – AVG TEMPERATURE

The same conclusions are drawn for other brakes – The average temperature of each WLTP-Brake cycle seems to slightly decrease (on average by 5-10°C) when progressing from bedding to emission cycles (data for Lab-N) – ***Temperature over emission cycles seems to stabilize with all brakes***



DEFAULT BEDDING – PEAK TEMPERATURE

The peak temperature of each WLTP-Brake cycle seems not to be affected significantly when progressing from bedding to emission cycles (Br1a) – Different trends were observed among the labs.



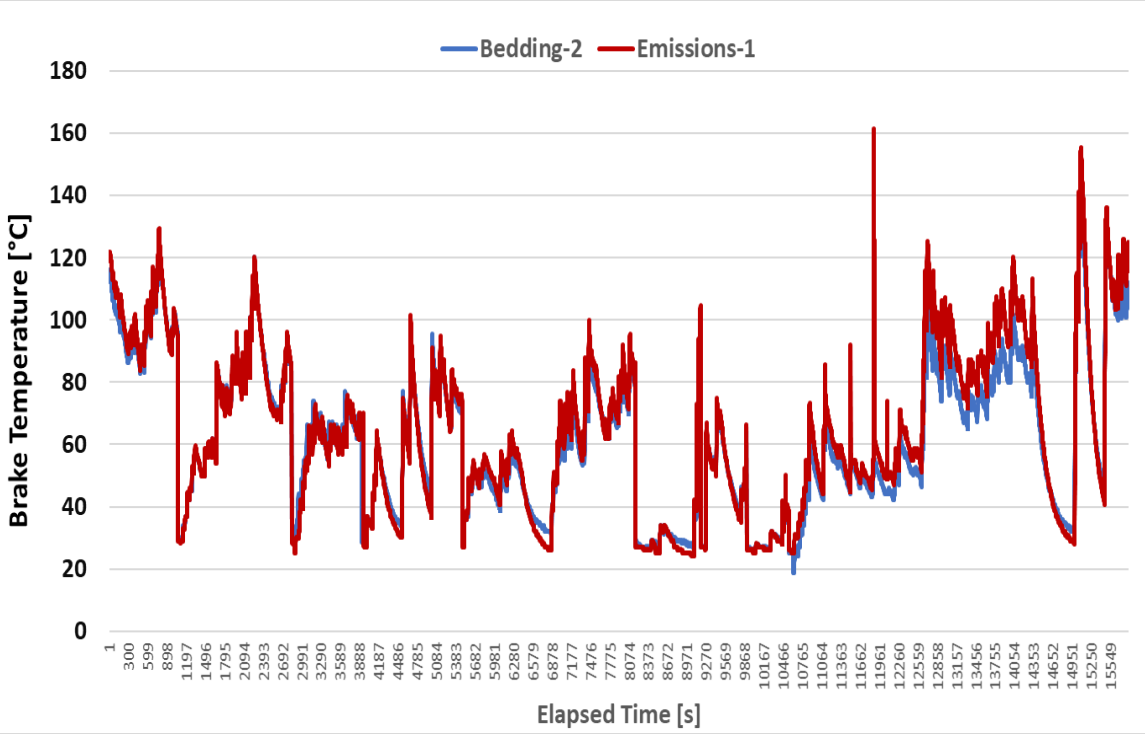
DEFAULT BEDDING – PEAK TEMPERATURE

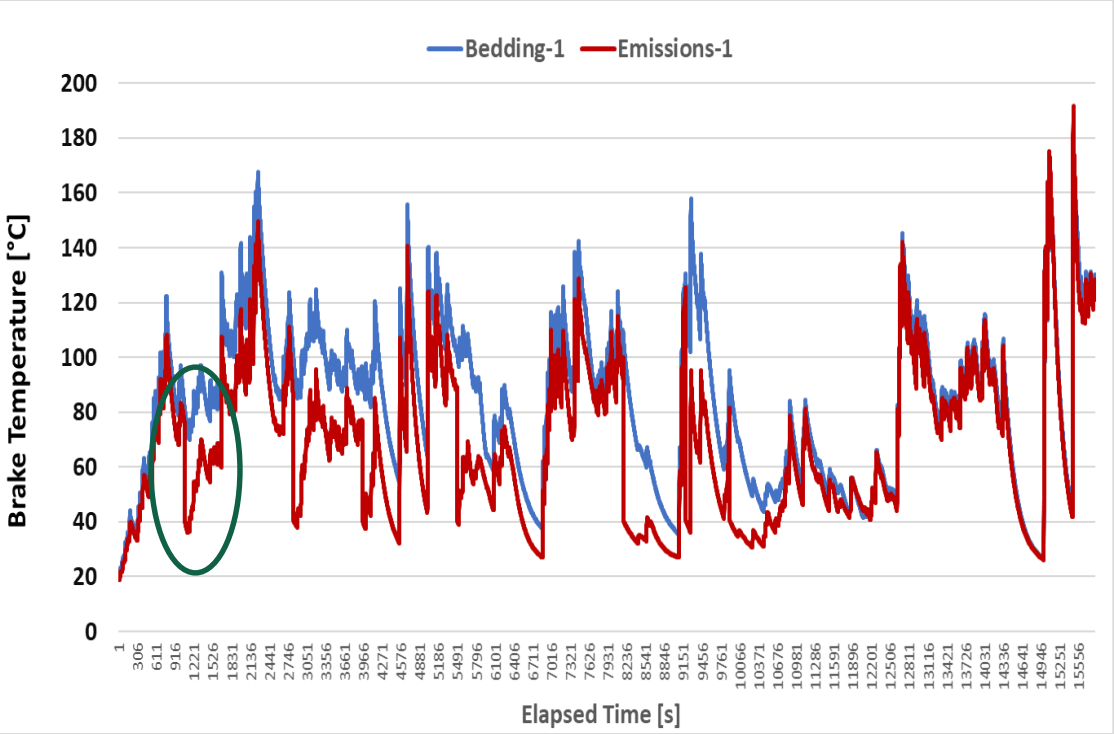
The peak temperature during the five bedding WLTP-Brake cycles is close to 175°C – The corresponding temperature during the three emission cycles is close to 180°C and ***IS STABLE*** – Different trends are observed (Labs H, J, K, L, S ➔ Slight increase / Other labs ➔ Rather Stable):

AVG Temp.	Bed-1 [C°]	Bed-2 [C°]	Bed-3 [C°]	Bed-4 [C°]	Bed-5 [C°]	Emis-1 [C°]	Emis-2 [C°]	Emis-3 [C°]
Lab-F	181.5	175.3	170.6	173.9	174.0	176.0	178.5	183.3
Lab-G	159.5	N/A	N/A	181.6	179.7	183.3	N/A	178.7
Lab-H	174.7	175.4	176.1	178.9	181.5	183.0	182.6	188.4
Lab-J	179.3	182.8	186.5	188.9	194.6	196.1	N/A	198.8
Lab-K	180.0	180.3	184.0	189.6	190.0	188.5	209.1	206.6
Lab-L	182.2	179.8	179.8	180.2	183.4	190.3	184.1	192.3
Lab-M	196.5	184.9	178.4	178.3	180.5	181.6	182.2	181.4
Lab-N	174.9	180.5	186.0	185.7	188.0	188.5	189.5	189.2
Lab-P	158.1	161.6	160.7	164.7	166.5	171.0	169.5	164.0
Lab-Q	157.5	150.6	147.1	145.7	145.8	145.7	145.1	145.2
Lab-R	149.4	144.8	140.1	143.9	155.2	161.2	146.8	149.4
Lab-S	184.9	182.3	182.6	183.7	184.5	191.5	190.6	190.5
Lab-T	157.8	160.7	163.8	166.2	168.8	168.9	167.3	170.6
AVG	**172.0**	**171.6**	**171.3**	**174.0**	**176.3**	**178.9**	**176.8**	**179.9**
StDev	14.0	13.6	15.4	15.0	14.0	14.1	18.9	18.2

Similar Behavior | **Slight Temp. Increase**

DEFAULT BEDDING VARIATIONS – LAB-R

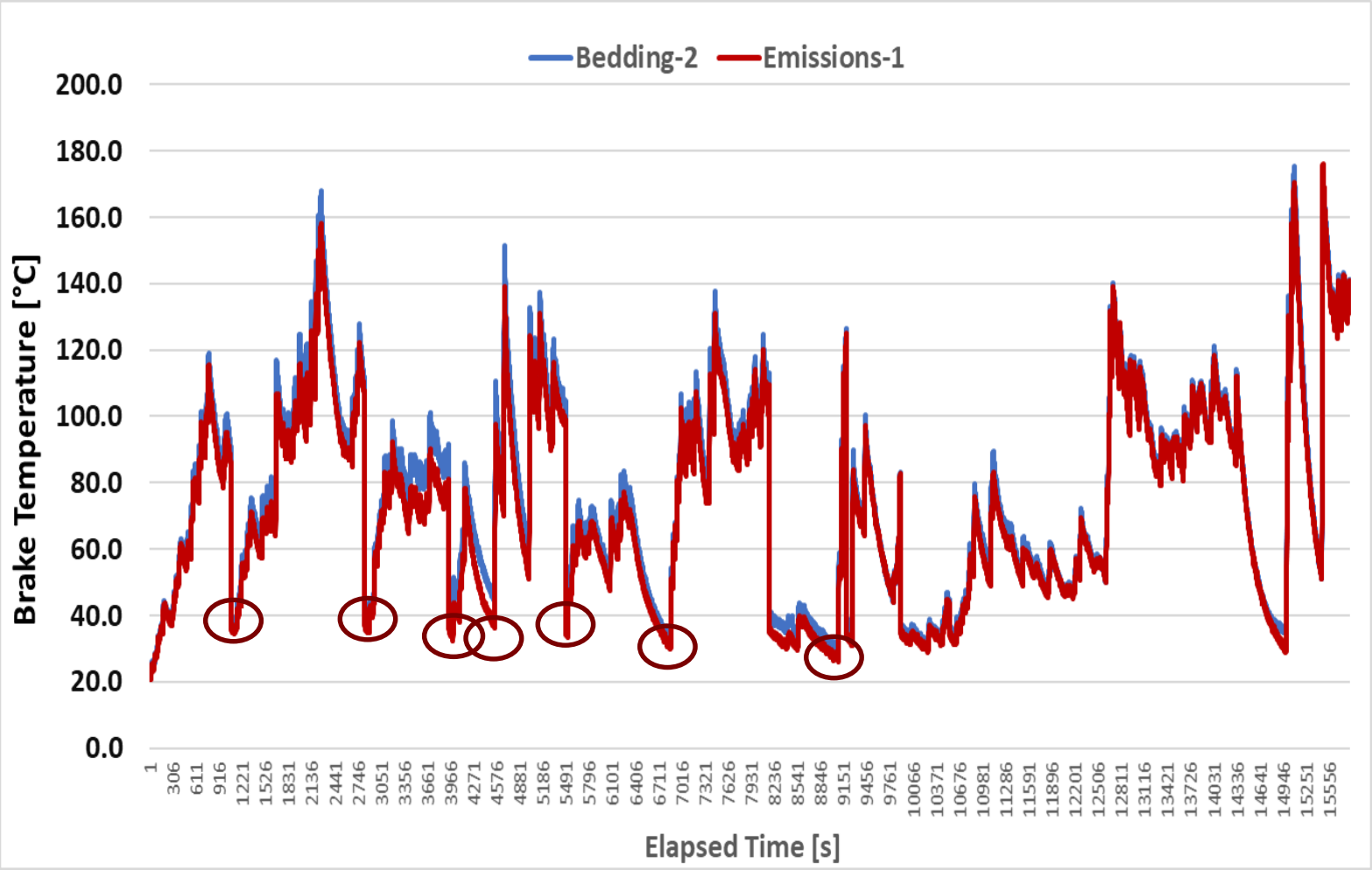




Lab-R	Bedding	Emissions
Average	62.0°C	64.3°C
MIN VALUE	18.8°C	24.2°C
50th Percentile	58.8°C	60.7°C
MAX VALUE	144.8°C	161.2°C

- ✓ Bedding-2 vs. Emission-1 tests disc temperature traces show that Lab-R did not apply the correct bedding protocol – All bedding trips were cooled down to 40°C
- ✓ Example case shown for Lab-S (Bedding-1 vs. Emission-1) demonstrates that after the end of Trip #1 (approximately at 1060s) the temperature during bedding remains close to 70°C whereas during emissions falls at 40°C.

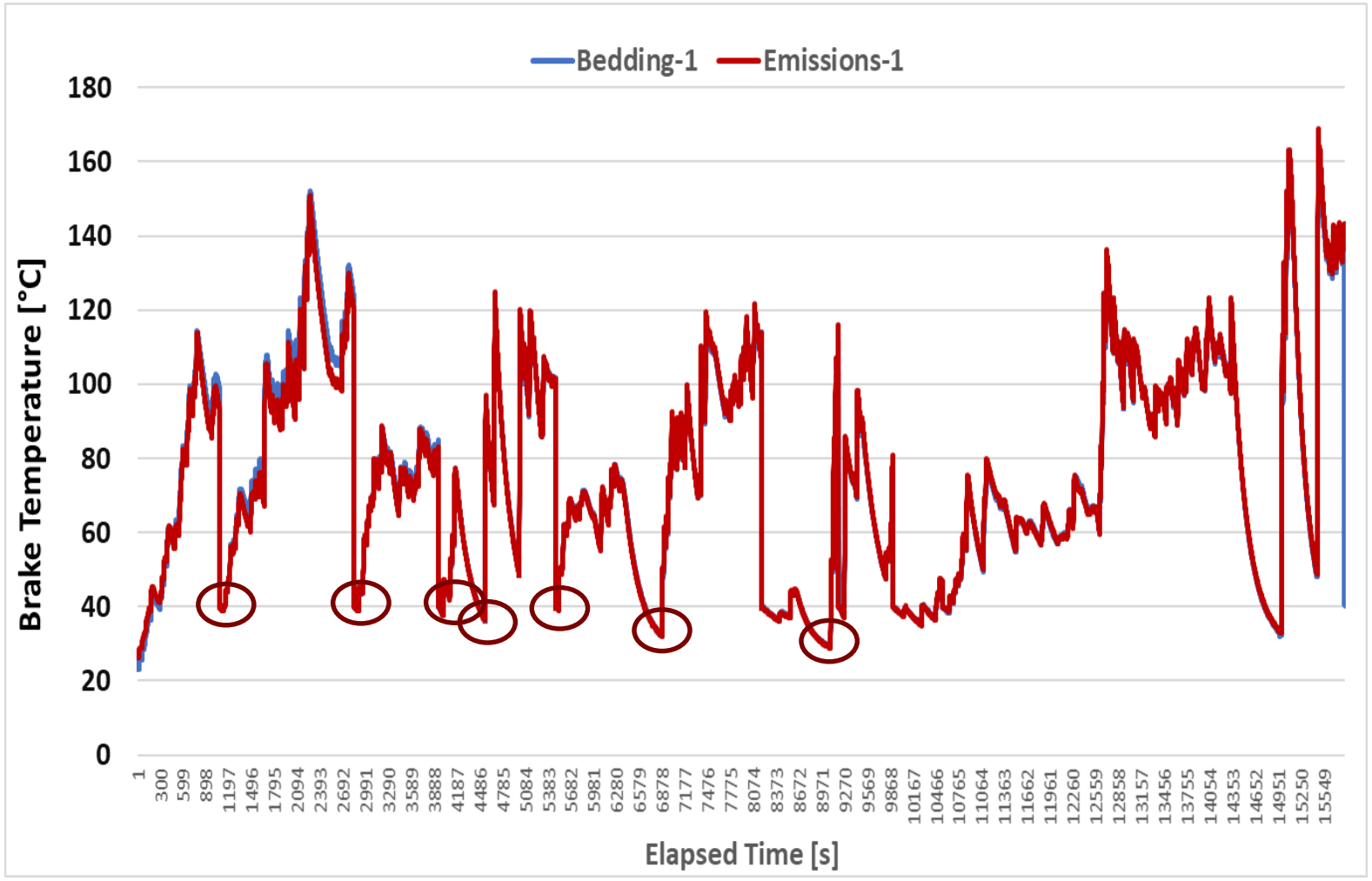
DEFAULT BEDDING VARIATIONS – LAB-F



Lab-F	Bedding	Emissions
Average	76.3°C	72.4°C
MIN VALUE	21.2°C	20.7°C
50th Percentile	73.5°C	68.6°C
MAX VALUE	175.3°C	176.0°C

- ✓ Identical traces show that Lab-F applied cooling to 40°C also during bedding;
- ✓ PM emissions are higher than the filtered average (26.5% for PM_{10} and 11.1% for $PM_{2.5}$);
- ✓ PN emissions are not affected.

DEFAULT BEDDING VARIATIONS – LAB-T



Lab-T	Bedding	Emissions
Average	75.4°C	75.3°C
MIN VALUE	23.1°C	26.3°C
50th Percentile	71.7°C	71.1°C
MAX VALUE	157.8°C	168.9°C

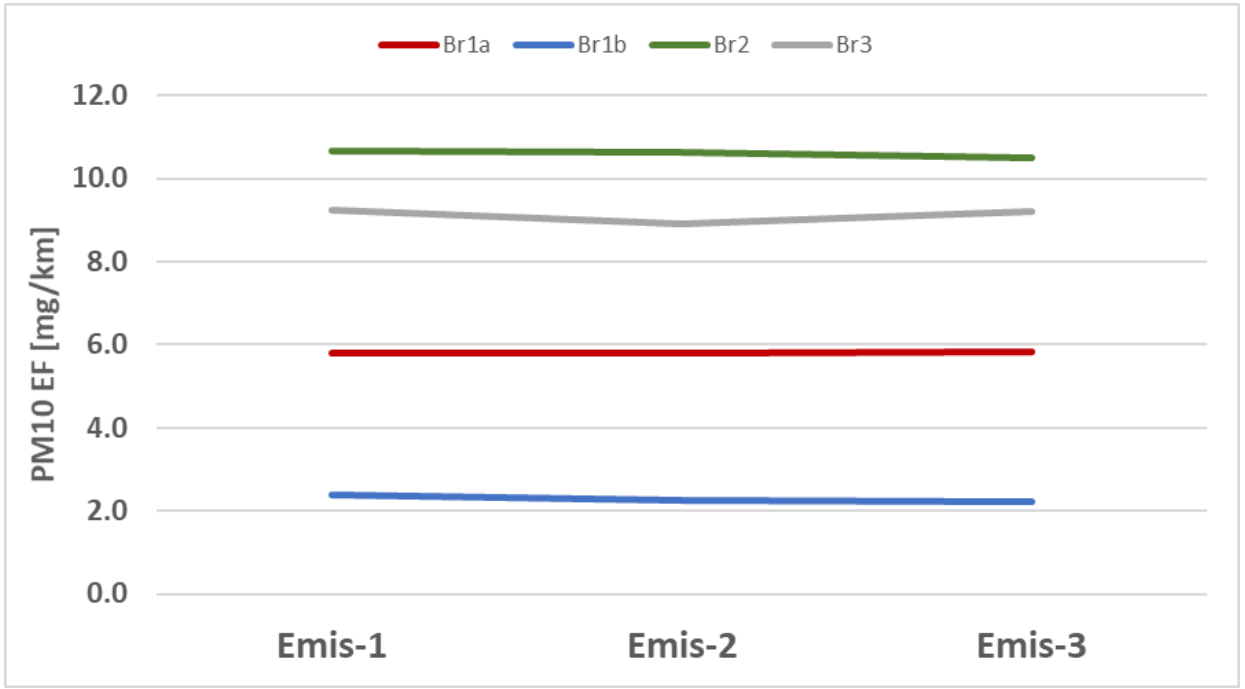
- ✓ Identical traces show that Lab-T applied cooling to 40°C also during bedding;
- ✓ PN emissions are higher than the average since volatiles were detected;
- ✓ PM is higher than the filtered average (10.5% for PM_{10}).

DEFAULT BEDDING – INFLUENCE ON PM EMISSIONS

PM_{10} emission levels measured with Br1a over the three repetitions of the emission tests are very similar and do not seem to decrease with further repetitions – ***The emission behavior of the brakes seems to be adequately stabilized with the execution of the default bedding schedule***

Br1a	Emissions-1 [mg/km]	Emissions-2 [mg/km]	Emissions-3 [mg/km]
Lab-F	7.2	7.2	7.6
Lab-G	6.5	6.3	6.2
Lab-H	1.7	3.5	4.1
Lab-J	6.1	5.9	5.7
Lab-K	2.7	2.8	2.8
Lab-L	5.6	5.7	5.8
Lab-M	7.3	7.8	7.9
Lab-N	4.0	4.2	4.1
Lab-P	N/A	3.0	2.6
Lab-Q	2.8	2.6	2.4
Lab-R	2.5	N/A	N/A
Lab-S	5.0	4.6	4.7
Lab-T	5.9	6.6	6.7
AVG	**4.8**	**5.0**	**5.0**
F. AVG	**5.8**	**5.8**	**5.9**

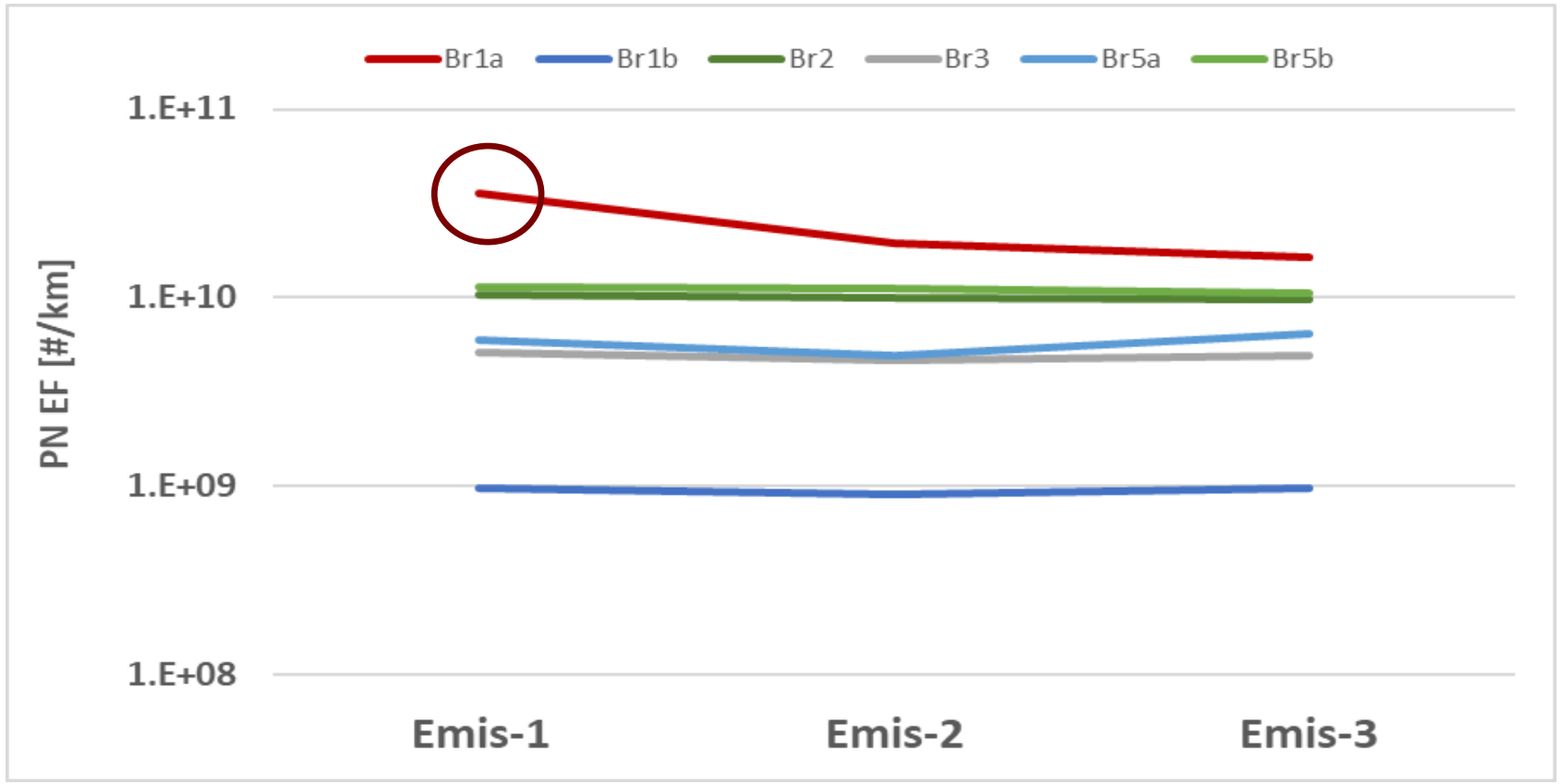
Valid Measurements	Questionable Measurements



Trend confirmed for other brakes, too – Very few data point to illustrate also for Br5a and Br5b

DEFAULT BEDDING – INFLUENCE ON PN EMISSIONS

PN emission levels with all brakes seem to stabilize after the execution of 5 WLTP-Brake cycles – ***Only in case of Br1a there seems to be a decrease from the first emissions test to the next; however, this average is largely defined from 1 measurement that included volatiles***



Lab-T (Br1a - Test)	Emissions (#/km)
Emissions-1	3.4E+11
Emissions-2	1.4E+11
Emissions-3	1.5E+11

Emissions-1 PN value significantly increases the overall average for Br1a Emissions-1 Test

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DEFAULT BEDDING PROCEDURE – OBSERVATIONS

- ✓ Most laboratories managed to complete the bedding procedure as it was defined without major issues – Some misunderstandings led to differences in three labs;
- ✓ The average temperature the WLTP-Brake cycle seems to slightly decrease (on average by 5-10°C) when progressing from bedding to emission cycles;
- ✓ The peak temperature of the WLTP-Brake cycle seems not to be affected significantly when progressing from bedding to emission cycles – Different trends are observed;
- ✓ The application of cooling sections during the bedding procedure results in similar temperatures as of emission tests (5-10°C lower compared to default bedding) – *The application of a 25h test at constantly lower temperatures might influence the emissions behavior 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.*

DEFAULT BEDDING – DRUM BRAKE

BEDDING PROCEDURE DRUM BRAKE OVERVIEW

During the ILS, 5 labs performed tests with Br4 – All of them applied the default bedding procedure with five WLTP-Brake cycles followed by 3 emissions WLTP-Brake cycles. There were some issues with the bedding procedure among the labs.

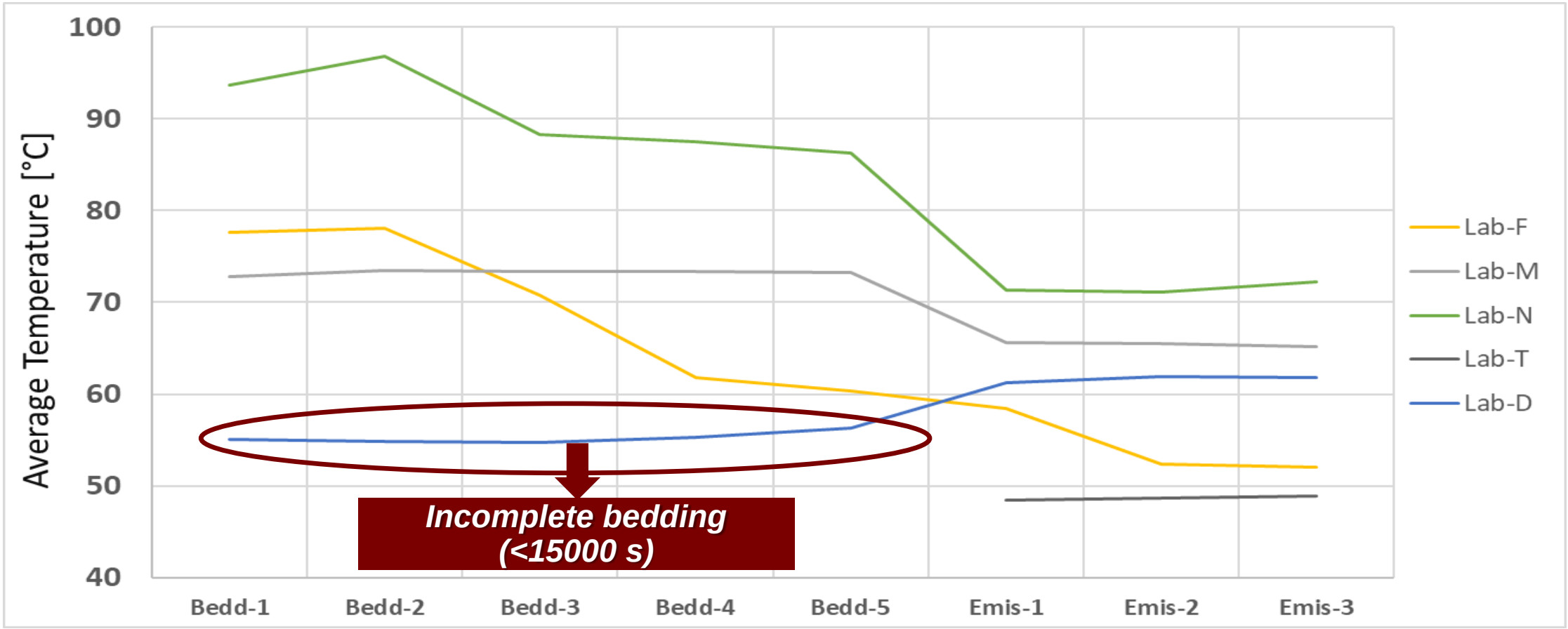
- ✓ ***Successful Tests:*** 6 emission WLTP-Brake cycles were completed with Br4 successfully – 10 bedding WLTP-Brake cycles were completed without problems (Lab M and Lab N);

- ✓ ***Incorrect Tests:*** 6 emission WLTP-Brake cycles were completed with Br4 – 10 bedding WLTP-Brake cycles were completed; however, all included cooling sections (Lab F and Lab T) – Lab-T did not submit the bedding data;

- ✓ ***Questionable Tests:*** 3 emission WLTP-Brake cycles were completed with Br4 by Lab-D – 5 bedding WLTP-Brake cycles were ran; however, the bedding data have been submitted incomplete.

DRUM BRAKE – AVG TEMPERATURE

The average temperature of each WLTP-Brake cycle seems to significantly decrease (on average by 15-25°C) when progressing from bedding to emission cycles mostly due to no cooling sections in bedding cycles.



DRUM BRAKE – AVG TEMPERATURE

The average brake temperature during the five bedding WLTP-Brake cycles is close to 70-75°C – The average temperature during the three emission cycles is close to 60°C and ***IS STABILIZED*** **–** Peak temperature seems not to be affected by bedding.

AVG Temp.	Bed-1 [C°]	Bed-2 [C°]	Bed-3 [C°]	Bed-4 [C°]	Bed-5 [C°]	Emis-1 [C°]	Emis-2 [C°]	Emis-3 [C°]
Lab-D	55.1	54.8	54.8	55.2	56.3	61.2	61.9	61.8
Lab-F	72.8	73.5	73.4	73.4	73.3	65.6	65.5	65.1
Lab-M	93.7	96.8	88.3	87.6	86.3	71.3	71.1	72.2
Lab-N	77.7	78.1	70.8	61.8	60.4	58.4	52.3	52.1
Lab-T	N/A	N/A	N/A	N/A	N/A	48.4	48.7	48.9
AVG	**74.8**	**75.8**	**71.8**	**69.5**	**69.0**	**61.0**	**59.9**	**60.0**

Peak Temp.	Bed-1 [C°]	Bed-2 [C°]	Bed-3 [C°]	Bed-4 [C°]	Bed-5 [C°]	Emis-1 [C°]	Emis-2 [C°]	Emis-3 [C°]
Lab-D	162.4	162.9	163.1	164.0	163.2	173.5	172.5	175.2
Lab-F	202.8	223.5	198.2	165.8	160.9	165.7	151.3	150.9
Lab-M	250.8	237.8	234.7	231.6	230.1	229.8	230.4	229.2
Lab-N	233.5	258.0	255.8	236.2	244.6	243.2	244.6	241.1
Lab-T	N/A	N/A	N/A	N/A	N/A	182.0	183.2	185.7
AVG	**212.4**	**220.6**	**213.0**	**199.4**	**199.7**	**198.8**	**196.4**	**196.4**

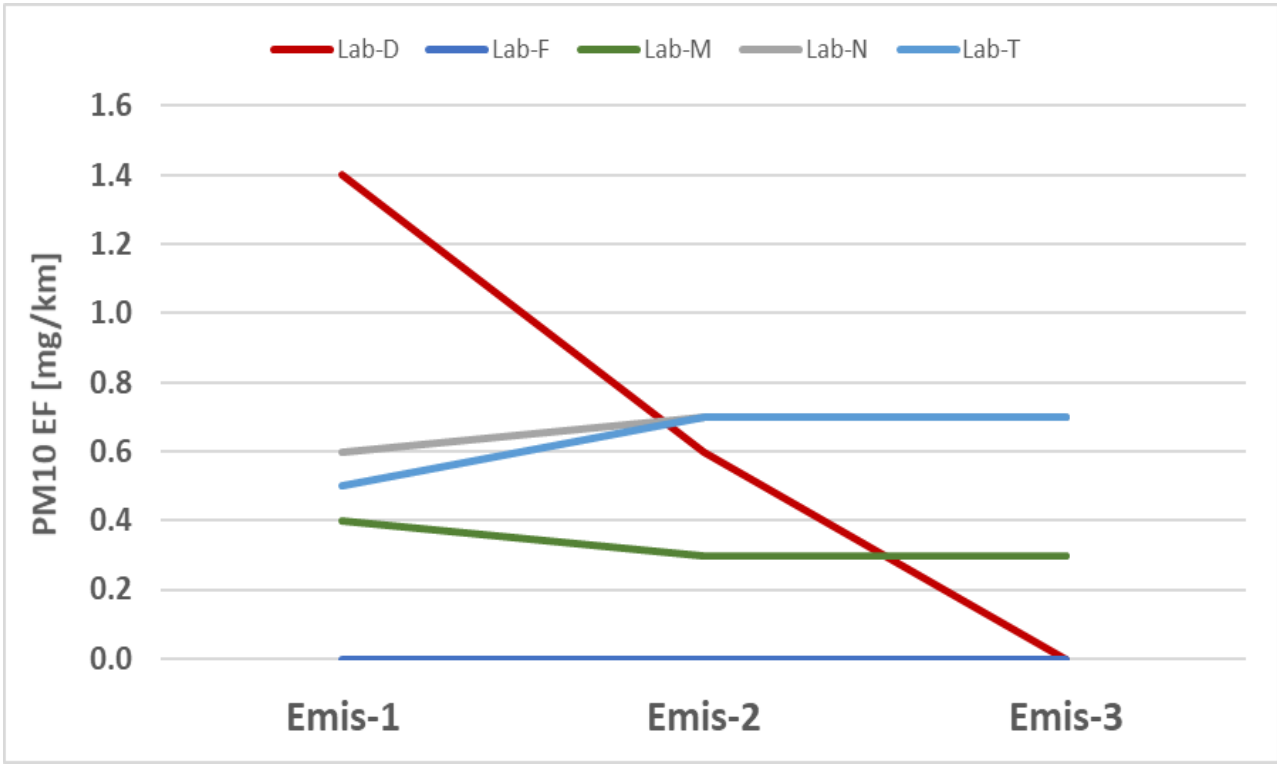
Average Behavior | Different Trend

DRUM BRAKE – INFLUENCE ON PM EMISSIONS

PM emission levels measured with Br4 over the three repetitions of the emission tests are very similar with the exception of Lab-D – ***The emission behavior of the drum brake seems to be adequately stabilized with the execution of the default bedding schedule (few data points)***

Br4 PM10	Emissions-1 [mg/km]	Emissions-2 [mg/km]	Emissions-3 [mg/km]
Lab-D	1.4	0.6	0.0
Lab-F	0.0	0.0	0.0
Lab-M	0.4	0.3	0.3
Lab-N	0.6	0.7	0.7
Lab-T	0.5	0.7	0.7
AVG	**0.6**	**0.5**	**0.4**

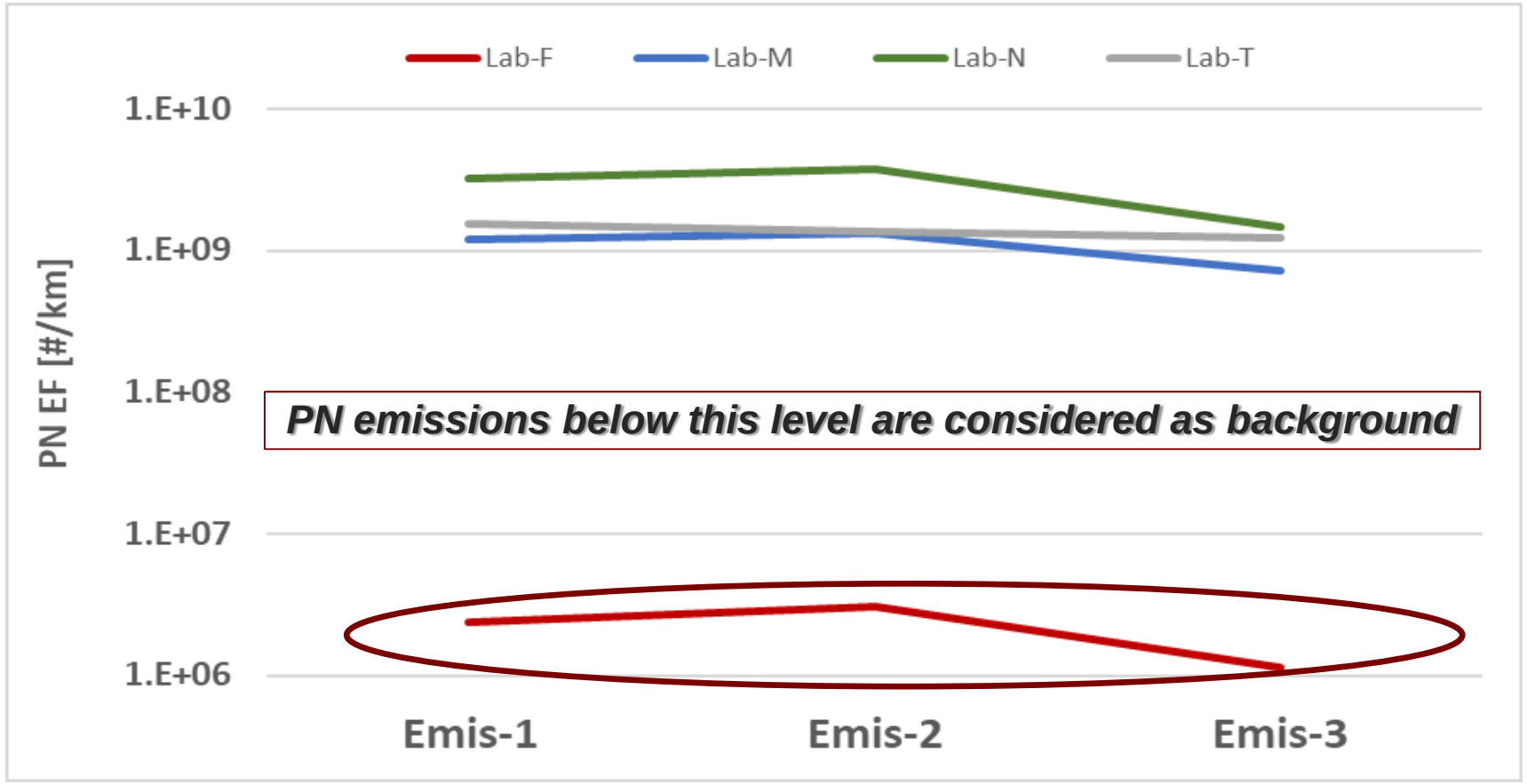
Br4 PM2.5	Emissions-1 [mg/km]	Emissions-2 [mg/km]	Emissions-3 [mg/km]
Lab-D	N/A	N/A	N/A
Lab-F	0.0	0.0	0.0
Lab-M	0.2	0.2	0.2
Lab-N	0.4	0.4	0.5
Lab-T	0.3	0.4	0.4
AVG	**0.2**	**0.3**	**0.3**



Valid Measurements	Questionable Measurements

DRUM BRAKE – INFLUENCE ON PN EMISSIONS

PN emission levels with all brakes seem to stabilize at very low levels after the execution of 5 WLTP-Brake cycles – There is a slight tendency of further reducing but is not confirmed for all Labs – In case of Lab-F PN emissions are below the background levels; therefore, are not considered valid



DRUM BRAKE – OBSERVATIONS

- ✓ Two laboratories managed to complete the bedding procedure as it was defined without issues – Some misunderstandings led to differences in two labs;
- ✓ The average temperature 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 significantly when progressing from bedding to emission cycles;
- ✓ The application of cooling sections during the bedding procedure results in slightly lower temperatures compared to default bedding – *The application of a 25h test at constantly lower temperatures might influence the emissions behavior of the brake; however, emission levels too low to see the effect*;
- ✓ *The PM and PN emission behavior of the brake seems to be adequately stabilized with the execution of the default bedding schedule – very few data points to reach a solid conclusion.*

DRUM BRAKE – ADDITIONAL CONSIDERATION

Excerpt from	Reporting lab & date	Description of the issue	Possible solution	Issue Closed
Clause 6	Lab-T 16/11/2021	During the drum brake tests the bedding procedure is to be classified as a critical part. It requires a lot of time / number of cycles to reach a reproducible emission level. We should pay attention to this. Also, the proportion of contact surfaces between brake shoe and drum is very different (data to be provided if necessary).	Would a possible solution be to run the bedding procedure for drum brakes using the front axle inertia and WL settings?	NO

- ✓ Imposing an excessive load on rear brakes can be questionable. Brake force distribution for M1 vehicles is nominally 70:30 and for N1 vehicles is 60:40 or similar. So, using 2 or 3 times higher front brake load on a rear brake can change the friction behaviour during bedding and emission particle properties in the subsequent test cycles.

PROPOSAL

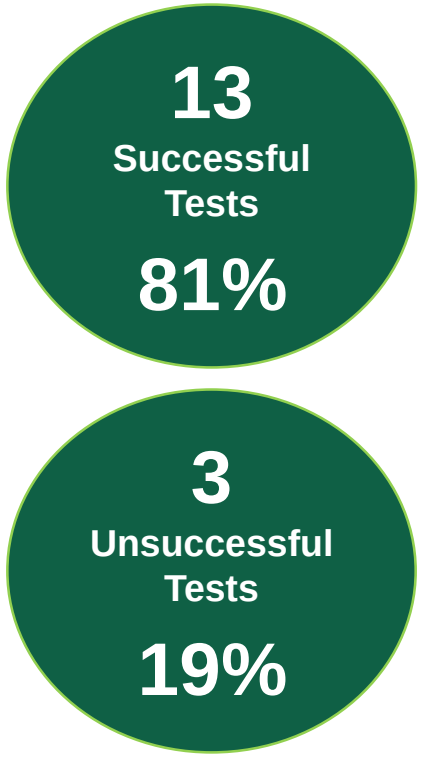
The PM and PN emission behavior of the brake seems to be adequately stabilized with the execution of the default bedding schedule – Suggestion not to apply a different approach.

ALTERNATIVE BEDDING PROCEDURE

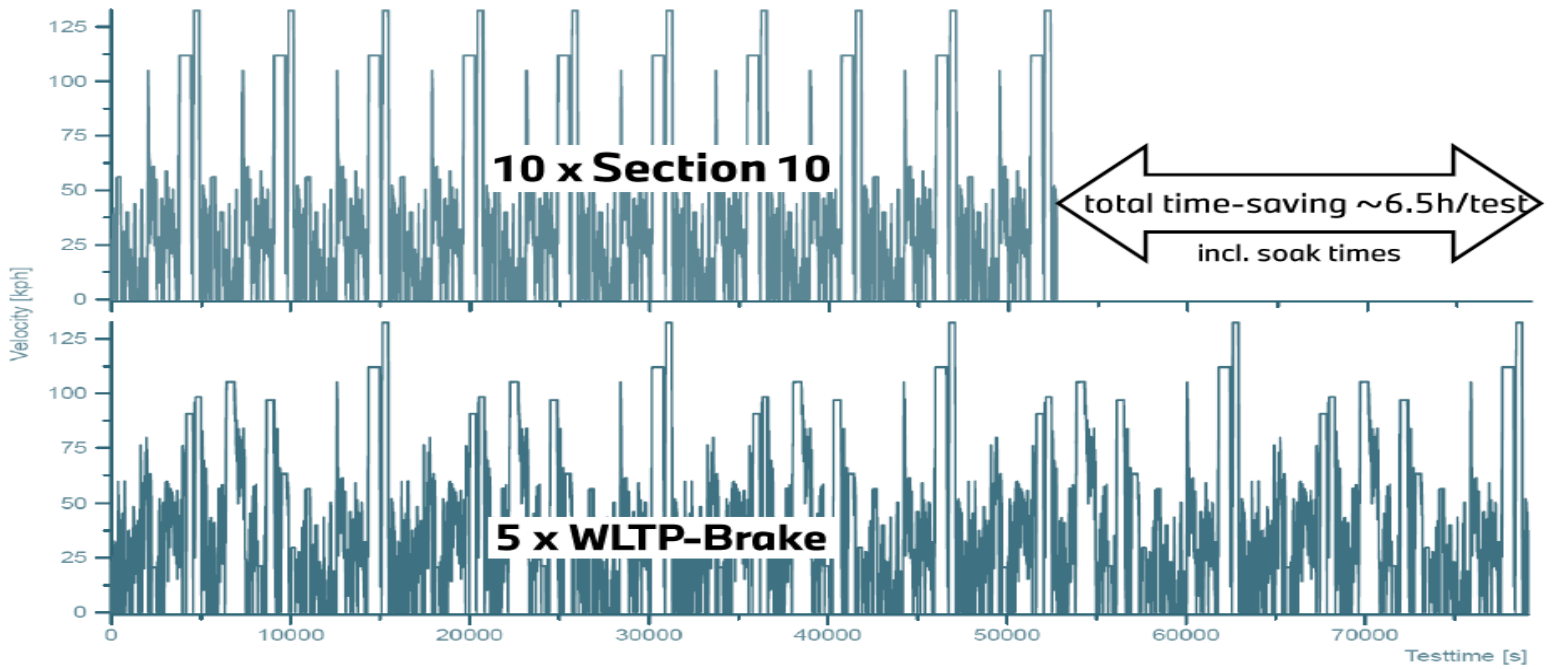
ALTERNATIVE BEDDING – OVERVIEW

During the ILS, 3 labs performed alternative bedding tests – All of them applied both the default and the alternative bedding procedure with five WLTP-Brake cycles vs. 10 Trips #10 followed by 3 emissions WLTP-Brake cycles. In principle, all bedding cycles were executed successfully.

- ✓ ***Successful Tests:*** 13 emission WLTP-Brake cycles were completed with Br1a, Br1b, Br2, and Br3 successfully – 10 bedding WLTP-Brake cycles were completed without problems (Lab L and Lab N);
- ✓ ***Incorrect Tests:*** 3 emission WLTP-Brake cycles were completed by Lab-B with Br1a – 10 bedding WLTP-Brake cycles were completed; however, emissions data from the lab are not considered valid in the analysis;
- ✓ Both procedures will be compared against each other in terms of brake temperature and emission behavior of the tested brakes.



ALTERNATIVE BEDDING – OVERVIEW



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Lab-B – Br1a
Default: 23h 20min
Alternative: 16h 50 min
Difference: 6.5h

Lab-N – Br3
Default: 23h 45min
Alternative: 16h 40min
Difference: 7h

	Default Duration [h]	Braking Energy [Wh]	Brake Events [#]	Avg Deceleration [m/s2]
5 x WLTP-Brake	22.0	168.9	1515	0.97
10 x Trip #10	14.6	113.4	1140	0.93
Difference [%]	33%	33%	25%	4%

Pros | **Cons**

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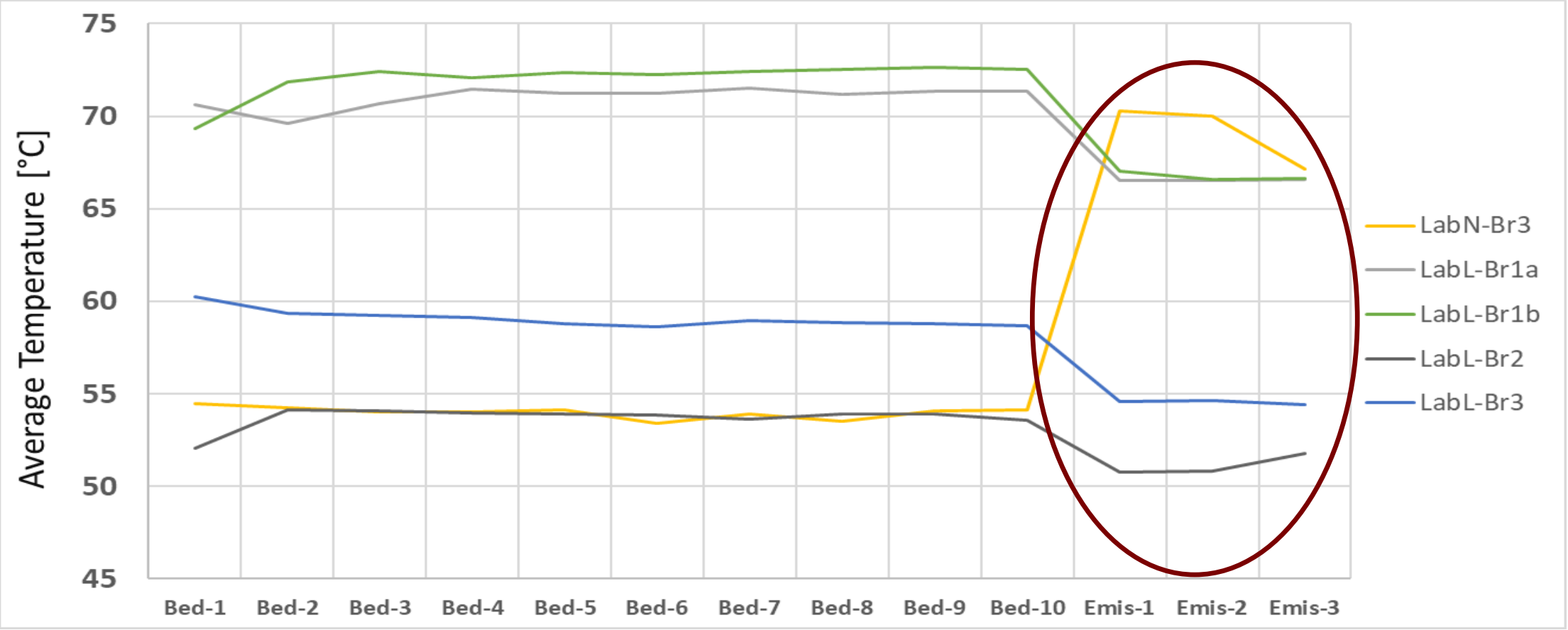
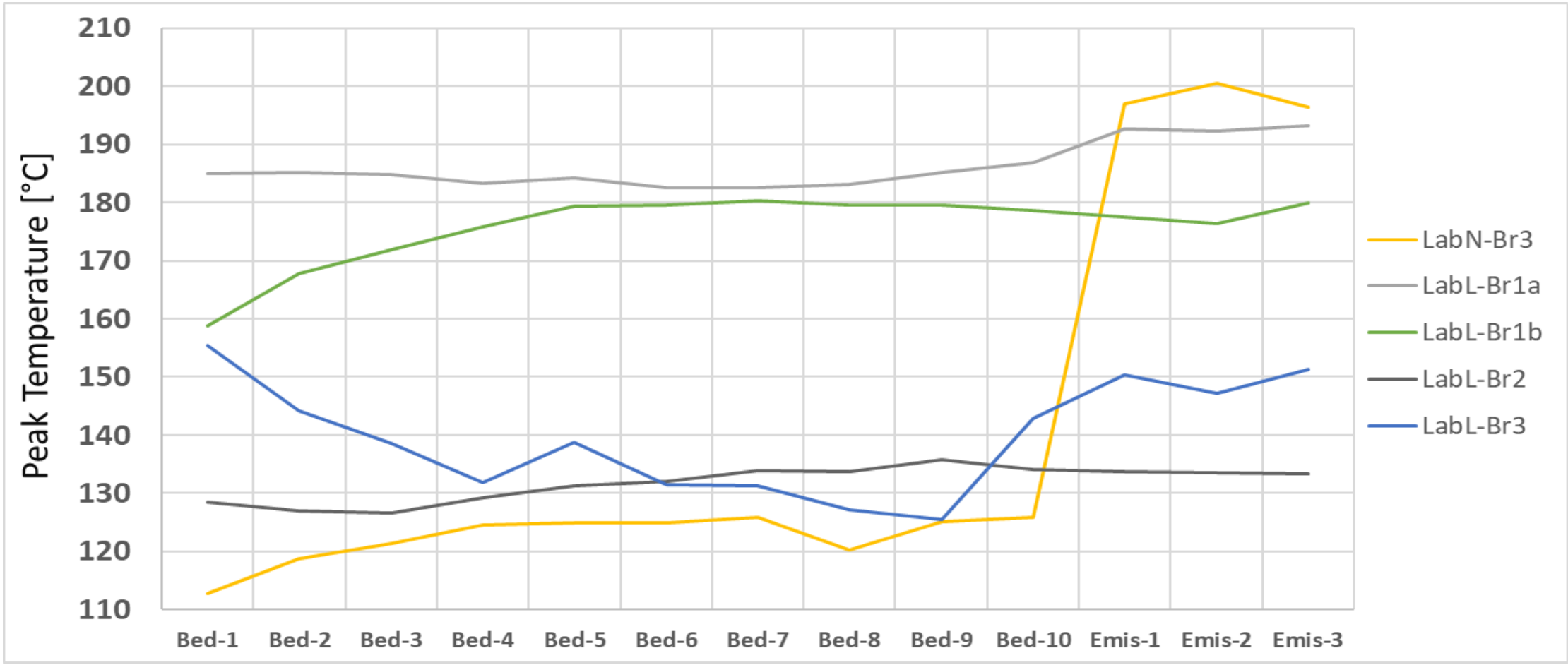
ALTERNATIVE BEDDING – AVG TEMPERATURE

- ✓ The average temperature of each Trip #10 during bedding seems to be stable after a few repetitions of the cycle;
- ✓ The average temperature of each WLTP-Brake cycle during emissions tests seem to be stable after the execution of the alternative bedding procedure – exception is Lab-N test with Br3 that shows fluctuations.



ALTERNATIVE BEDDING – PEAK TEMPERATURE

The peak temperature presents significant deviations in several cases – No clear trend also due to lack of enough data points.



ALTERNATIVE BEDDING – INFLUENCE ON PM EMISSIONS

PM10 emission levels reported with the alternative bedding method are compared to the default bedding emission tests – ***Overall emission levels and stability of the reported emission factors are examined with the two methods***

Alter. Bedding PM10	Emissions-1 [mg/km]	Emissions-2 [mg/km]	Emissions-3 [mg/km]	AVG - Alt. Bedding [mg/km]	Variability [%]
Lab L - Br1a	6.7	5.7	5.5	**6.0**	**11%**
Lab L - Br1b	3.3	3.4	4.3	**3.7**	**15%**
Lab L - Br2	9.3	N/A	N/A	**9.3**	**N/A**
Lab L - Br3	9.5	9.4	9.2	**9.4**	**2%**
Lab N - Br3	5.2	4.6	4.4	**4.7**	**9%**

Default Bedding PM10	Emissions-1 [mg/km]	Emissions-2 [mg/km]	Emissions-3 [mg/km]	AVG - Def. Bedding [mg/km]	Variability [%]
Lab L - Br1a	5.6	5.7	5.8	**5.7**	**2%**
Lab L - Br1b	3.4	3.4	3.8	**3.5**	**7%**
Lab L - Br2	9.6	9.3	9.6	**9.5**	**2%**
Lab L - Br3	8.5	8.6	8.6	**8.6**	**1%**
Lab N - Br3	7.6	7.1	6.1	**6.9**	**11%**

- ✓ PM measurements with the alternative bedding method come with generally higher variability compared to the default method;
- ✓ PM emission levels do not seem to be significantly affected by the bedding method except for tests with Br3;
- ✓ ***The emission behavior seems to be more stabilized when the default method is applied – very few data points to confirm***

ALTERNATIVE BEDDING – INFLUENCE ON PN EMISSIONS

Total PN emission levels reported with the alternative bedding method are compared to the default bedding emission tests – ***Overall emission levels and stability of the reported emission factors are examined with the two methods***

Alter. Bedding PN	Emissions-1 [#/km]	Emissions-2 [#/km]	Emissions-3 [#/km]	AVG - Alt. Bedding [#/km]	Variability [%]
Lab L - Br1a	1.3E+09	1.3E+09	1.3E+09	**1.3E+09**	**2%**
Lab L - Br1b	1.4E+09	1.2E+09	1.1E+09	**1.2E+09**	**12%**
Lab L - Br2	N/A	N/A	N/A	**N/A**	**N/A**
Lab L - Br3	3.1E+09	3.1E+09	3.1E+09	**3.1E+09**	**1%**
Lab N - Br3	4.3E+08	4.3E+08	4.1E+08	**4.2E+08**	**3%**

Default Bedding PN	Emissions-1 [#/km]	Emissions-2 [#/km]	Emissions-3 [#/km]	AVG - Def. Bedding [#/km]	Variability [%]
Lab L - Br1a	1.4E+09	1.4E+09	1.4E+09	**1.4E+09**	**0%**
Lab L - Br1b	1.2E+09	1.1E+09	1.1E+09	**1.1E+09**	**6%**
Lab L - Br2	5.4E+09	5.7E+09	5.6E+09	**5.6E+09**	**3%**
Lab L - Br3	3.0E+09	3.0E+09	3.1E+09	**3.1E+09**	**1%**
Lab N - Br3	5.5E+09	5.0E+09	5.1E+09	**5.2E+09**	**4%**

- ✓ PN measurements with the alternative bedding method come similar variability compared to the default method;
- ✓ PN emission levels do not seem to be affected by the bedding method – exception is Lab's N test with Br3 that shows a high difference;
- ✓ ***It is not possible to reach a sound conclusion about the emission behavior with the two examined methods due to few data points.***

ALTERNATIVE BEDDING – OBSERVATIONS

- ✓ Two laboratories managed to complete the tests with the application of the alternative bedding procedure without issues;
- ✓ The average temperature of each WLTP-Brake cycle seems to slightly decrease by maximum 5°C when progressing from bedding to emission cycles – Not confirmed in one case whereas very few data points do not allow for a safe conclusion;
- ✓ The peak temperature presents significant deviations in several cases – No clear trend also due to lack of enough data points;
- ✓ ***The PM emissions behavior seems to be more stabilized when the default method is applied – very few data points to confirm***;
- ✓ ***It is not possible to reach a sound conclusion about the emission behavior with the two examined methods due to few data points***.

CLAUSE 6 – BEDDING METHOD

PROPOSAL

Five repetitions of the WLTP-Brake cycle shall apply for bedding of the tested brake

- ✓ The 5 WLTP-Brake cycles shall run consecutively without any interruption – In case of interruption provisions in Clause 1.3.2 apply *(The overall 20% increased test time compared to AB is offset by the seemingly more stabilized behavior of the brake)*;
- ✓ Each repetition of the WLTP-Brake cycle shall take place without the application of soak times between the individual trips of the WLTP-Brake cycle *(There are strong indications that the brakes are better conditioned if no cooling sections are applied)*;
- ✓ The first repetition of the WLTP-Brake cycle shall commence at 20±5°C. The subsequent four repetitions of the WLTP-Brake cycle shall commence at 40°C *(In line with specs related to the cycle)*.
- ✓ The method shall apply for all front and rear axle brakes mounted in all types of M1 and N1 vehicles *(Effective preconditioning is necessary also for brakes with regen)*

Thank you

European Commission