Final Report of the Proficiency Testing in Vehicles Emissions 8th Round

Inmetro
Instituto Nacional de Metrologia, Qualidade e Tecnologia

PEP-Inmetro

Programa de Ensaios de Proficiência do Inmetro

PROFICIENCY TESTING IN VEHICLES EMISSIONS – 8th ROUND

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SUMMARY

1. Introduction

Air pollution problem is a serious threat to human health decreasing the quality of human life. Automotive vehicles are potential agents of pollution worldwide as their gas emissions carry several toxic substances which, in some cases, in contact with the respiratory system, can produce several negative health effects and cause traffic accidents due to decreased visibility.

The analysis of pollutants is one of the most delicate items of a vehicle or an engine emission test. The Proficiency Testing Schemes (PT Scheme) of automotive emissions evaluate laboratories by the determination of the compound amounts in vehicle emissions, providing then subsidies to laboratories to identify and solve analytical problems, contributing to the harmonization of emission measurements in the country.

Proficiency testing scheme is a quality tool for the identification of interlaboratory differences, but the assessment is punctual. A PT Scheme aims to compare measurement results from different laboratories, performed under similar conditions, and then to obtain an assessment of the technical competence of participating laboratories in order to demonstrate the reliability of their measurement processes. The participating laboratories, in their turn, have the opportunity to review their analysis procedures and to implement improvements in their processes, if necessary.

In this round, the following vehicle emission parameters were evaluated: (CO, CO_2, THC, NO_x, NMHC, ETOH, NMHC-ETOH and Total aldehydes (formaldehyde + acetaldehyde)) in g/km, and urban autonomy and road autonomy in km/L for urban cycle. CO, CO_2, THC, NO_x, NMHC in g/km for hot cycle and CO, CO_2, THC, NO_x, NMHC in g/km for road cycle. These parameters were evaluated with participation of seventeen laboratories, one more than the last round.

This report presents the results of the performance evaluation of participants, the methodology used in the tests and the procedure used for the statistical analysis.

The objectives of this PT scheme were:

- To determine the performance of laboratories for the proposed tests;
- To monitor the ongoing performance of the analytical vehicle emissions laboratories;
- To increase the confidence of the measuring emission process of the vehicle emission laboratories;
- To continuously improve the measurement techniques of vehicle emissions laboratories.

2. Materials and Methods

2.1. Test Item

The test item was a vehicle supplied by General Motors Brazil having the following characteristics: Model Chevrolet ONIX LTZ, black, identification code BR028273, engine 1.4 LSPE/4, 6 speed automatic transmission, FlexPower, equivalent inertia of 1247 kg. The test vehicle was correlated without the purge system of the blow-by gas canister and exhaust (the test item was supplied with the needed adjustments), as there wasn´t, in this edition, evaporative emission measurement.

Each participating laboratory should use its own fuel (Reference Hydrated Ethanol according to current ABNT NBR 8689).

2.2. Methodology

The standard methods used for emission measurements were ABNT NBR 6601, 7024, 12026 and 15598. The tests defined by these standard methods are complementary and were carried out simultaneously. The values of deceleration times (coast down) were provided by GM Brazil emission laboratory, vehicle owner, to the participants in order to adjust their dynamometers and reproduce the deceleration times. The laboratories should replicate the deceleration times in the dynamometer informed by GM emission lab.

Three different tests were performed:

- THC; NMHC, ETOH, NMHC-ETOH, Total Aldehydes, NOx, CO, CO_2, Urban and Road Autonomy determination , according to ABNT NBR 6601, 7024, 12026 and 15598.
- THC, NMHC, NOx, CO e CO_2 determination according to the third phase of ABNT NBR 6601 – HOT 505 cycle.
- THC, NMHC, NOx, CO e CO_2 determination in road cycle according to ABNT NBR 7024 standard.

Participants should have followed the test flow chart presented below and they preferably should have started the test at a 25 ºC temperature in order to minimize the effects of the cold start in the results.

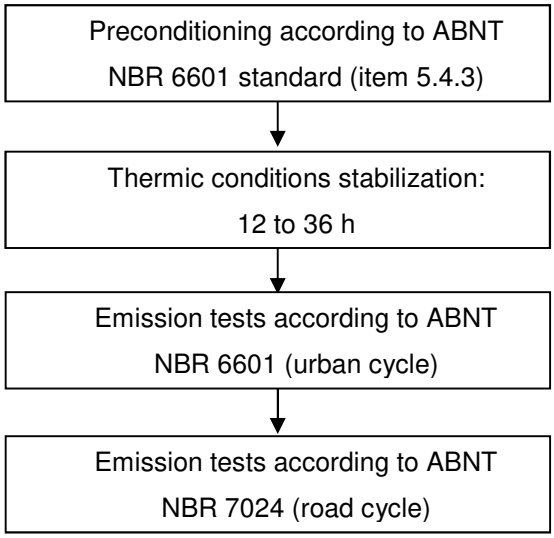

Figure 1- Measurement activities flow chart of the Proficiency Testing

3. Test Item Conditions

The results of GM emission laboratory performed in the beginning, in the middle and in the end of the round were used to statistically evaluate the integrity of the test item.

For the 10 analyzed parameters (CO, CO_2, THC, NO_x, NMHC, ETOH, NMHC-ETOH, Total Aldehydes, urban Autonomy and Road Autonomy), for urban cycle, the 5 parameters for the hot cycle (THC, NMHC, NOx, CO e CO_2) and the last five for road cycle (THC, NMHC, NOx, CO e CO_2), the results were the same, with *p-value* greater than 0.05. Therefore, it can be stated that there is no statistically significant difference between the means at a confidence level of 95% and the sample data can be regarded as arising from the same population. Thus, the vehicle remained intact during the course of this Proficiency Test for the different tests.

Due to the confidentiality of the results, as GM has participated in the PT, these results are not shown.

4. Performance Evaluation

4.1. *Z*-score

For performance evaluation of the individual participant results, one of the criteria described in ABNT NBR ISO/IEC 17043:2011 was carried out, the *z*-score (measure of the relative distance of the participant measurement result from the PT assigned value), that was calculated according to equation 1.

$$z_i = \frac{x_i - X}{\hat{\sigma}} \quad (1)$$

Where:

x_i is the average result of each participant;

X is the assigned value for this PT;

$\hat{\sigma}$ is the standard deviation for the PT, which was calculated in this round based on ISO 13528:2015, i.e., a robust standard deviation based on the results of the participants.

The interpretations of the *z*-score are presented as follows:

|z| ≤ 2,0 - Indicates "satisfactory" performance and generates no signal;

2,0 < |z| <3,0 - Indicates "questionable" performance and generates a warning signal;

|z| ≥ 3,0 - Indicates "unsatisfactory" performance and generates an action signal.

5. Assigned Values

According to the available procedures to establish assigned values in ABNT NBR ISO/IEC 17043:2011, the assigned values of this PT were calculated using statistical methods described in item 5.6 of ISO 13528:2015 standard, i.e., consensus values of participants.

ISO 13528:2015 describes the robust analysis involving the use of the "A" estimation algorithm for the calculation of the assigned value and the standard deviation. Robust statistical techniques are used to minimize the influence that extreme results can have on the average and standard deviation.

Initially, all values object of the analysis (values sent by the participants) were placed in ascending order. Then, values of robust average and robust standard deviation of these data by (x^*) and (s^*) were denoted. The initial values of (x^*) and (s^*) were calculated according to the following equations:

$$x^* = median\ of\ x_i \tag{2}$$

$$s^* = 1{,}483 \times \text{median}\ |x_i - x^*| \tag{3}$$

The values of (x^*) e (s^*) were updated as follows:

$$\delta = 1{,}5\, s^* \tag{4}$$

For each x_i (i = 1, 2,..., p), it was calculated:

$$x_i^* = \begin{cases} x^* - \delta, & if \quad x_i < x^* - \delta \\ x^* + \delta, & if \quad x_i > x^* + \delta \\ x_i, & otherwise \end{cases} \tag{5}$$

new values of (x^*) e (s^*) should be calculated from the equations:

$$x^* = \sum x_i^* / p \tag{6}$$

$$s^* = 1{,}134 \sqrt{\sum (x_i^* - x^*)^2 / (p - 1)} \tag{7}$$

Where the summation is over *i*.

The robust estimations (x^*) and (s^*) can be obtained by an iterative calculation, i.e., by updating the values of (x^*) and (s^*) several times using the modified data, until the process converges. Convergence may be assumed when there is no change from one iteration to the next in the third significant figure of the robust standard deviation and of the equivalent figure in the robust average.

The results out of 2 standard deviation intervals after the robust average and robust standard deviation calculation were considered as outliers and new assigned values as well new robust standard deviation results were calculated for each parameter of the PT, removing those outliers.

The tables below present the assigned values and the robust standard deviation for all parameters, including all PT participants, as well as the new robust average and standard deviation values after removal of the outlier results.014

Table 01 - Assigned Values and standard deviation of the PT – Urban Cycle.

Parameter	Assigned Value	Standard Deviation	Outliers (Participants)	Recalculated Assigned Value	Recalculated Standard Deviation
CO (g/km)	0.948	0.108	55	0.958	0.100
CO_2(g/km)	155.2	3.2	45	154.9	2.9
THC (g/km)	0.127	0.019	51	0.125	0.018
NO_x (g/km)	0.017	0.004	27.86	0.016	0.003
NMHC (g/km)	0.098	0.017	51	0.096	0.016
ETOH (g/km)	0.1626	0.0349	-	-	-
NMHC-ETOH (g/km)	0.033	0.022	86	0.028	0.016
Total Aldehydes (g/km)	0.0088	0.0018	39	0.0091	0.0014
Urban Autonomy (km/L)	9.15	0.20	45	9.17	0.19
Road Autonomy (km/L)	12.45	0.23	45	12.47	0.21

Table 02 - Assigned Values and standard deviation of the PT – HOT Cycle

Parameter	Assigned Value	Standard Deviation	Outliers (Participants)	Recalculated Assigned Value	Recalculated Standard Deviation
CO (g/km)	0.407	0.078	-	-	-
CO_2(g/km)	143.4	3.2	-	-	-
THC (g/km)	0.013	0.003	5	0.013	0.002
NO_x (g/km)	0.016	0.005	-	-	-
NMHC (g/km)	0.001	0.001	1	0.001	0.001

Table 03 - Assigned Values and standard deviation of the PT – Road Cycle

Parameter	Assigned Value	Standard Deviation	Outliers (Participants)	Recalculated Assigned Value	Recalculated Standard Deviation
CO (g/km)	0.162	0.039	75	0.158	0.033
CO_2(g/km)	115.4	2.4	13. 26	114.9	2.0
THC (g/km)	0.004	0.001	71	0.004	0.001
NO_x (g/km)	0.008	0.002	30.75	0.008	0.001
NMHC (g/km)	0.001	0.001	-	-	-

6. Dispersion Results

In the presented graphs for all tested parameters, a continuous line represents the assigned value and each laboratory is identified by its identification code. Dotted lines are representations of Ref ± 1s and ± 2s, where "Ref" is the assigned value (robust average) and "s" is the robust standard deviation.

6.1. Urban Cycle Emissions

Figures 02 to 11 present graphically the means and standard deviations of the emission results reported by the laboratories for each analyzed parameter.

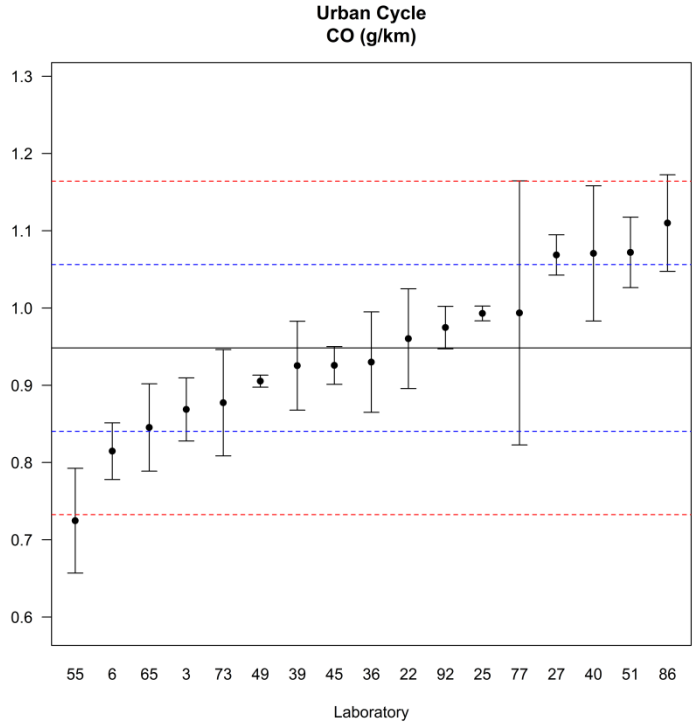

Figure 02 – Scatter plot of the results for CO determination – Urban Cycle

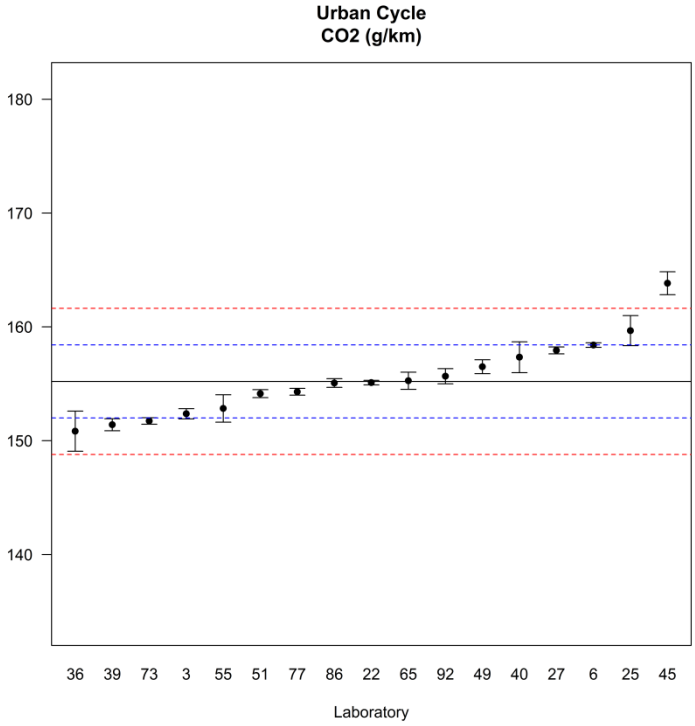

Figure 03 – Scatter plot of the results for CO_2 determination – Urban Cycle

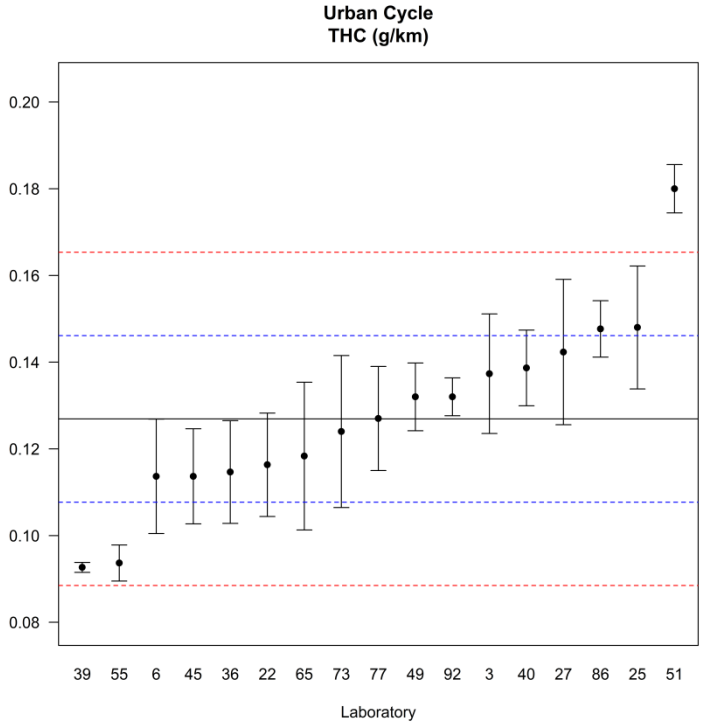

Figure 04 – Scatter plot of the results for THC determination – Urban Cycle

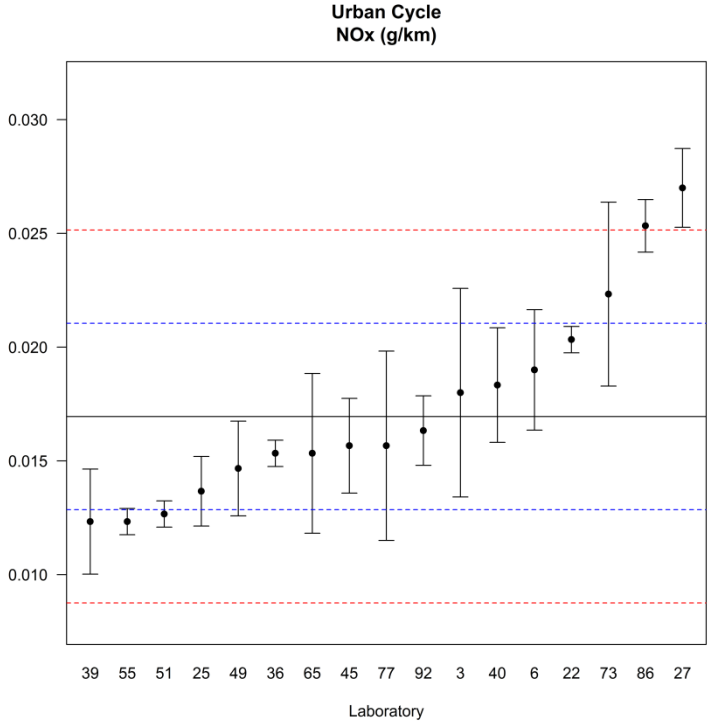

Figure 05 – Scatter plot of the results for NO_x determination – Urban Cycle

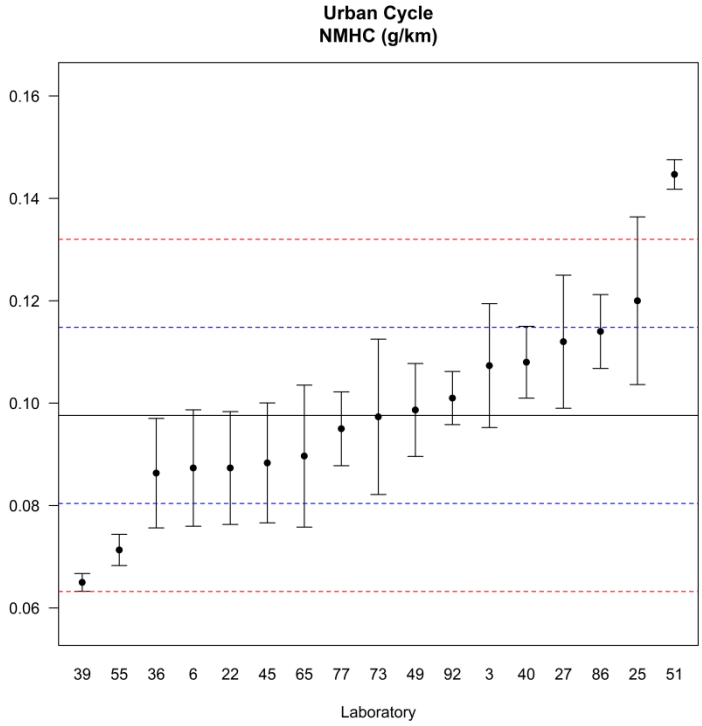

Figure 06 – Scatter plot of the results for NMHC determination – Urban Cycle

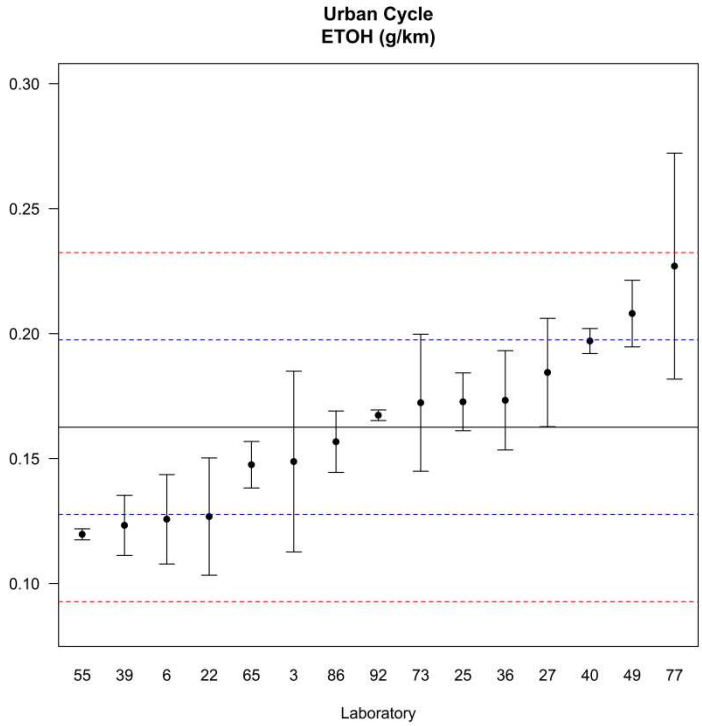

Figure 07 – Scatter plot of the results for ETOH determination – Urban Cycle

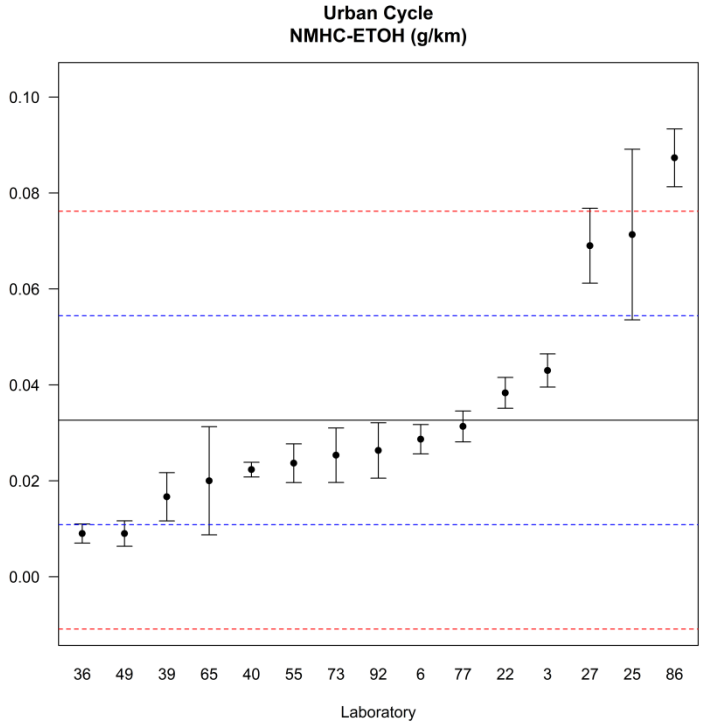

Figure 08 – Scatter plot of the results for NMHC-ETOH determination – Urban Cycle

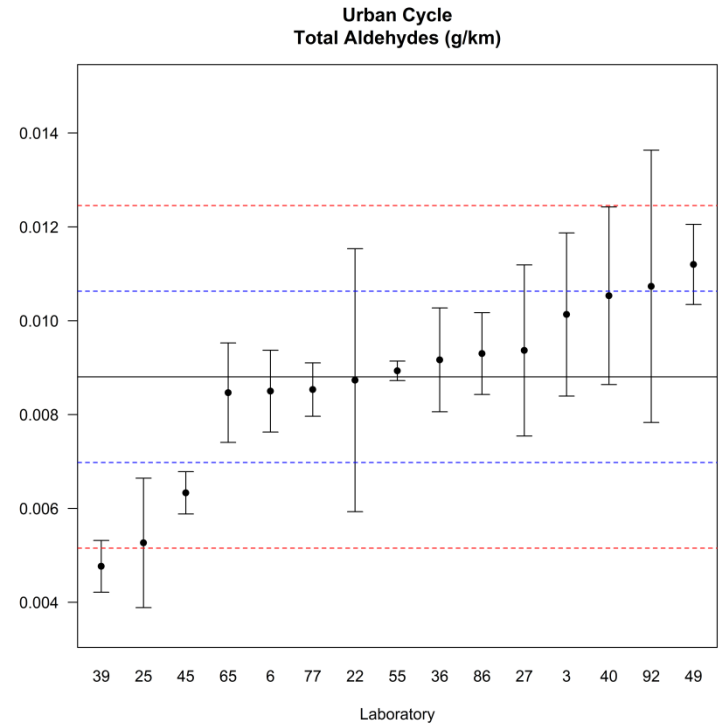

Figure 09 – Scatter plot of the results for Total Aldehydes determination – Urban Cycle

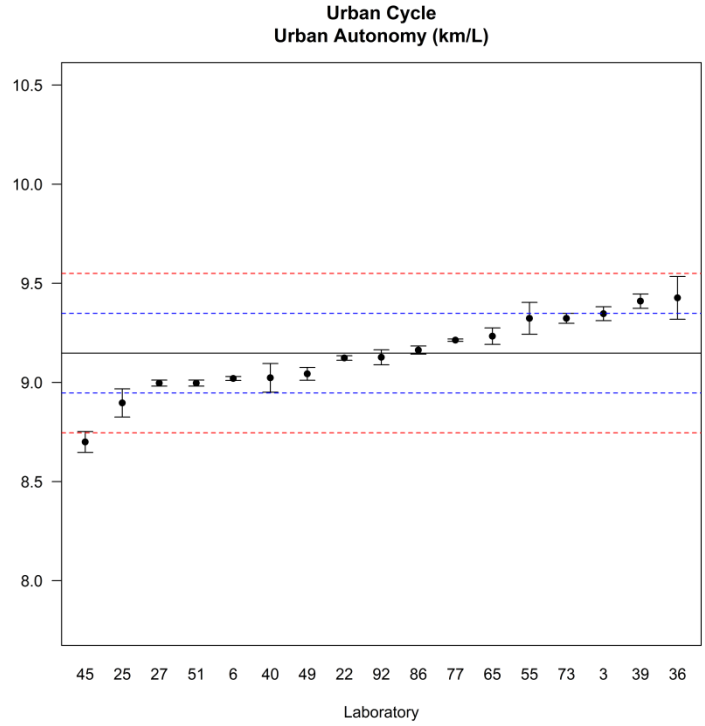

Figure 10 – Scatter plot of the results for Urban Autonomy determination – Urban Cycle

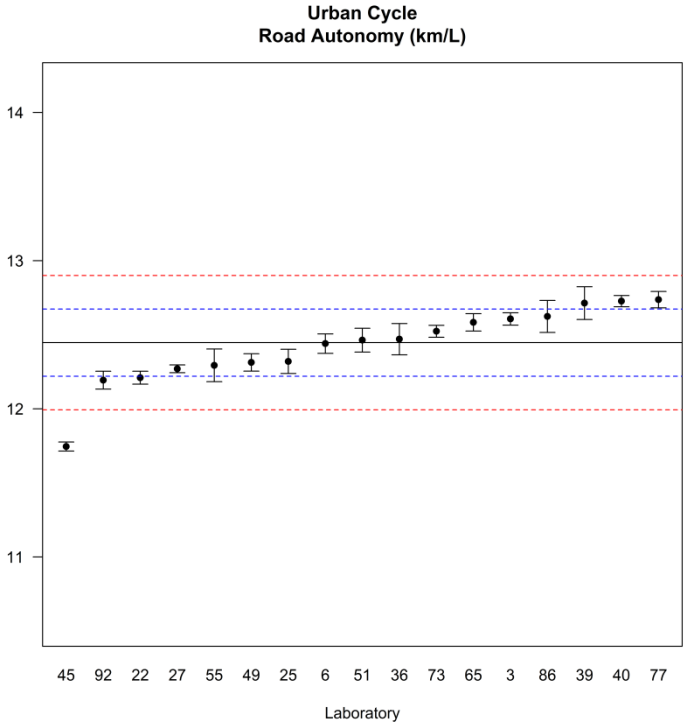

Figure 11 – Scatter plot of the results for Road Autonomy determination – Urban Cycle

Through the graphs, it can be seen that:

- CO (g/km): 11 participants presented results between the range of Ref ± 1*s* and the participants 6, 27, 40, 51 and 86 presented results between the range of Ref ± 1*s* and Ref ± 2*s.* Participant 55 presented result out of Ref ± 2*s* limits, considered an outlier.
- CO_2 (g/km): 12 participants presented results between the range of Ref ± 1*s* and the participants 25, 36, 39 and 73 presented results between the range of Ref ± 1*s* and Ref ± 2*s.* Participant 45 presented result out of Ref ± 2*s* limits, considered an outlier.
- THC (g/km): among the 17 participants, 11 of them presented results between the range of Ref ± 1*s* and the participants 25, 39, 55 and 86 presented results between the range Ref ± 1*s* and Ref ± 2*s.* Only the participant 51 had a result outside the range Ref ± 2*s*, considered an outlier.
- NO_x (g/km): 12 participants presented results between the range of Ref ± 1*s* and the participants 39, 55, 73 and 86 presented results between the range Ref ± 1*s* and Ref ± 2*s.* Participants 27 and 86 presented results outside the range of Ref ± 2*s*, considered outliers.
- NMHC (g/km): 13 of the 17 participants presented results between the range of Ref ± 1*s* and the participants 25, 39 and 55 presented results between the range Ref ± 1*s* and Ref ± 2*s.* Only participant 51 had a result outside the range of Ref ± 2*s*, considered an outlier.
- ETOH (g/km): 15 participants reported valid results, among them 10 presented results between the range of Ref ± 1*s* and 5 presented results between the range Ref ± 1*s* and Ref ± 2*s*. There were no outliers.
- NMHC-ETOH (g/km): among the 15 participants that reported valid results, 10 presented results between the range of Ref ± 1*s* and participants 25, 27, 36 and 49 presented results between the range Ref ± 1*s* and Ref ± 2*s*. Participant 86 presented result out of Ref ± 2*s* limits, considered an outlier.
- Total Aldehydes (g/km): The majority of the participants (10) presented results between the range of Ref ± 1*s* and the participants 25, 45, 49 and 92 presented results between the range of Ref ± 1*s* and Ref ± 2*s.* Participant 39 presented result out of Ref ± 2*s* limits, considered an outlier.
- Urban Autonomy (km/L): 13 of 17 valid results for this parameter presented results between the range of Ref ± 1*s* and participants 25, 36 and 39 presented results between the range of Ref ± 1*s* and Ref ± 2*s.* Participant 45 presented result out of Ref ± 2*s* limits, considered an outlier.
- Road Autonomy (km/L): Most of participants presented results between the range of Ref ± 1*s* and participants 22, 39, 40, 77 and 92 presented results between the range of Ref ± 1*s* and Ref ± 2*s.* Participant 45 presented result out of Ref ± 2*s* limits, considered an outlier.

6.2. Hot Cycle Emissions

Figures 12 to 16 present graphically the means and standard deviations of the results reported by the laboratories for each analyzed parameter of Hot Cycle.

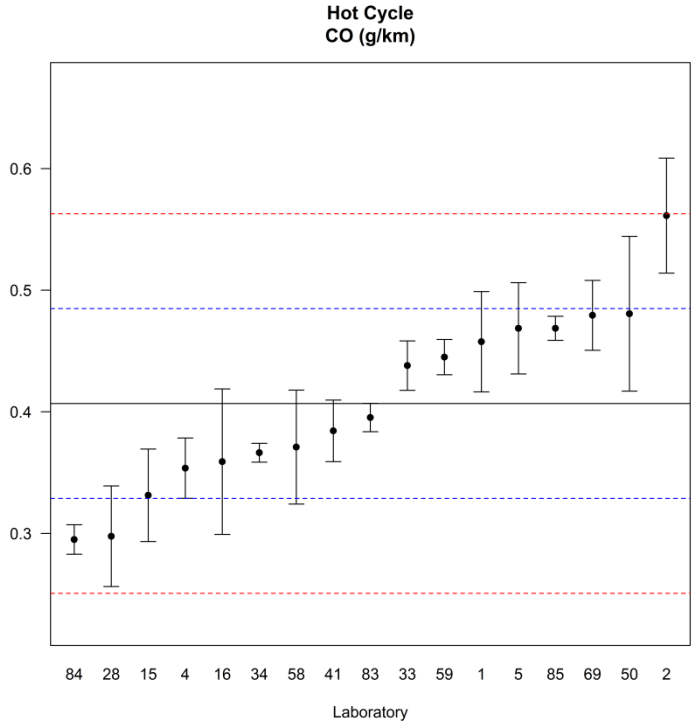

Figure 12 – Scatter plot of the results for CO determination – Hot Cycle

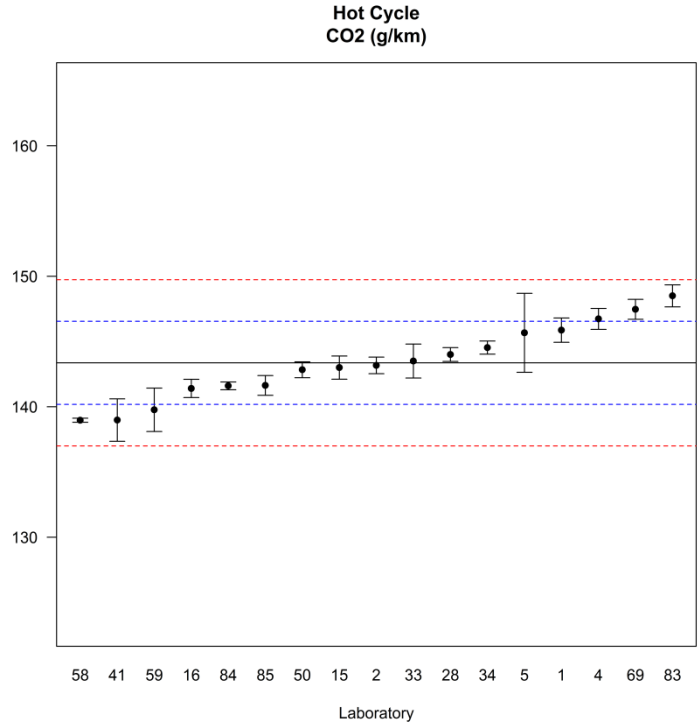

Figure 13 – Scatter plot of the results for CO_2 determination – Hot Cycle

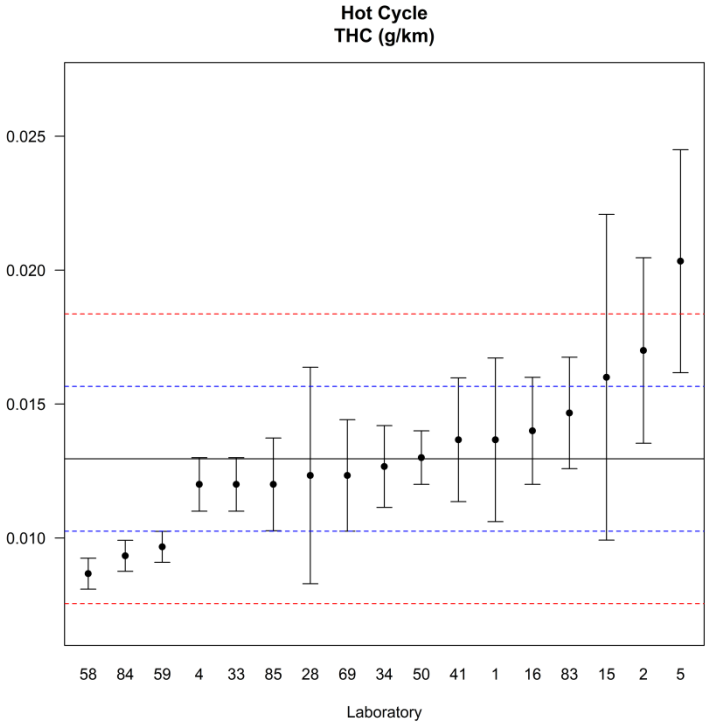

Figure 14 – Scatter plot of the results for THC determination – Hot Cycle

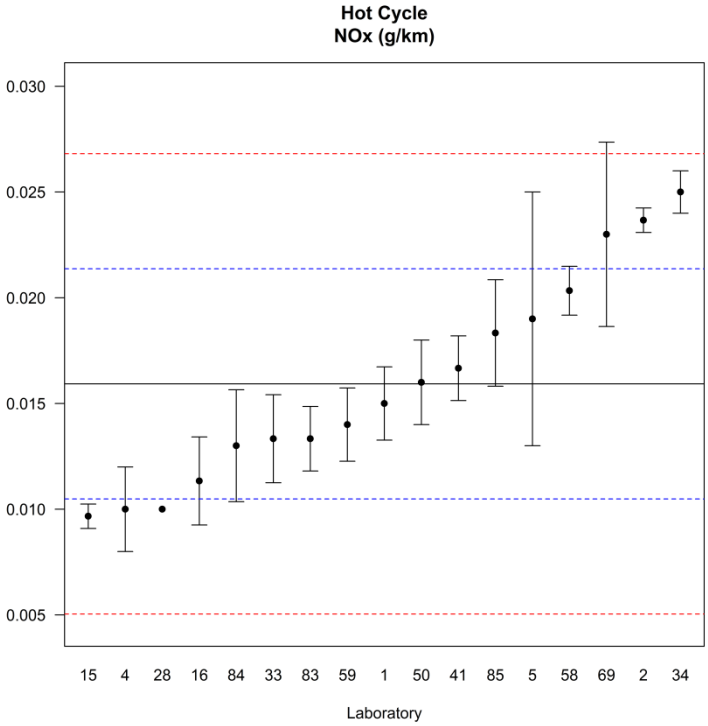

Figure 15 – Scatter plot of the results for NOx determination – Hot Cycle

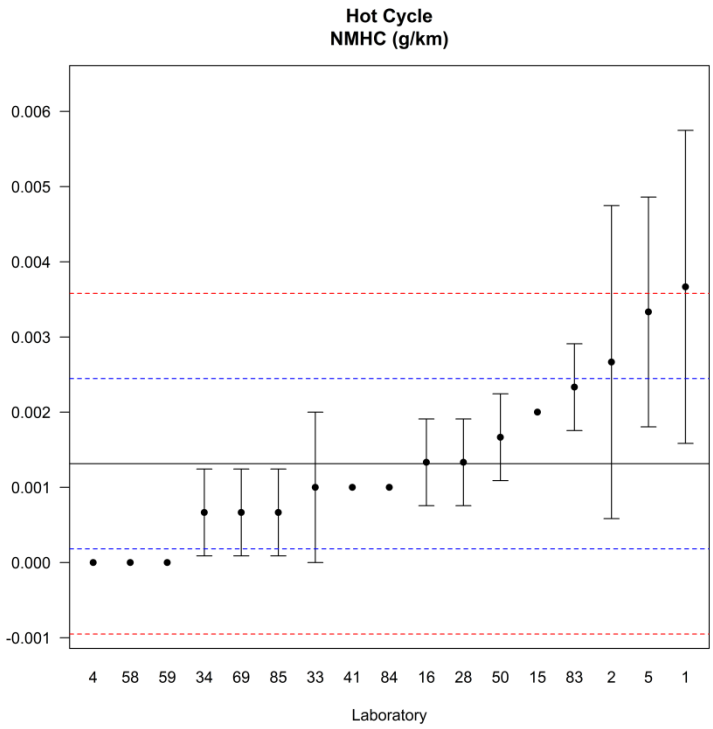

Figure 16 – Scatter plot of the results for NMHC determination – Hot Cycle

Through the graphs, it can be seen that:

- CO (g/km): All the reported results for this parameter are in the range Ref ± 2*s*. Among them 14 presented results between the range of Ref ± 1*s* and the participants 2, 28 and 84 presented results between the range of Ref ± 1*s* and Ref ± 2*s.*
- CO_2 (g/km): 11 participants presented results between the range of Ref ± 1*s* and the participants 4, 41, 58, 59, 69 e 83 presented results between the range of Ref ± 1*s* and Ref ± 2*s*. There was no result out of the Ref ± 2*s* limits for this parameter.
- THC (g/km): 11 among the 17 participants presented results between the range of Ref ± 1*s* and participants 2, 15, 58, 59 and 84 presented results between the range Ref ± 1*s* and Ref ± 2*s.* Only participant 5 presented result out of the Ref ± 2*s* limits, considered an outlier.
- NO_x (g/km): Most of the participants (11) presented results between the range of Ref ± 1*s* and participants 2, 4, 15, 28, 34 and 69 presented results between the range Ref ± 1*s* and Ref ± 2*s.* There was no result out of the Ref ± 2*s* limits for this parameter.
- NMHC (g/km): The reported concentrations for this parameter are very low and the results dispersion is high. 11 participants presented results between the range of Ref ± 1*s* and the participants 2, 4, 5, 58 and 59 presented results between the range Ref ± 1*s* and Ref ± 2*s*. Only participant 1 presented result out of Ref ± 2*s* limits, considered an outlier.

6.3. Road Cycle Emissions

Figures 17 to 21 present graphically the means and standard deviations of the results reported by the laboratories for each analyzed parameter of Road Cycle.

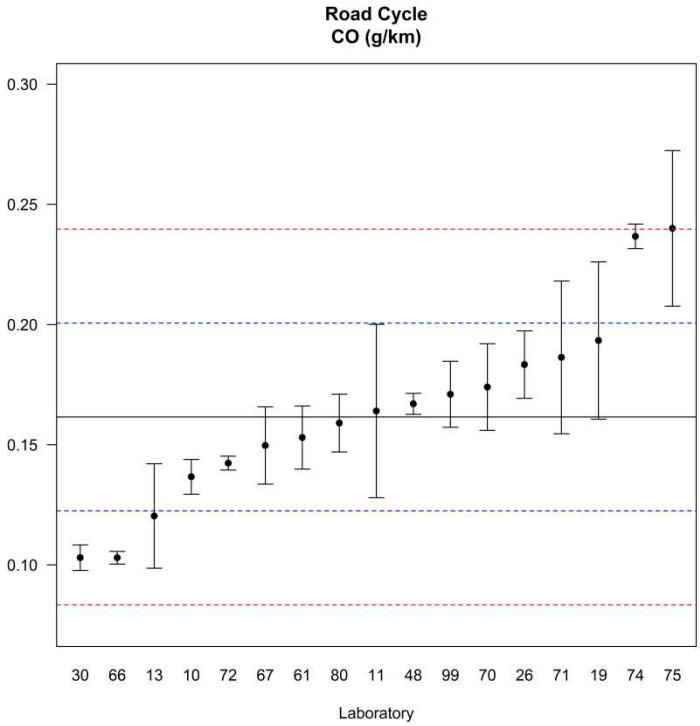

Figure 17 – Scatter plot of the participants results for CO determination – Road Cycle

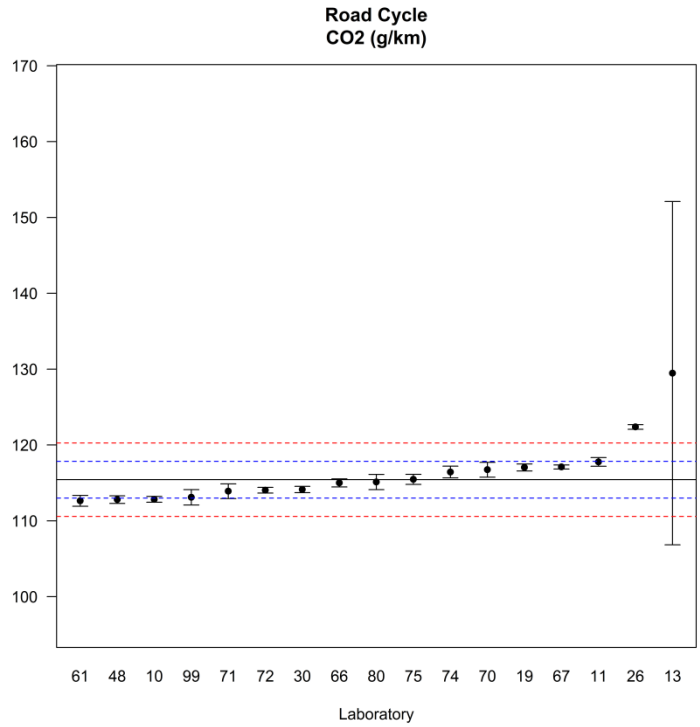

Figure 18 – Scatter plot of the participants results for CO_2 determination – Road Cycle

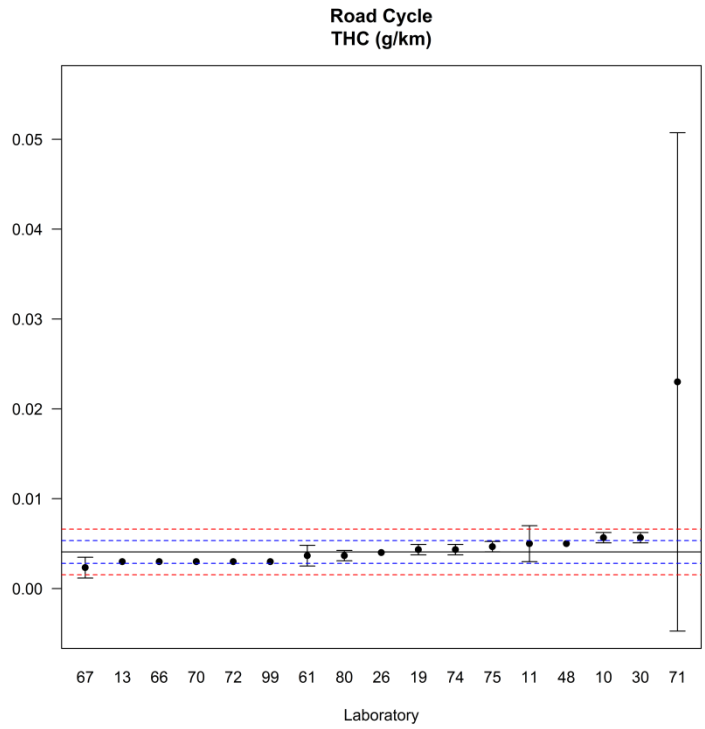

Figure 19 – Scatter plot of the participants results for THC determination – Road Cycle

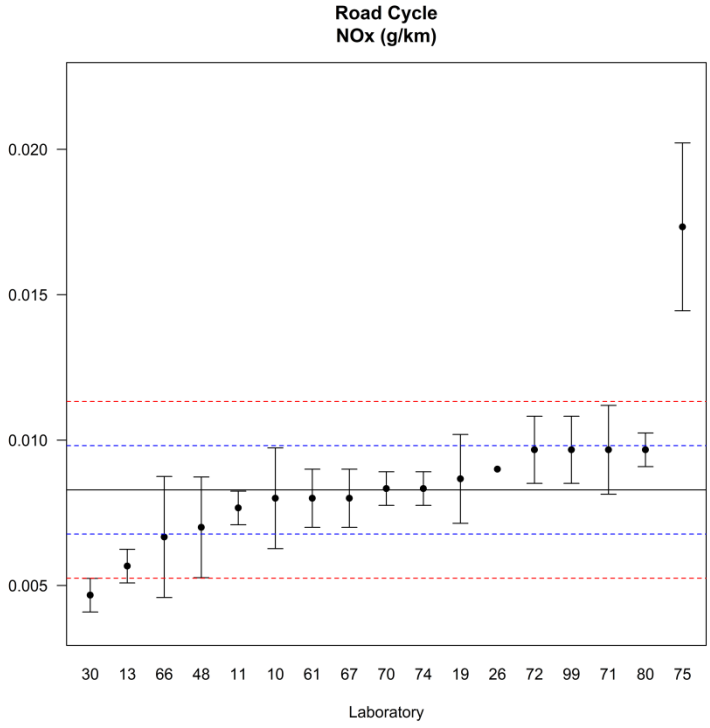

Figure 20 – Scatter plot of the participants results for NOx determination – Road Cycle

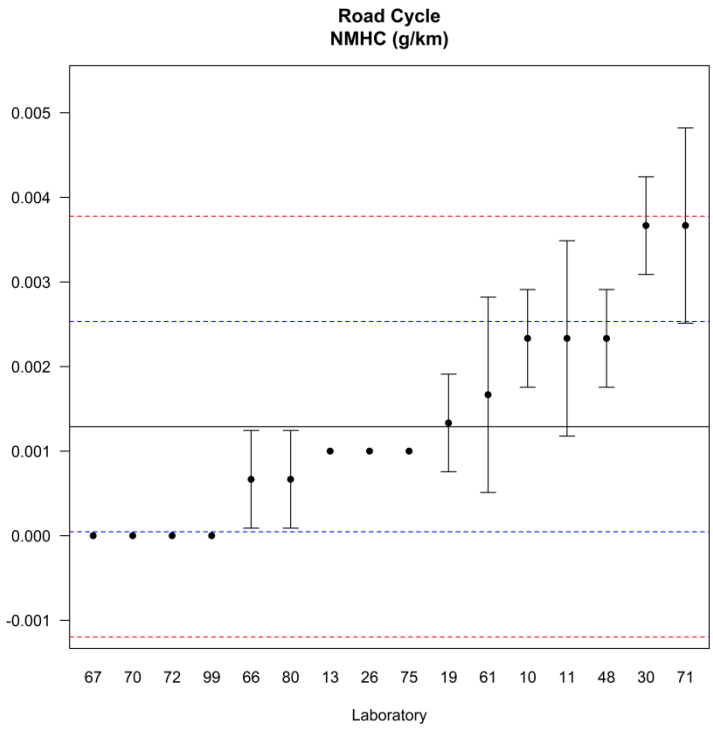

Figure 21 – Scatter plot of the participants results for NMHC determination – Road Cycle

Through the graphs, it can be seen that:

- CO (g/km): Most of the participants presented results between the range of Ref ± 1*s* and the participants 13, 30, 66 and 74 presented results between the range of Ref ± 1*s* and Ref ± 2*s.* Participant 75 presented result out of Ref ± 2*s* limits, considered an outlier.
- CO_2 (g/km): Most of the participants presented results between the range of Ref ± 1*s* and the participants 10, 48 and 61 presented results between the range of Ref ± 1*s* and Ref ± 2*s.* Participants 13 and 26 presented results out of Ref ± 2*s* limits, considered outliers. Participant 13 showed a very high standard deviation compared to the other participants.
- THC (g/km): 13 participants presented results between the range of Ref ± 1*s* and participants 10, 30 and 67 presented results between the range Ref ± 1*s* and Ref ± 2*s.* Participant 71 presented result out of Ref ± 2*s* limits, considered an outlier. The presented average was 8 times higher than the calculated robust average and the variation coefficient for the measurement was 100 %.
- NO_x (g/km): 13 out of 17 participants presented results between the range of Ref ± 1*s* and the participants 13 and 66 presented results between the range Ref ± 1*s* and Ref ± 2*s.* Participants 30 and 75 presented results out of Ref ± 2*s* limits, considered outliers.
- NMHC (g/km): 16 participants reported valid results for this parameter that shows low concentration levels and a high dispersion of the results. 14 participants presented results between the range of Ref ± 1*s* and participants 30 and 71 presented results between the range Ref ± 1*s* and Ref ± 2*s*.

7. Laboratories' Results

In this report each participant is identified only by the final numbering of its identification code in the tables and graphs.

7.1. Urban Cycle Emissions

The tables 04 and 05 show the averages and standard deviations for each participant, where the result is the average value of the replicates.

Note: All decimal places were considered for calculations, but the values in the tables below were rounded to the same number of decimal places as requested in the results form.

Table 04 – Average and standard deviation of the participants for the parameters CO, CO_2, THC, NO_X and NMHC (g/km) – Urban Cycle

Lab Code	CO (g/km)		CO_2 (g/km)		THC (g/km)		NOx (g/km)		NMHC (g/km)	
	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
03	0.869	0.033	152.4	0.4	0.137	0.011	0.018	0.004	0.107	0.010
06	0.815	0.030	158.4	0.2	0.114	0.011	0.019	0.002	0.087	0.009
22	0.960	0.053	155.1	0.2	0.116	0.010	0.020	0.000	0.087	0.009
25	0.993	0.008	159.7	1.1	0.148	0.012	0.014	0.001	0.120	0.013
27	1.069	0.021	157.9	0.2	0.142	0.014	0.027	0.001	0.112	0.011
36	0.930	0.053	150.8	1.4	0.115	0.010	0.015	0.000	0.086	0.009
39	0.925	0.047	151.4	0.4	0.093	0.001	0.012	0.002	0.065	0.001
40	1.071	0.071	157.3	1.1	0.139	0.007	0.018	0.002	0.108	0.006
45	0.926	0.020	163.8	0.8	0.114	0.009	0.016	0.002	0.088	0.010
49	0.905	0.006	156.5	0.5	0.132	0.006	0.015	0.002	0.099	0.007
51	1.072	0.037	154.1	0.3	0.180	0.005	0.013	0.000	0.145	0.002
55	0.725	0.055	152.8	1.0	0.094	0.003	0.012	0.000	0.071	0.002
65	0.845	0.046	155.3	0.6	0.118	0.014	0.015	0.003	0.090	0.011
73	0.877	0.056	151.7	0.2	0.124	0.014	0.022	0.003	0.097	0.012
77	0.994	0.140	154.3	0.2	0.127	0.010	0.016	0.003	0.095	0.006
86	1.110	0.051	155.1	0.3	0.148	0.005	0.025	0.001	0.114	0.006
92	0.975	0.022	155.7	0.5	0.132	0.004	0.016	0.001	0.101	0.004

Table 05 – Average and standard deviation of the participants for the parameters ETOH, NMHC-ETOH, Total Aldehydes (g/km), Urban Autonomy (km/L) and Road Autonomy (km/L) – Urban Cycle

Lab Code	ETOH (g/km)		NMHC-ETOH (g/km)		Total Aldehydes (g/km)		Urban Autonomy (km/L)		Road Autonomy (km/L)	
	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
03	0.1488	0.0296	0.043	0.003	0.0101	0.0014	9.35	0.03	12.61	0.03
06	0.1257	0.0146	0.029	0.002	0.0085	0.0007	9.02	0.01	12.44	0.05
22	0.1268	0.0192	0.038	0.003	0.0087	0.0023	9.12	0.01	12.21	0.04
25	0.1727	0.0095	0.071	0.015	0.0053	0.0011	8.90	0.06	12.32	0.07
27	0.1844	0.0177	0.069	0.006	0.0094	0.0015	9.00	0.01	12.27	0.02
36	0.1733	0.0162	0.009	0.002	0.0092	0.0009	9.43	0.09	12.47	0.09
39	0.1233	0.0098	0.017	0.004	0.0048	0.0004	9.41	0.03	12.71	0.09
40	0.1970	0.0041	0.022	0.001	0.0105	0.0015	9.02	0.06	12.73	0.03
45	NM	NM	NM	NM	0.0063	0.0004	8.70	0.04	11.75	0.03
49	0.2080	0.0109	0.009	0.002	0.0112	0.0007	9.04	0.03	12.31	0.05
51	NM	NM	NM	NM	NM	NM	9.00	0.01	12.46	0.07
55	0.1197	0.0018	0.024	0.003	0.0089	0.0002	9.32	0.07	12.29	0.09
65	0.1475	0.0076	0.020	0.009	0.0085	0.0009	9.23	0.03	12.58	0.05
73	0.1723	0.0224	0.025	0.005	NM	NM	9.32	0.02	12.52	0.03
77	0.2270	0.0369	0.031	0.003	0.0085	0.0005	9.21	0.00	12.74	0.04
86	0.1567	0.0100	0.087	0.005	0.0093	0.0007	9.16	0.02	12.62	0.09
92	0.1673	0.0017	0.026	0.005	0.0107	0.0024	9.13	0.03	12.19	0.05

NM - Not Measured

For the performance evaluation of the participants, *z*-score values were calculated, after the exclusion of the outlier results, using the robust average and robust standard deviation of the results for each parameter as assigned value and its standard deviation. Tables 06 and 07 and figures 22 to 31 show these results.

Table 06 – *z*-score values for the parameters CO, CO_2, THC, NO_X and NMHC – Urban Cycle

CO (g/km)		CO_2 (g/km)		THC (g/km)		NO_X (g/km)		NMHC (g/km)	
Lab	**Z score**	**Lab**	**Z score**	**Lab**	**Z score**	**Lab**	**Z score**	**Lab**	**Z score**
03	-0.90	**03**	-0.86	**03**	0.69	**03**	0.63	**03**	0.71
06	-1.44	**06**	1.20	**06**	-0.65	**06**	0.96	**06**	-0.55
22	0.02	**22**	0.07	**22**	-0.50	**22**	1.38	**22**	-0.55
25	0.35	**25**	1.63	**25**	1.29	**25**	-0.76	**25**	1.52
27	1.10	**27**	1.04	**27**	0.97	**27**	**3.52**	**27**	1.01
36	-0.28	**36**	-1.38	**36**	-0.59	**36**	-0.22	**36**	-0.62
39	-0.33	**39**	-1.19	**39**	-1.84	**39**	-1.19	**39**	-1.97
40	1.12	**40**	0.84	**40**	0.76	**40**	0.74	**40**	0.76
45	-0.33	**45**	**3.05**	**45**	-0.65	**45**	-0.11	**45**	-0.49
49	-0.53	**49**	0.55	**49**	0.39	**49**	-0.44	**49**	0.17
51	1.14	**51**	-0.26	**51**	**3.10**	**51**	-1.08	**51**	**3.08**
55	**-2.34**	**55**	-0.70	**55**	-1.78	**55**	-1.19	**55**	-1.57
65	-1.13	**65**	0.13	**65**	-0.39	**65**	-0.22	**65**	-0.40
73	-0.81	**73**	-1.07	**73**	-0.07	**73**	**2.03**	**73**	0.08
77	0.35	**77**	-0.20	**77**	0.10	**77**	-0.11	**77**	-0.07
86	1.52	**86**	0.06	**86**	1.27	**86**	**2.99**	**86**	1.14
92	0.16	**92**	0.27	**92**	0.39	**92**	0.10	**92**	0.31

Highlighted in blue: questionable values. In red: unsatisfactory values

Table 07 – *z*-score values for the parameters ETOH, NMHC-ETOH, Total Aldehydes (g/km), Urban Autonomy (km/L) e Road Autonomy (km/L)– Urban Cycle

ETOH (g/km)		NMHC-ETOH (g/km)		Total Aldehydes (km/L)		Urban Autonomy (km/L)		Road Autonomy (km/L)	
Lab	**Z score**	**Lab**	**Z score**	**Lab**	**Z score**	**Lab**	**Z score**	**Lab**	**Z score**
03	-0.39	**03**	0.95	**03**	0.72	**03**	0.96	**03**	0.66
06	-1.06	**06**	0.02	**06**	-0.43	**06**	-0.79	**06**	-0.13
22	-1.03	**22**	0.64	**22**	-0.26	**22**	-0.23	**22**	-1.23
25	0.29	**25**	**2.77**	**25**	**-2.69**	**25**	-1.45	**25**	-0.70
27	0.63	**27**	**2.62**	**27**	0.18	**27**	-0.91	**27**	-0.94
36	0.31	**36**	-1.25	**36**	0.04	**36**	1.39	**36**	0.01
39	-1.13	**39**	-0.75	**39**	**-3.04**	**39**	1.30	**39**	1.17
40	0.99	**40**	-0.39	**40**	1.00	**40**	-0.77	**40**	1.23
45	**NM**	**45**	**NM**	**45**	-1.94	**45**	**-2.50**	**45**	**-3.43**
49	1.30	**49**	-1.25	**49**	1.46	**49**	-0.66	**49**	-0.73
51	**NM**	**51**	**NM**	**51**	**NM**	**51**	-0.91	**51**	-0.02
55	-1.23	**55**	-0.30	**55**	-0.12	**55**	0.84	**55**	-0.83
65	-0.43	**65**	-0.54	**65**	-0.45	**65**	0.36	**65**	0.55
73	0.28	**73**	-0.19	**73**	**NM**	**73**	0.84	**73**	0.26
77	1.85	**77**	0.19	**77**	-0.40	**77**	0.25	**77**	1.28
86	-0.17	**86**	**3.81**	**86**	0.13	**86**	-0.02	**86**	0.74
92	0.14	**92**	-0.13	**92**	1.14	**92**	-0.21	**92**	-1.30
Highlighted in blue: questionable values. In red: unsatisfactory values, NM = Not Measured									

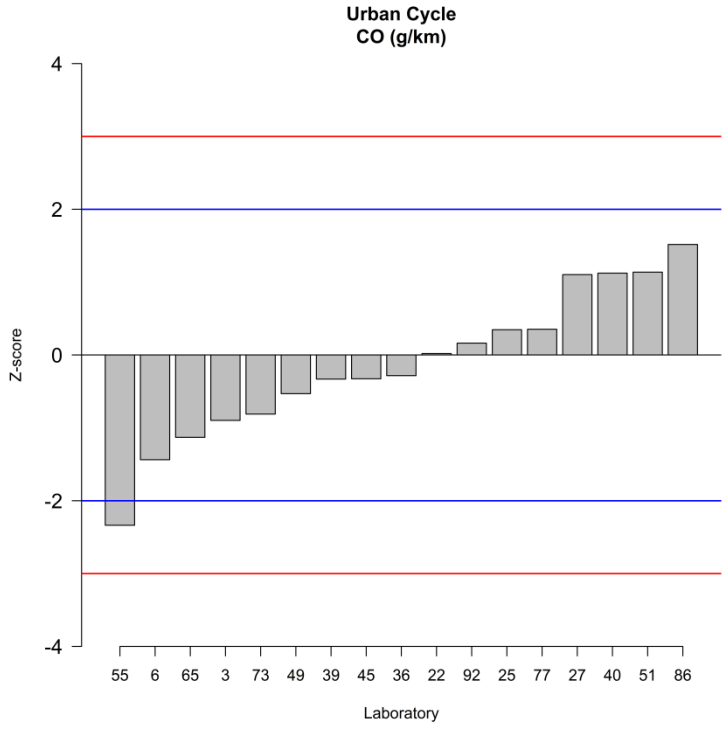

Figure 22 – *z*-score graph for CO measurement – Urban cycle

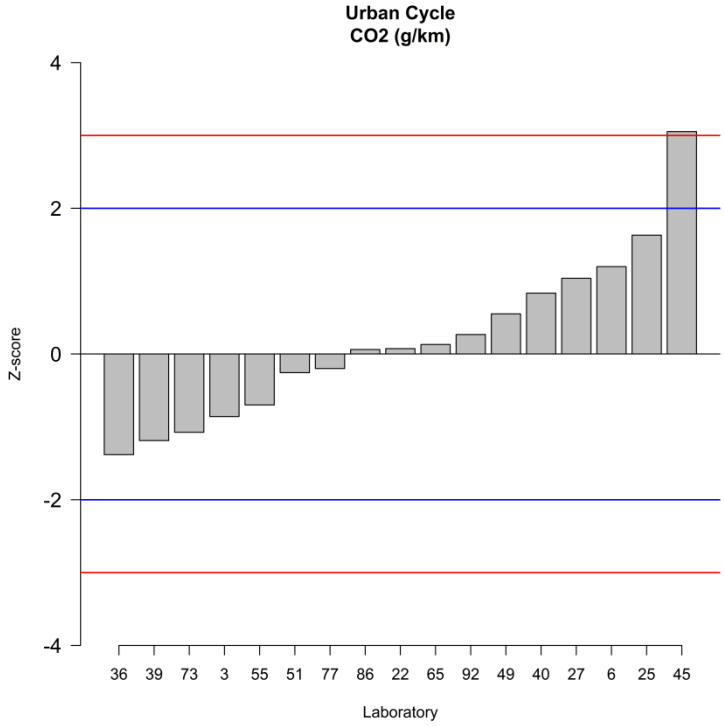

Figure 23 – *z*-score graph for CO_2 measurement – Urban Cycle

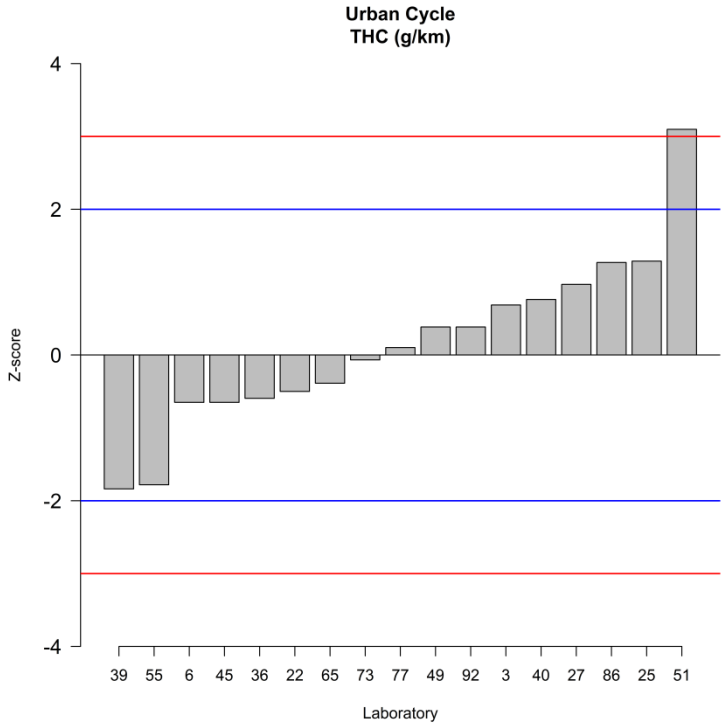

Figure 24 – *z*-score graph for THC measurement – Urban Cycle

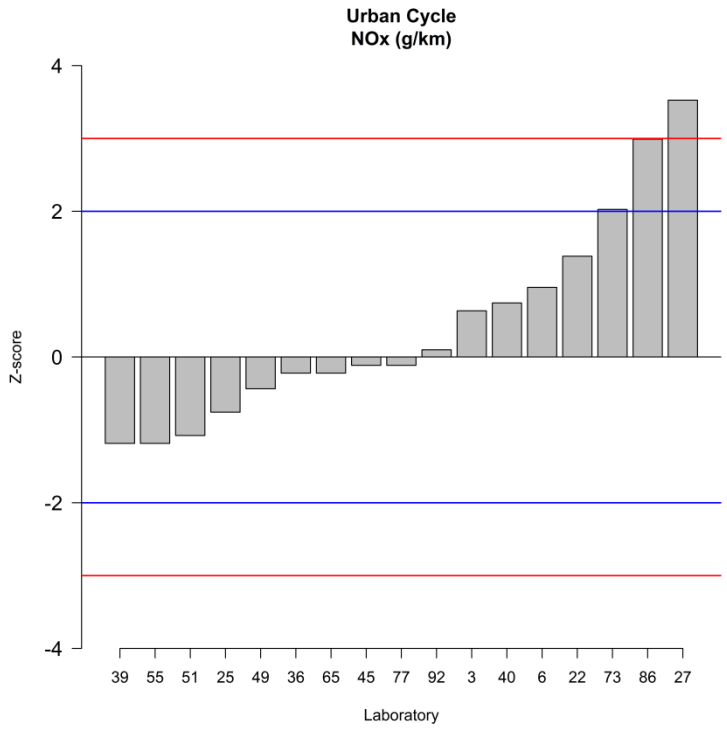

Figure 25 – *z*-score graph of for NO_x measurement - Urban Cycle

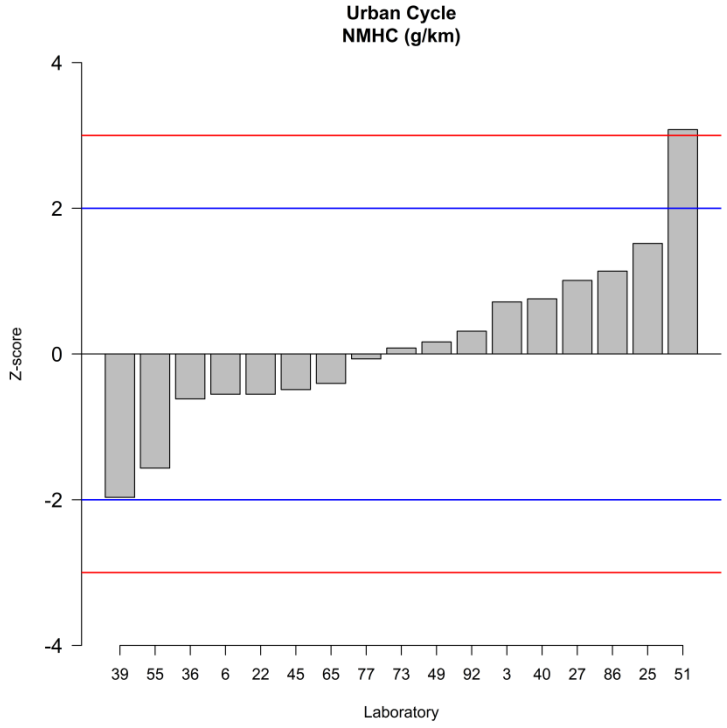

Figure 26 – *z*-score graph for NMHC measurement – Urban Cycle

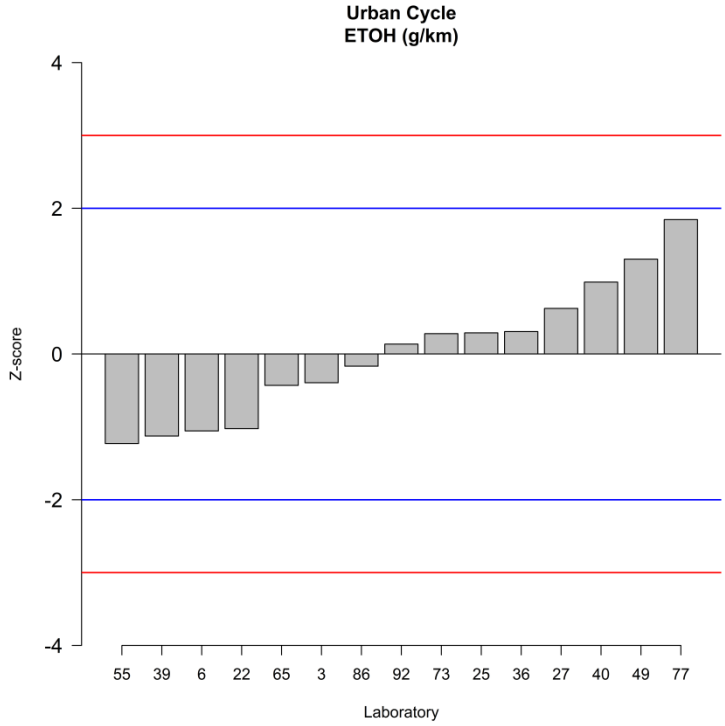

Figure 27 – *z*-score graph for Total Aldheydes measurement – Urban Cycle

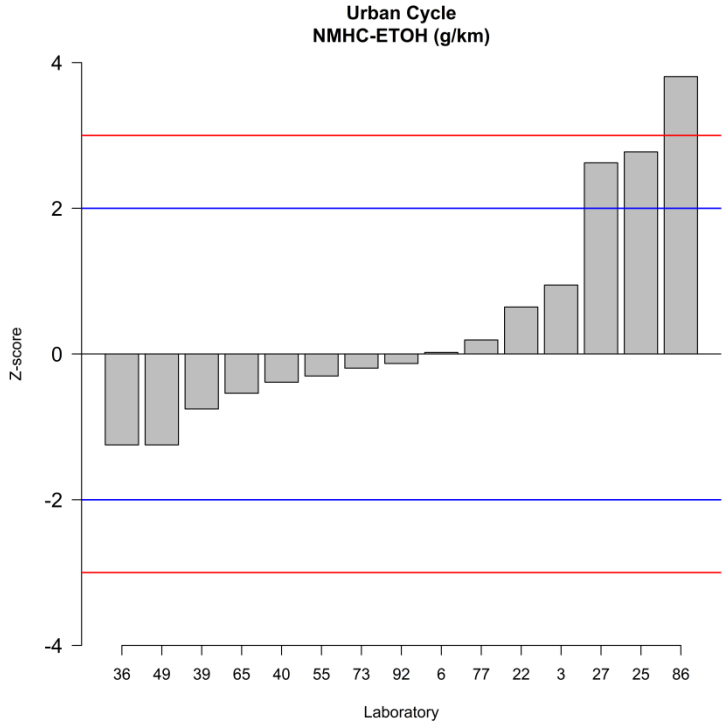

Figure 28 – *z*-score graph for NMHC-ETOH measurement – Urban Cycle

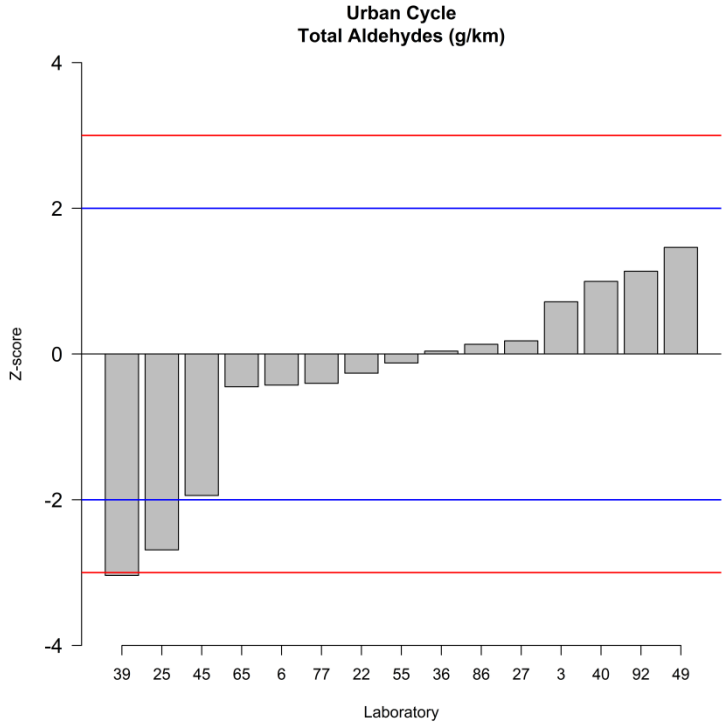

Figure 29 – *z*-score graph for Total Aldehydes measurement – Urban Cycle

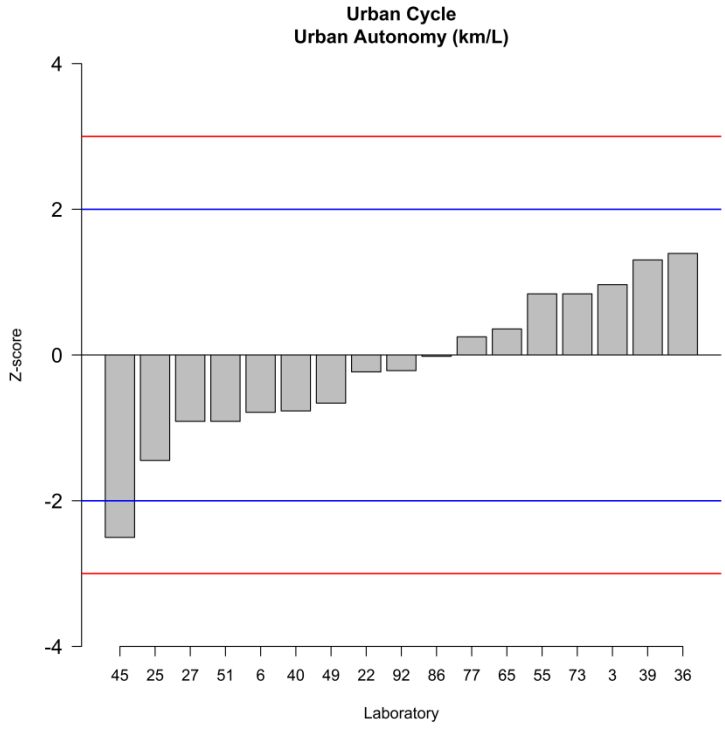

Figure 30 – *z*-score graph for Urban Autonomy measurement – Urban Cycle

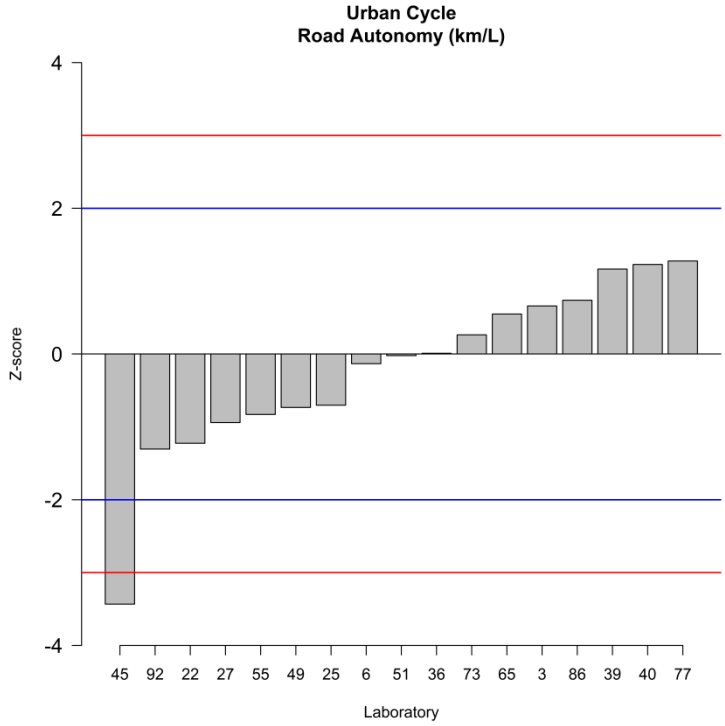

Figure 31 – *z*-score graph for Road Autonomy measurement – Urban Cycle

Through *z*-score analysis, it can be seen that:

- CO (g/km): Participant 55 result was considered an outlier and it was excluded from the robust average calculation. The observed variation coefficient around 10% makes the acceptation limit lower and, even considered an outlier, the presented result is considered questionable. If there was no exclusion of the results, this one would be considered satisfactory.
- CO_2 (g/km): Participant 45 had its result removed from the robust mean, as it was out of the Ref ± 2*s* limits. In this case, as the mean result is discrepant compared to the other participants, the result is considered unsatisfactory.
- THC (g/km): Only participant 51 showed unsatisfactory result.
- NO_x (g/km): Participants 73 and 86 showed questionable results and participant 27 showed unsatisfactory result.
- NMHC (g/km): Only participant 51 showed unsatisfactory result.
- ETOH (g/km): All 15 participants that presented valid results, showed satisfactory results. Participant 45 didn't reported valid results, while participant 51 didn't report results for this parameter.
- NMHC-ETOH (g/km): Participants 45 and 49 didn´t report their results. Participants 25 and 27 showed questionable results, while participant 86 showed unsatisfactory result.
- Total Aldehydes (g/km): Participants 51 and 73, participant 25 showed a questionable result and participant 39 showed an unsatisfactory result.
- Urban Autonomy (km/L): Participant 45 showed a questionable result.
- Road Autonomy (km/L): Participant 45 showed unsatisfactory result.

7.2. Hot Cycle Emissions

Table 08 shows the averages and standard deviations for each participant, where the result is the average value of the replicates.

Note: All decimal places were considered for calculations, but the values in the tables below were rounded to the same number of decimal places as requested in the results form.

Table 08 – Average and standard deviation of the participants for the parameters CO, CO_2, THC, NO_X and NMHC (g/km) – Hot Cycle

Lab Code	CO (g/km)		CO_2 (g/km)		THC (g/km)		NOx (g/km)		NMHC (g/km)	
	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
01	0.458	0.034	145.9	0.8	0.014	0.002	0.015	0.001	0.004	0.002
02	0.561	0.039	143.2	0.5	0.017	0.003	0.024	0.000	0.003	0.002
04	0.354	0.020	146.7	0.7	0.012	0.001	0.010	0.002	0.000	0.000
05	0.469	0.031	145.7	2.5	0.020	0.003	0.019	0.005	0.003	0.001
15	0.331	0.031	143.0	0.7	0.016	0.005	0.010	0.000	0.002	0.000
16	0.359	0.049	141.4	0.6	0.014	0.002	0.011	0.002	0.001	0.000
28	0.298	0.034	144.0	0.4	0.012	0.003	0.010	0.000	0.001	0.000
33	0.438	0.017	143.5	1.1	0.012	0.001	0.013	0.002	0.001	0.001
34	0.366	0.006	144.5	0.4	0.013	0.001	0.025	0.001	0.001	0.000
41	0.384	0.021	139.0	1.3	0.014	0.002	0.017	0.001	0.001	0.000
50	0.481	0.052	142.8	0.5	0.013	0.001	0.016	0.002	0.002	0.000
58	0.371	0.038	139.0	0.1	0.009	0.000	0.020	0.001	0.000	0.000
59	0.445	0.012	139.8	1.4	0.010	0.000	0.014	0.001	0.000	0.000
69	0.479	0.023	147.5	0.6	0.012	0.002	0.023	0.004	0.001	0.000
83	0.395	0.010	148.5	0.7	0.015	0.002	0.013	0.001	0.002	0.000
84	0.295	0.010	141.6	0.2	0.009	0.000	0.013	0.002	0.001	0.000
85	0.469	0.008	141.6	0.6	0.012	0.001	0.018	0.002	0.001	0.000

For the performance evaluation of the participants, *z*-score values were calculated, after the exclusion of the outlier results, using the robust average and robust standard deviation of the results for each parameter as assigned value and its standard deviation. Table 09 and figures 32 to 36 show these results.

Table 09 – *z*-score values for the parameters CO, CO_2, THC, NO_X and NMHC – Hot Cycle

CO (g/km)		CO_2 (g/km)		THC (g/km)		NO_X (g/km)		NMHC (g/km)	
Lab	**Z score**	**Lab**	**Z score**	**Lab**	**Z score**	**Lab**	**Z score**	**Lab**	**Z score**
01	0.65	**01**	0.78	**01**	0.42	**01**	-0.17	**01**	**2.46**
02	1.98	**02**	-0.06	**02**	1.82	**02**	1.42	**02**	1.46
04	-0.68	**04**	1.06	**04**	-0.28	**04**	-1.09	**04**	-1.18
05	0.79	**05**	0.72	**05**	**3.22**	**05**	0.56	**05**	**2.13**
15	-0.97	**15**	-0.12	**15**	1.40	**15**	-1.15	**15**	0.80
16	-0.61	**16**	-0.62	**16**	0.56	**16**	-0.84	**16**	0.14
28	-1.40	**28**	0.20	**28**	-0.14	**28**	-1.09	**28**	0.14
33	0.40	**33**	0.04	**33**	-0.28	**33**	-0.48	**33**	-0.19
34	-0.52	**34**	0.37	**34**	0.00	**34**	1.67	**34**	-0.52
41	-0.29	**41**	-1.38	**41**	0.42	**41**	0.14	**41**	-0.19
50	0.95	**50**	-0.17	**50**	0.14	**50**	0.01	**50**	0.47
58	-0.46	**58**	-1.38	**58**	-1.68	**58**	0.81	**58**	-1.18
59	0.49	**59**	-1.13	**59**	-1.26	**59**	-0.35	**59**	-1.18
69	0.93	**69**	1.29	**69**	-0.14	**69**	1.30	**69**	-0.52
83	-0.15	**83**	1.61	**83**	0.84	**83**	-0.48	**83**	1.13
84	-1.43	**84**	-0.56	**84**	-1.40	**84**	-0.54	**84**	-0.19
85	0.79	**85**	-0.54	**85**	-0.28	**85**	0.44	**85**	-0.52

Highlighted in blue: questionable values. In red: unsatisfactory values.

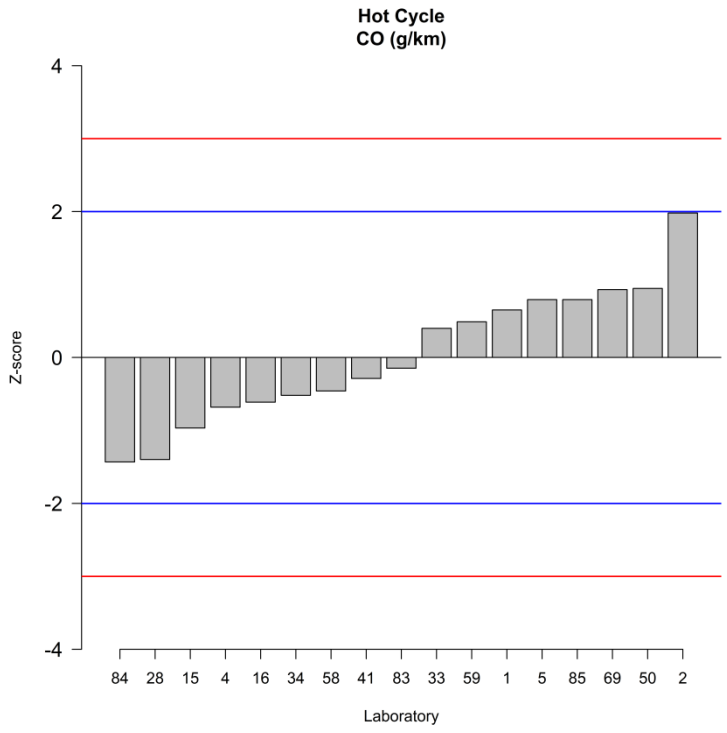

Figure 32 – *z*-score graph for CO measurement – Hot Cycle

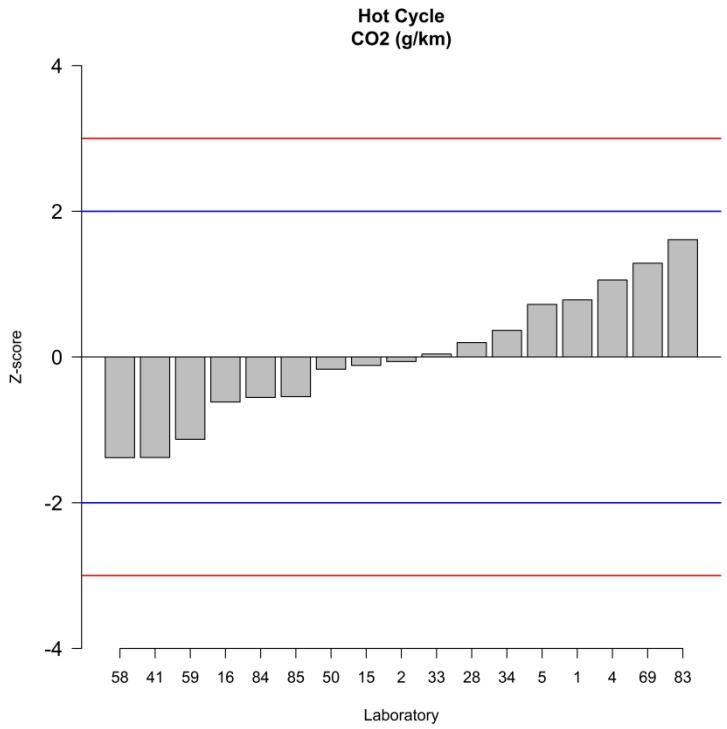

Figure 33 – *z*-score graph for CO_2 measurement – Hot Cycle

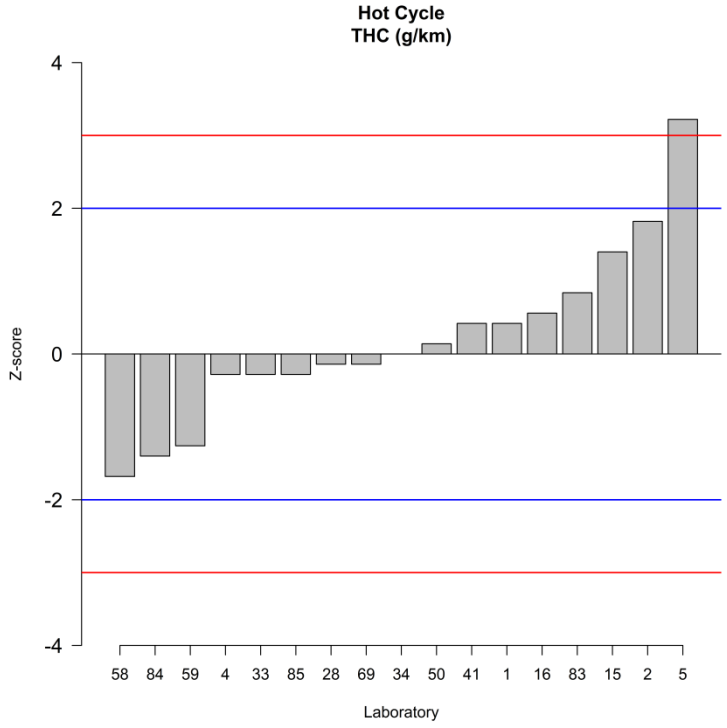

Figure 34 – *z*-score graph for THC measurement – Hot Cycle

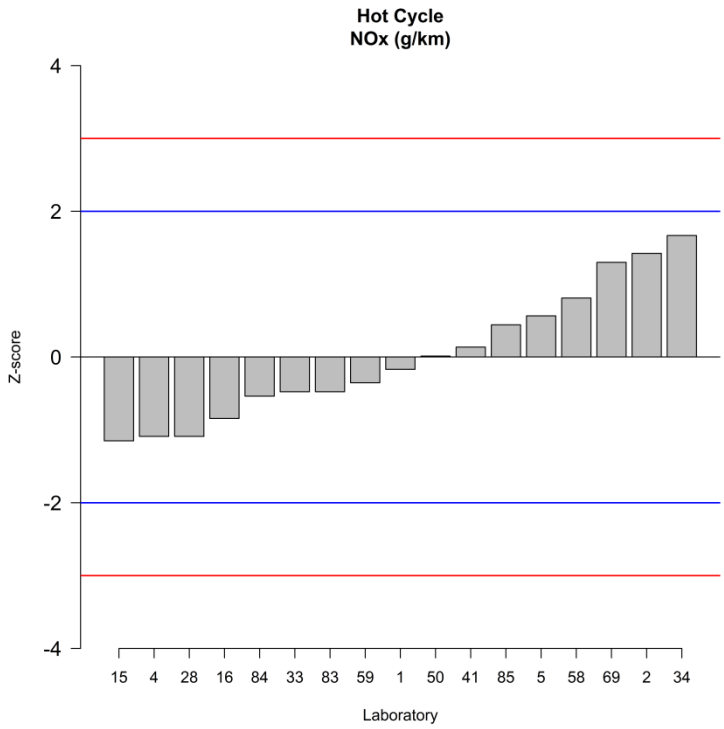

Figure 35 – *z*-score graph for NOx measurement – Hot Cycle

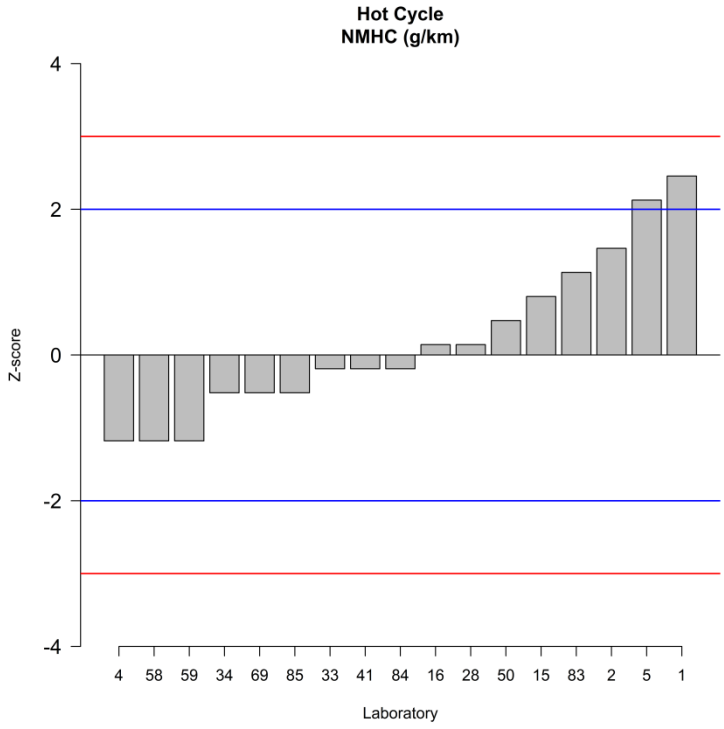

Figure 36 – *z*-score graph for NMHC measurement – Hot Cycle

Through *z*-score graph analysis, it can be seen that:

- CO (g/km): All participants showed satisfactory results.
- CO_2 (g/km): All participants showed satisfactory results.

- THC (g/km): Only participant 05 showed unsatisfactory result.
- NO_x (g/km): All participants showed satisfactory results.
- NMHC (g/km): Participants 01 and 05 showed questionable results.

7.3. Road Cycle Emissions

Table 10 shows the averages and standard deviations for each participant, where the result is the average value of the replicates.

Note: All decimal places were considered for calculations, but the values in the tables below were rounded to the same number of decimal places as requested in the results form.

Table 10 – Average and standard deviation of the participants for the parameters CO, CO_2, THC, NO_X and NMHC (g/km) – Road Cycle

Lab Code	CO (g/km)		CO_2 (g/km)		THC (g/km)		NOx (g/km)		NMHC (g/km)	
	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
10	0.137	0.006	112.8	0.3	0.006	0.000	0.008	0.001	0.002	0.000
11	0.164	0.029	117.8	0.5	0.005	0.002	0.008	0.000	0.002	0.001
13	0.120	0.018	129.5	18.5	0.003	0.000	0.006	0.000	0.001	0.000
19	0.193	0.027	117.0	0.4	0.004	0.000	0.009	0.001	0.001	0.000
26	0.183	0.011	122.4	0.2	0.004	0.000	0.009	0.000	0.001	0.000
30	0.103	0.004	114.1	0.3	0.006	0.000	0.005	0.000	0.004	0.000
48	0.167	0.004	112.8	0.4	0.005	0.000	0.007	0.001	0.002	0.000
61	0.153	0.011	112.6	0.6	0.004	0.001	0.008	0.001	0.002	0.000
66	0.103	0.002	115.0	0.4	0.003	0.000	0.007	0.002	0.001	0.000
67	0.150	0.013	117.1	0.2	0.002	0.001	0.008	0.001	0.000	0.000
70	0.174	0.015	116.7	0.8	0.003	0.000	0.008	0.000	0.000	0.000
71	0.186	0.026	113.9	0.8	0.023	0.023	0.010	0.001	0.004	0.001
72	0.142	0.002	114.0	0.3	0.003	0.000	0.010	0.001	0.000	0.000
74	0.237	0.004	116.4	0.6	0.004	0.000	0.008	0.000	NM	NM
75	0.240	0.026	115.5	0.5	0.005	0.000	0.017	0.002	0.001	0.000
80	0.159	0.010	115.1	0.8	0.004	0.000	0.010	0.000	0.001	0.000
99	0.171	0.011	113.1	0.8	0.003	0.000	0.010	0.001	0.000	0.000

NM = Not Measured

For the performance evaluation of the participants, *z*-score values were calculated, after the exclusion of the outlier results, using the robust average and robust standard deviation of the results for each parameter as assigned value and its standard deviation. Table 11 and figures 37 to 41 show these results.

Table 11 – *z*-score values for the parameters CO, CO_2, THC, NO_X and NMHC – Road Cycle

CO (g/km)		CO_2 (g/km)		THC (g/km)		NO_X (g/km)		NMHC (g/km)	
Lab	**Z score**	**Lab**	**Z score**	**Lab**	**Z score**	**Lab**	**Z score**	**Lab**	**Z score**
10	-0.63	**10**	-1.06	**10**	1.45	**10**	-0.26	**10**	0.84
11	0.19	**11**	1.42	**11**	0.88	**11**	-0.53	**11**	0.84
13	-1.12	**13**	**7.31**	**13**	-0.81	**13**	**-2.16**	**13**	-0.23
19	1.07	**19**	1.05	**19**	0.32	**19**	0.28	**19**	0.03
26	0.77	**26**	**3.74**	**26**	0.04	**26**	0.55	**26**	-0.23
30	-1.64	**30**	-0.41	**30**	1.45	**30**	**-2.98**	**30**	1.91
48	0.28	**48**	-1.08	**48**	0.88	**48**	-1.08	**48**	0.84
61	-0.14	**61**	-1.16	**61**	-0.25	**61**	-0.26	**61**	0.30
66	-1.64	**66**	0.03	**66**	-0.81	**66**	-1.35	**66**	-0.50
67	-0.24	**67**	1.09	**67**	-1.38	**67**	-0.26	**67**	-1.04
70	0.49	**70**	0.90	**70**	-0.81	**70**	0.01	**70**	-1.04
71	0.86	**71**	-0.52	**71**	**16.17**	**71**	1.10	**71**	1.91
72	-0.46	**72**	-0.46	**72**	-0.81	**72**	1.10	**72**	-1.04
74	**2.37**	**74**	0.75	**74**	0.32	**74**	0.01	**74**	**NM**
75	**2.47**	**75**	0.27	**75**	0.60	**75**	**7.34**	**75**	-0.23
80	0.04	**80**	0.09	**80**	-0.25	**80**	1.10	**80**	-0.50
99	0.40	**99**	-0.92	**99**	-0.81	**99**	1.10	**99**	-1.04

Highlighted in blue: questionable values. In red: unsatisfactory values, NM = Not Measured

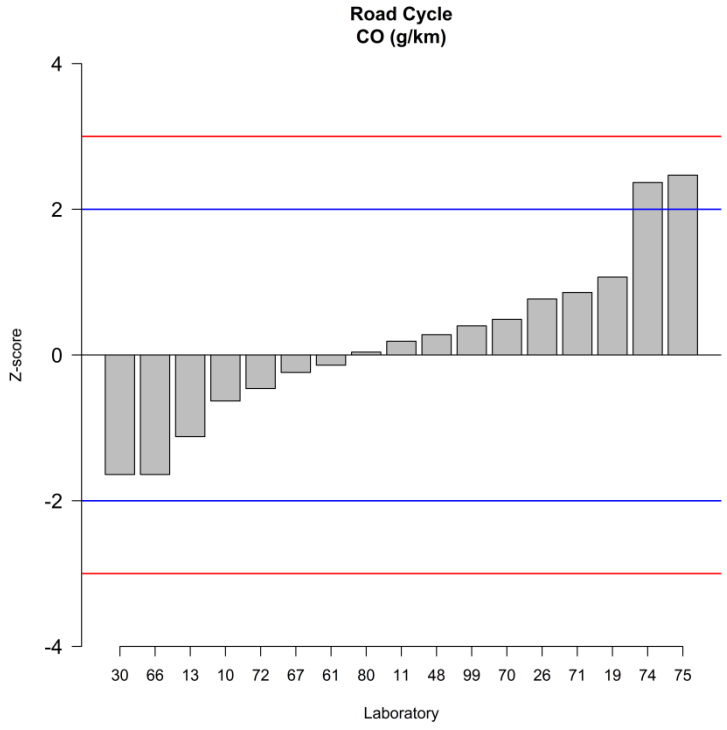

Figure 37 – *z*-score graph for CO measurement – Road Cycle

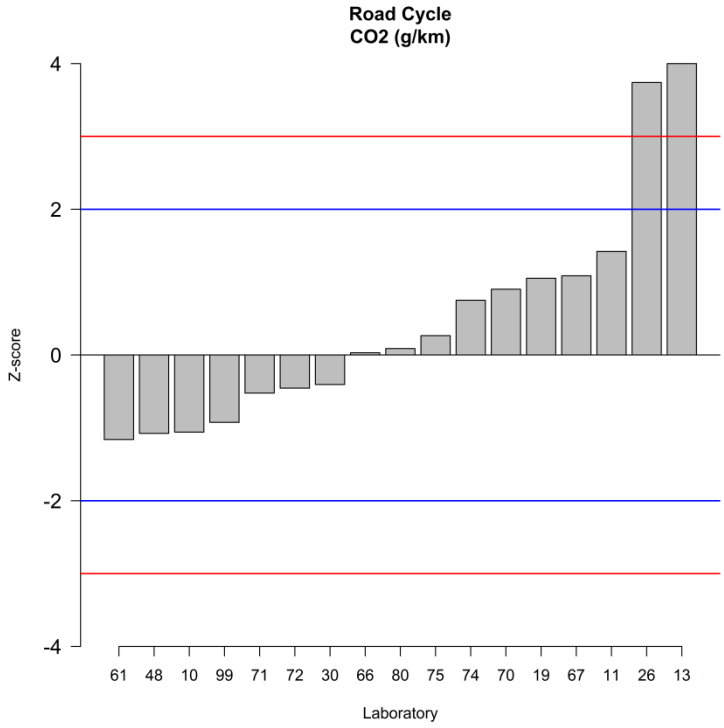

Figure 38 – *z*-score graph for CO_2 measurement – Road Cycle

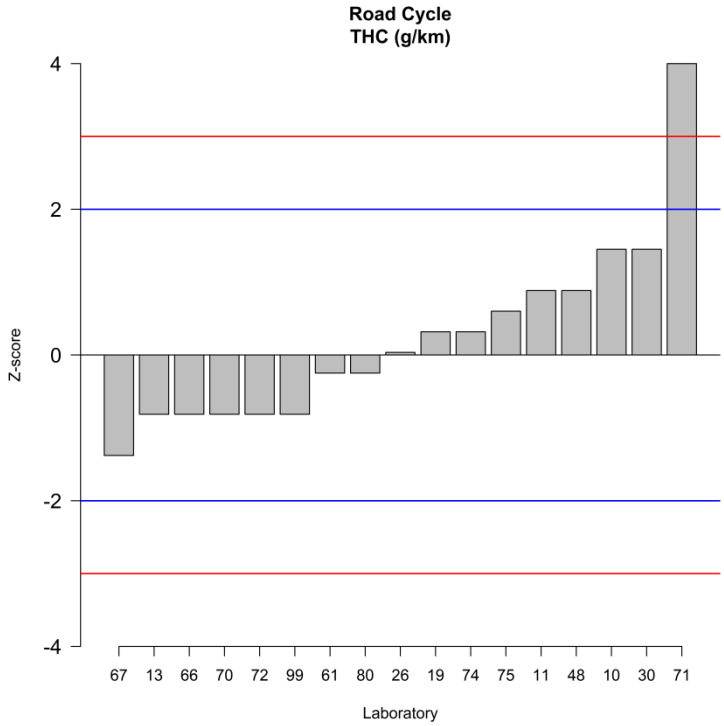

Figura 39 – *z*-score graph for THC measurement – Road Cycle

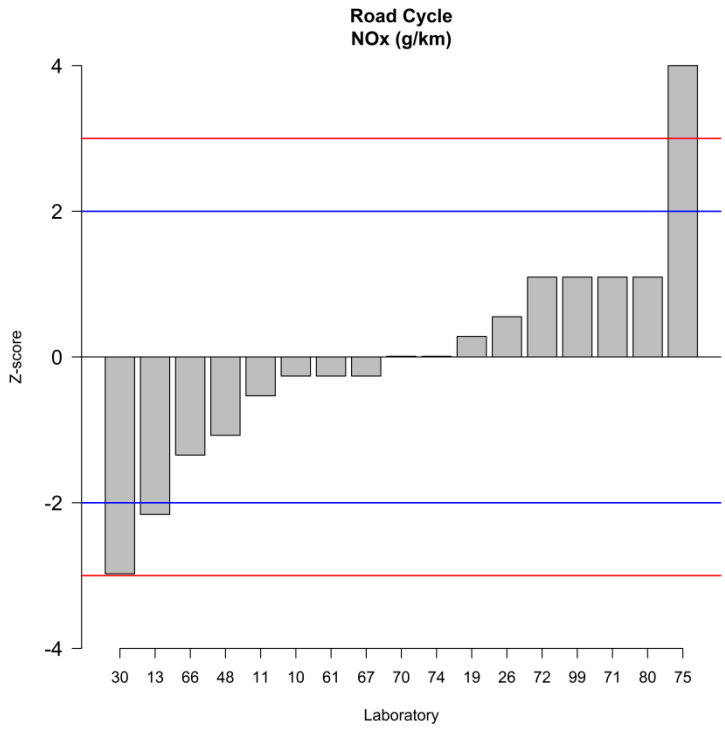

Figura 40 – *z*-score graph for NOx measurement – Road Cycle

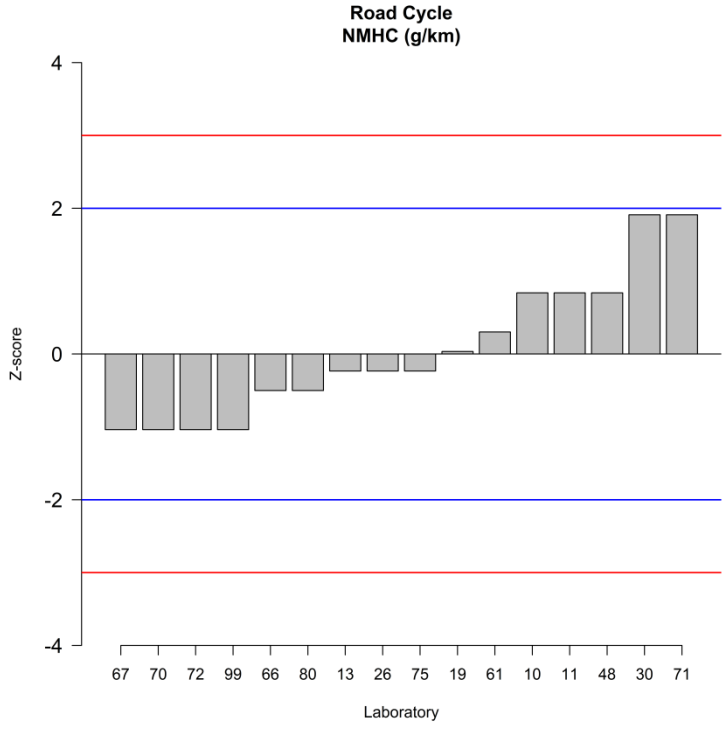

Figura 41 – *z*-score graph for NMHC measurement – Road Cycle

Through *z*-score graph analysis, it can be seen that:

- CO (g/km): Participants 74 and 75 showed questionable results.
- CO_2 (g/km): Participants 13 and 26 showed unsatisfactory results.
- THC (g/km): Participant 71 showed unsatisfactory result.

- NO_x (g/km): Participants 13 and 30 showed questionable results and participant 75 showed unsatisfactory result.
- NMHC (g/km): Participant 74 didn´t report properly the results for this parameter. All others showed satisfactory results.

8. Analysis Testimony

As established in the Proficiency Testing protocol, a CETESB representative witnessed one of the PT three measurements at each laboratory participant and sent the results to the PT coordination. After finishing the tests, each participant sent their results to the coordination for statistical treatment. Tables 12 to 15 show the comparison between the results sent by CETESB and those sent by the participants to PT coordination for all cycles. It is worth saying that all the sent values by CETESB were previously discussed with each one of the participants after the testimony.

8.1. Urban Cycle Emissions

Table 12– Comparison between testimony results sent by CETESB to PT coordination and those sent by the participants for the parameters CO, CO_2, THC, NO_X and NMHC (g/km) – Urban Cycle

Lab Code	CO (g/km)		CO_2 (g/km)		THC (g/km)		NOx (g/km)		NMHC (g/km)	
	CETESB	PEP	CETESB	PEP	CETESB	PEP	CETESB	PEP	CETESB	PEP
03	0.904	0.904	152.8	152.8	0.153	0.153	0.022	0.022	0.121	0.121
06	0.857	0.857	158.4	158.4	0.128	0.128	0.021	0.021	0.100	0.100
22	0.897	0.897	155.1	155.1	0.103	0.103	0.020	0.020	0.076	0.076
25	0.983	0.983	161.1	161.1	0.159	0.159	0.015	0.015	0.134	0.134
27	1.048	1.048	158.2	158.2	0.153	0.153	0.026	0.026	0.120	0.120
36	0.967	0.967	148.8	148.8	0.122	0.122	0.015	0.015	0.093	0.093
39	0.978	0.978	**151.7**	**151.8**	0.094	0.094	0.015	0.015	0.064	0.064
40	1.010	1.010	158.9	158.9	0.141	0.141	0.016	0.016	0.111	0.111
45	0.935	0.935	163.9	163.9	0.120	0.120	0.015	0.015	0.093	0.093
49	0.899	0.899	156.9	156.9	0.127	0.127	0.017	0.017	0.092	0.092
51	1.028	1.028	154.5	154.5	0.174	0.174	0.012	0.012	0.143	0.143
55	0.796	0.796	154.1	154.1	0.095	0.095	0.012	0.012	0.072	0.072
65	**0.844**	**0.845**	**154.0**	**154.4**	0.136	0.136	0.019	0.019	0.105	0.105
73	0.857	0.857	151.9	151.9	0.107	0.107	0.018	0.018	0.081	0.081
77	0.805	0.805	154.6	154.6	0.115	0.115	0.011	0.011	0.089	0.089
86	1.097	1.097	155.5	155.5	0.141	0.141	0.024	0.024	0.106	0.106
92	0.975	0.975	154.9	154.9	0.137	0.137	0.015	0.015	0.107	0.107

Table 13– Comparison between testimony results sent by CETESB to PT coordination and those sent by the PT participants for the parameters ETOH, NMHC-ETOH, Total Aldehydes (g/km), Urban Autonomy (km/L) and Road Autonomy (km/L) – Urban Cycle

Lab Code	ETOH (g/km)		NMHC-ETOH (g/km)		Aldeídos Totais (g/km)		Autonomia urbana (km/L)		Autonomia estrada (km/L)	
	CETESB	PEP	CETESB	PEP	CETESB	PEP	CETESB	PEP	CETESB	PEP
03	0.1900	0.1900	0.039	0.039	**0.0120**	**0.0121**	9.31	9.31	12.64	12.64
06	0.1456	0.1456	0.032	0.032	0.0095	0.0095	9.02	9.02	**12.36**	**12.37**
22	**0.1010**	**0.1001**	0.037	0.037	**0.0059**	**0.0060**	9.13	9.13	12.19	12.19
25	**0.1760**	**0.1761**	0.084	0.084	0.0037	0.0037	8.82	8.82	12.23	12.23
27	0.1970	0.1970	0.074	0.074	0.0110	0.0110	8.98	8.98	12.29	12.29
36	0.1835	0.1835	0.011	0.011	0.0102	0.0102	9.55	9.55	12.57	12.57
39	0.1308	0.1308	0.012	0.012	0.0045	0.0045	9.38	9.38	**12.69**	**12.70**
40	0.1946	0.1946	0.021	0.021	**0.0129**	**0.0127**	8.94	8.94	12.70	12.70
45	0.6994	0.6994	**-**	**-0.239**	0.0063	0.0063	8.69	8.69	11.76	11.76
49	0.1935	0.1935	0.007	0.007	0.0113	0.0113	9.02	9.02	12.27	12.27
51	-	-	-	-	-	-	8.98	8.98	12.54	12.54
55	0.1176	0.1176	0.026	0.026	0.0090	0.0090	9.24	9.24	12.24	12.24
65	0.1529	0.1529	0.033	0.033	0.0096	0.0096	9.28	9.28	12.54	12.54
73	0.1478	0.1478	0.019	0.019	**0.0045**	**-**	9.32	9.32	12.57	12.57
77	0.2790	0.2790	0.030	0.030	0.0079	0.0079	**9.22**	**9.21**	12.79	12.79
86	0.1427	0.1427	0.081	0.081	0.0083	0.0083	9.14	9.14	**12.66**	**12.67**
92	0.1649	0.1649	0.033	0.033	0.0137	0.0137	9.17	9.17	12.13	12.13

Discrepancies were found in 13 of 170 sent results (7,6 %) for the urban cycle. 10 among 17 participants of this PT round showed any discrepancy between the values sent by CETESB and those informed by the participants to the PT coordination. These discrepancies are mainly due to rounding or digitation errors by the participant when sending the results to PT coordination.

8.2. Hot Cycle Emissions

Table 14 – Comparison between testimony results sent by CETESB to PT coordination and those sent by the PT participants for the parameters CO, CO_2, THC, NO_X and NMHC (g/km) – Hot Cycle

Lab Code	CO (g/km)		CO_2 (g/km)		THC (g/km)		NOx (g/km)		NMHC (g/km)	
	CETESB	PEP	CETESB	PEP	CETESB	PEP	CETESB	PEP	CETESB	PEP
01	0.463	0.463	146.9	146.9	0.017	0.017	0.016	0.016	0.006	0.006
02	0.598	0.598	**143.8**	**143.9**	0.015	0.015	0.023	0.023	0.001	0.001
04	0.327	0.327	146.8	146.8	0.013	0.013	0.010	0.010	0.000	0.000
05	0.430	0.430	149.1	149.1	0.025	0.025	0.013	0.013	0.005	0.005
15	0.319	0.319	143.3	143.3	0.012	0.012	0.010	0.010	0.002	0.002
16	0.391	0.391	142.1	142.1	0.016	0.016	0.009	0.009	0.001	0.001
28	0.288	0.288	144.2	144.2	0.010	0.010	0.010	0.010	0.001	0.001
33	0.416	0.416	144.3	144.3	0.013	0.013	0.011	0.011	0.002	0.002
34	0.375	0.375	144.6	144.6	0.013	0.013	0.026	0.026	0.001	0.001
41	0.389	0.389	137.2	137.2	0.015	0.015	0.015	0.015	0.001	0.001

Lab Code	CO (g/km)		CO_2 (g/km)		THC (g/km)		NOx (g/km)		NMHC (g/km)	
	CETESB	PEP	CETESB	PEP	CETESB	PEP	CETESB	PEP	CETESB	PEP
50	0.440	0.440	142.7	142.7	0.013	0.013	0.014	0.014	0.002	0.002
58	0.384	0.384	139.1	139.1	0.009	0.009	0.019	0.019	0.000	0.000
59	0.446	0.446	**137.8**	**137.9**	0.010	0.010	0.016	0.016	0.000	0.000
69	0.502	0.502	**148.4**	**148.3**	0.013	0.013	0.021	0.021	0.001	0.001
83	0.385	0.385	148.7	148.7	0.014	0.014	0.013	0.013	0.002	0.002
84	0.308	0.308	141.9	141.9	0.009	0.009	0.016	0.016	0.001	0.001
85	0.464	0.464	141.3	141.3	0.011	0.011	0.016	0.016	0.001	0.001

Discrepancies were found in 3 of 85 sent results (3.5 %) for the hot cycle. 3 among 17 participants of this PT round showed any discrepancy between the values sent by CETESB and those informed by the participants to the PT coordination.

8.3. Road Cycle Emissions

Table 15 – Comparison between testimony results sent by CETESB to PT coordination (PEP) and those sent by the PT participants for the parameters CO, CO_2, THC, NO_X and NMHC (g/km) – Road Cycle

Lab Code	CO (g/km)		CO_2 (g/km)		THC (g/km)		NOx (g/km)		NMHC (g/km)	
	CETESB	PEP	CETESB	PEP	CETESB	PEP	CETESB	PEP	CETESB	PEP
10	0.133	0.133	113.1	113.1	0.006	0.006	0.010	0.010	0.003	0.003
11	0.154	0.154	118.4	118.4	0.003	0.003	0.008	0.008	0.001	0.001
13	0.124	0.124	116.5	116.5	0.003	0.003	0.006	0.006	0.001	0.001
19	0.156	0.156	117.3	117.3	0.005	0.005	0.007	0.007	0.002	0.002
26	0.172	0.172	122.2	122.2	0.004	0.004	0.009	0.009	0.001	0.001
30	**0.096**	**0.097**	113.8	113.8	0.006	0.006	0.004	0.004	**0.003**	**0.004**
48	0.165	0.165	112.3	112.3	0.005	0.005	0.006	0.006	0.003	0.003
61	0.141	0.141	112.0	112.0	0.003	0.003	0.009	0.009	0.001	0.001
66	0.105	0.105	115.4	115.4	0.003	0.003	0.009	0.009	0.000	0.000
67	0.138	0.138	116.9	116.9	0.003	0.003	0.007	0.007	0.000	0.000
70	0.194	0.194	117.2	117.2	0.003	0.003	0.008	0.008	0.000	0.000
71	0.176	0.176	113.5	113.5	**0.005**	**0.055**	0.008	0.008	0.003	0.003
72	0.139	0.139	113.6	113.6	0.003	0.003	0.009	0.009	0.000	0.000
74	0.241	0.241	117.3	117.3	0.005	0.005	0.009	0.009	NM	NM
75	0.217	0.217	116.2	116.2	0.005	0.005	0.019	0.019	0.001	0.001
80	0.159	0.159	114.2	114.2	0.004	0.004	0.009	0.009	0.001	0.001
99	0.168	0.168	**113.2**	**113.3**	0.003	0.003	0.009	0.009	0.000	0.000

Discrepancies were found in 4 of 85 sent results (4.7 %) for the road cycle. 3 among 17 participants of this PT round showed any discrepancy between the values sent by CETESB and those informed by the participants to the PT coordination, as one participant reported two discrepant results.

9. Confidentiality

Each participant was identified by an individual code which is only known by the participant and the PT coordination. As stated on the registration form, the identification of accredited laboratories and laboratories in stage of accreditation will be forwarded for information of Accreditation General Coordination (Cgcre). The participant received, by email, his own identification code corresponding to the participation in this PT. This code was used to identify the participant in the results registration form. The results may be used in studies and publications by INMETRO respecting the confidentiality of each participant.

As established in section 4.10.4 of ABNT ISO/IEC 17043:2011, in exceptional circumstances, a regulatory authority may require the results and the identification of the participants to the PT provider. If this occurs, the provider will notify the PT participants about this action.

10. Conclusions

Proficiency Testing Schemes in vehicle emissions is a type of study carried out only in Brazil and, considering the particular features of such study, we can conclude that the results are very satisfactory and this initiative is very important to the industry and society along these eight rounds held in collaboration between Inmetro and AEA.

In this round, 3 Proficiency Testing Schemes were carried out, involving a large number of variables and the testimony of a regulation body (CETESB). This large numbers of variables in the vehicle emissions PT certainly have influence in the reported results. Therefore it is recommended that participants that showed questionable performance to critically evaluate their measurement methods.

Some discrepancies between the reported results during CETESB testimony and those sent to PT coordination were observed. They were digitation or round errors that did not influence the quality of the results, but these discrepancies denote a checking problem before sending the results to PT coordination. It is an opportunity to improve the data checking procedures after the analysis.

It is worth saying that for this round the acceptance limits were lowered, as those results out of Ref ± 2*s* limits were considered outliers. In other rounds these results could be considered as satisfactory and they became questionable or unsatisfactory due to the new criteria.

It was observed then a slight decrease on measurement performance compared to last rounds, as for urban cycle 88.1 % of the reported results were satisfactory, six results not correctly reported or not measured (3.5 %), seven questionable results (4.1 %) and 7 others unsatisfactory (4.1 %).

For the Hot cycle, 94 % of the reported results were satisfactory, 2 were questionable (4 %) and 1 was unsatisfactory (2 %).

For road cycle, 76 results were considered satisfactory (89 %), one did not report the result or did not measure the parameter (2 %), 4 questionable results (4.5 %) and other 4 unsatisfactory results (4.5 %)

It should be emphasized the importance of different laboratory participation in a proficiency test scheme, since it constitutes an useful tool to monitor the procedures in routine analysis and to evaluate the laboratory measurement results, enabling the improvement of the results quality and ensuring greater reliability of the measurements.

It is up to PT participant to carry out a critical analysis of the results, where the entire process and laboratory experience must be considered. Therefore, the continuous participation in a proficiency test can assure information to the laboratory about the measurement capability and it is of great importance for monitoring the validity of the results.

11. Participating Laboratories

Nineteen laboratories were registered in the 8th round of the Car Emissions Proficiency Test and seventeen attended to it because two of them had equipment problems and informed the coordination. The list of laboratories that sent results to this PT coordination is presented in Table 16. It is important to note that the numbering of the laboratories in the table only indicates the number of participants in the PT, under no circumstances it is associated to laboratory identification in presenting their results.

Table 16 – Participating Laboratories

	Institution
1.	CAOA Montadora de Veículos Centro de Pesquisas e Eficiência Energética
2.	Continental Brasil Indústria Automotiva Ltda Laboratório de Emissões Veiculares – Centro Tecnológico “Geraldo Negri Rangel”
3.	Delphi Automotive Systems do Brasil Ltda.
4.	FCA Fiat Chrysler Automóveis Brasil Ltda Laboratório de Emissões e Consumo
5.	Ford Motor Company Brasil Ltda Laboratório de Emissões do Campo de Provas de Tatuí
6.	General Motors do Brasil Ltda Laboratório de Emissões do Campo de Provas de Cruz Alta
7.	Honda Automóveis do Brasil Ltda Laboratório de Emissões Honda Automóveis
8.	Instituto de Tecnologia para o Desenvolvimento – Institutos LACTEC LEME – Laboratório de Emissões Veiculares
9.	Magneti Marelli Sistemas Automotivos Indústria e Comércio Ltda
10.	Peugeot Citroen do Brasil Automotive Ltda
11.	Petróleo Brasileiro S.A. Laboratório de Ensaios Veiculares - CENPES

	Institution
12.	Renault do Brasil S/A LEV – Laboratório de Emissões Veiculares
13.	Robert Bosch Ltda Laboratório de emissões veiculares – Robert Bosch
14.	SENAI – Serviço Nacional de Aprendizagem Industrial Laboratório de Emissões Veiculares – IST AUTO
15.	Toyota do Brasil Ltda Laboratório de Emissões Indaiatuba
16.	Umicore Brasil Ltda Laboratório de Emissões Veiculares - Umicore
17.	Volkswagen do Brasil Ltda Laboratório de Emissões Veiculares da Volkswagen do Brasil Ltda

Total participants: 17 laboratories.

12. Bibliographic References

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