Final Report of the Proficiency Testing in Vehicles Emissions 10th Round - Diesel Vehicles

Inmetro
Instituto Nacional de Metrologia, Qualidade e Tecnologia

PEP-Inmetro

Programa de Ensaios de Proficiência do Inmetro

Final Report of the Proficiency Testing in Vehicles Emissions
10th Round - Diesel Vehicles

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SUMÁRIO

1. Introduction

Scientific studies results have shown that air pollution represents a serious threat to human health, increasing the occurrence of respiratory diseases and decreasing the quality of life of the population. Vehicles are potential agents of pollution worldwide. Gas emissions from vehicles 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. Diesel vehicles are responsible for a great amount of emission in atmosphere and it can be specified, besides other gases, CO, NO_x and the particulate matter as one of the main agents that cause this pollution. Besides, diesel has Hydrocarbons because it is also a derivative of petroleum and they are heavier than those of gasoline.

Due to regulatory and accreditation bodies requirements there is an increasing need to perform better measurement of pollutant gases. Besides that, due to constant emissions limits reductions, measurement methods should adequate to new needs. Pollutants analysis is one of the most delicate items of a vehicle or engine emission test. In this sense, the execution of Proficiency Testing (PT) in vehicles emissions aims to evaluate the performance of laboratories in determining the amount of compounds present in vehicle emissions, providing subsidies for the identification and solution of analytical problems and contributing to the harmonization of measurement results in the country, besides being a tool for data generation that can support the preparation of new regulations.

The objectives of this PT scheme were:

1) To determine the performance of laboratories for the proposed tests;
2) To monitor the ongoing performance of the analytical vehicle emissions laboratories;
3) To increase the confidence of the measuring emission process of the vehicle emission laboratories;
4) To improve continuously 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 do Brasil (GM-CPCA) company with the following characteristics: Chevrolet Cobalt LTZ Model, black color, identification code APOIOGMPT09, 1.3L Diesel motor, 5-speed manual transmission and equivalent inertia of 1304 kg.
Each participant laboratory used its own fuel (Diesel S-10 B0 standard according to ABNT NBR 8689:2012 Standard).

2.2. Methodology

In this round, the following tests were evaluated, according to the current versions of the respective documents:

Urban and Road Cycle	ABNT NBR 6601:2012 standard - THC, NMHC, CO, CO_2 ABNT NBR 7024:2017 standard – Urban Autonomy; Road Autonomy; and Combined Autonomy;
NO_x	ABNT NBR 6601:2012 standard - NO_x;
Particulate Matter	ABNT NBR 6601:2012 standard - Particulate matter;
Opacity	ABNT NBR 13037:2001 standard - Opacity in free acceleration.

The laboratories reproduced the deceleration curve in dynamometer informed by the emission laboratory of General Motors do Brasil. Laboratories drained the fuel of the tank to refuel with 25 L and to perform all the tests planned in this PT. Participants should follow the test flow chart presented in figure 1 when performing the tests and preferably start the tests at 25 °C temperature, aiming minimizing cold start effects in results.

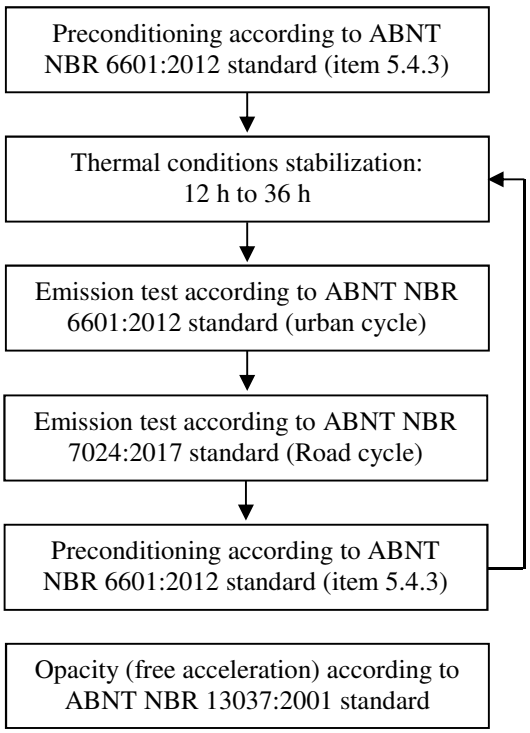

Figure 1- Flow chart of PT measurement activities.

Participants sent obligatorily, 3 (three) measurements for each parameter, with exception to the parameters the protocol consider optional, otherwise, their results would not be evaluated. The results of GM-CPCA to be considered referred to the tests performed in the beginning of the cycle (Y_1).

3. Test Item Integrity

GM do Brasil CPCA laboratory performed stability tests in the beginning and at the end do the cycle – first analysis (Y_1), second analysis (Y_2). It was verified if there were statistical differences between measurements of the 7 (seven) components of urban cycle: CO, CO_2, THC, NO_x, NMHC, particulate matter in g/km and urban autonomy in km/L and of 2 components of road cycle: road autonomy and combined autonomy in km/L.

It was also verified the opacity in free acceleration following Street Cycle.

All results were the same, with p-value greater than 0.05. Thereby, it can be assured that, to a level of confidence of 95 %, there are no difference statistically significant between the mean and the sample data can be considered as coming from the same population. Thus, the vehicle maintained integrity during the performance of this Proficiency Test.

Due to data confidentiality, once GM do Brasil CPCA is also participant of this PT, these results were not presented.

4. Statistical Analysis of Participants' Results

4.1. *z* Score

For the participants' results evaluation, it was followed one of ABNT NBR ISO/IEC 17043:2011 criteria, *z* score (distance measurement related of the laboratory measurement result in relation to the PT designated value, that was calculated according to equation 1.

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

Where:

x_i is the mean measurement result of the ith participant;

X is the PT designated value;

$\hat{\sigma}$ is the standard deviation for the proficiency testing, that in this round was established as described in ISO 13528:2015 standard, that is, a robust standard deviation based on participants' results.

The interpretation of z score is presented as follows:

$|z| \leq 2{,}0$ - indicates "satisfactory" performance and generates no signal;

$2{,}0 < |z| < 3{,}0$ – indicates "questionable" performance and generates a warning signal;

$|z| \geq 3{,}0$ - indicates "unsatisfactory" performance and generates an action signal.

5. Assigned Values

According to available procedures for the establishment of designated values by ABNT NBR ISO/IEC 17043:2011, the designated values of this PT were calculated by statistical methods described in 7.7 item of ISO 13528:2015 standard, that is, consensus values from participant results.

ISO 13528:2015 standard describes the robust analysis involving employment of the A algorithm for the calculation of designated value and standard deviation. The robust statistical techniques are used to minimize the influence that extreme results can have on estimates of mean and standard deviation.

Initially, all values object of the analysis (values sent by participants) were put in ascending order. Next, robust values and standard deviation of these data were denoted by (x*) and (s*). Initial values of (x*) and (s*) were calculated according to equations below:

$$x^* = x_i \text{ median} \quad (2)$$

$$s^* = 1{,}483 \text{ x median } |x_i - x^*| \quad (3)$$

(x*) e (s*) values were updated as follows. It was calculated:

$$\delta = 1{,}5 s^* \quad (4)$$

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

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

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

$$x^* = \sum x_i^* / p \quad (6)$$

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

Where the summation is over i.

The robust estimation (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.

Tables 1, 2 and 3 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.

Each participant in this report is identified by the last three characters of its identification code in tables, graphs and texts.

Table 1 – Designated value and standard deviations of the PT – urban and road cycle emissions.

Parameter	Designated value	Standard deviation	Outliers (participants)	Recalculated designated value	Recalculated standard deviation
CO (g/km)	2.129	0.249	-	-	-
CO_2 (g/km)	130.2	3.6	-	-	-
THC (g/km)	0.355	0.068	-	-	-
NMHC (g/km)	0.334	0.058	-	-	-
Urban autonomy (km/L)	19.04	0.49	-	-	-
Road autonomy (km/L)	26.04	0.64	-	-	-
Combined autonomy (km/L)	22.06	0.48	-	-	-

Table 2 - Designated value and standard deviations of the PT – particulate matter.

Parameter	Designated value	Standard deviation	Outliers (participants)	Recalculated designated value	Recalculated standard deviation
Particulate matter	0.0547	0.0150	-	-	-

Table 3 - Designated value and standard deviations of the PT – NO_x.

Parameter	Designated value	Standard deviation	Outliers (participants)	Recalculated designated value	Recalculated standard deviation
NO_x (g/km)	0.461	0.036	071 e 163	0.451	0.021

Table 4 - Designated value and standard deviations of the PT – opacity.

Parameter	Designated value	Standard deviation	Outliers (participants)	Recalculated designated value	Recalculated standard deviation
Opacity	0.80	0.36	-	-	-

6. Results Dispersion

In the presented graphs for all tested parameters, a continuous black line represents the assigned value and the last three digits of its identification code identify each laboratory. The blue and red lines, respectively, are representations of Ref ± 1s and Ref ± 2s, where "Ref" is the assigned value (robust average) and "s" is the robust standard deviation.

6.1. Urban and Road Cycle Emissions

Figures 2 to 8 graphically present the means and robust standard deviation of the reported urban and road cycle emission results by the laboratories for each analyzed parameter.

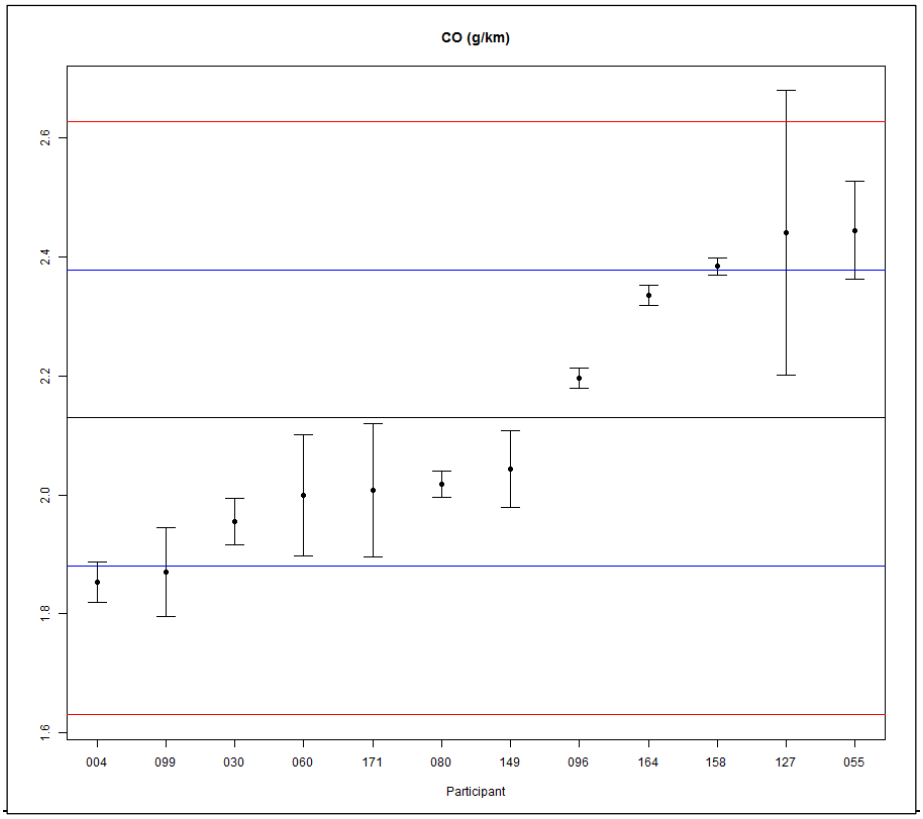

Figure 2 – Scatter plot of the participants' measurement results for CO – urban and road cycle.

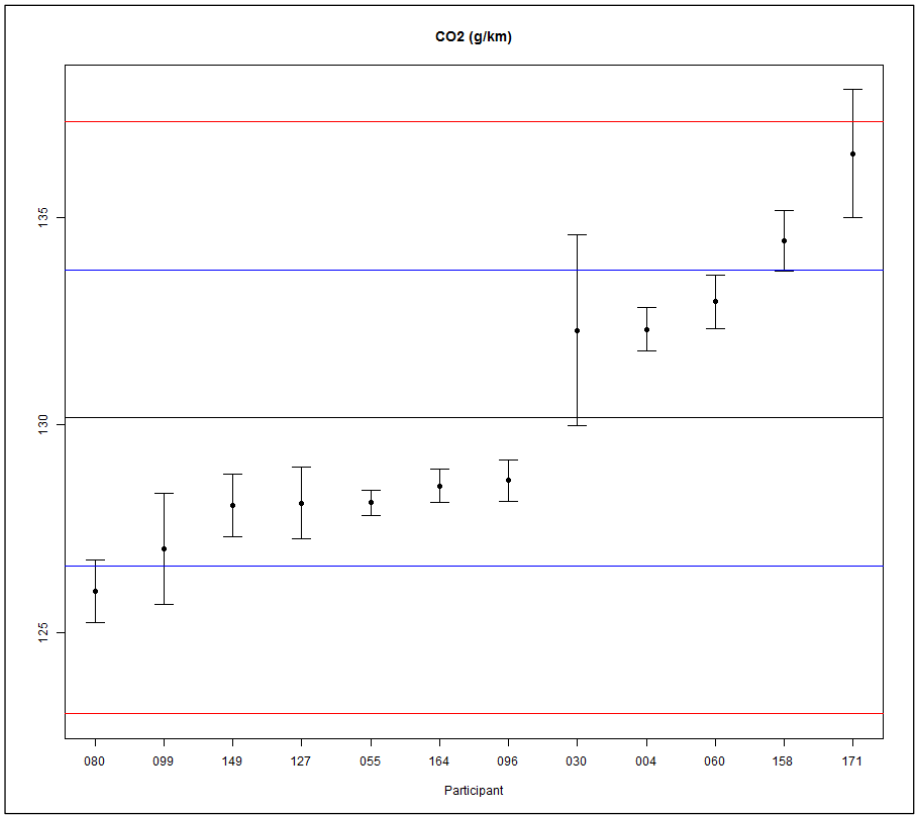

Figure 3 – Scatter plot of the participants' measurement results for CO_2 – urban and road cycle.

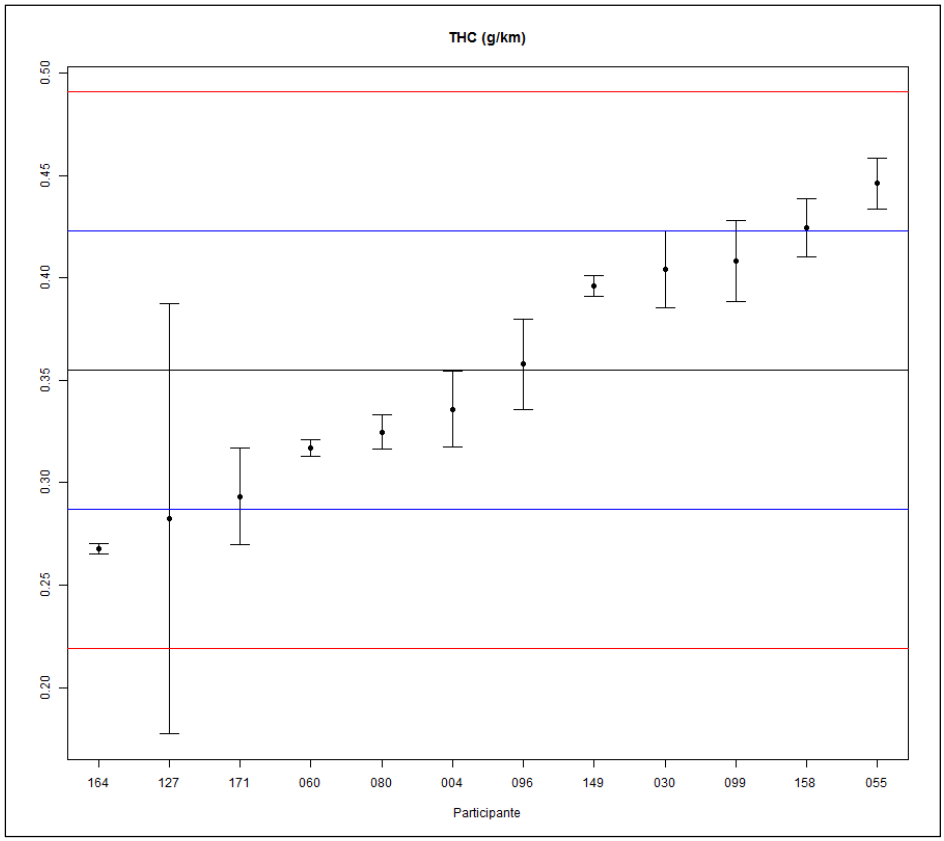

Figure 4 – Scatter plot of the participants' measurement results for THC – urban and road cycle.

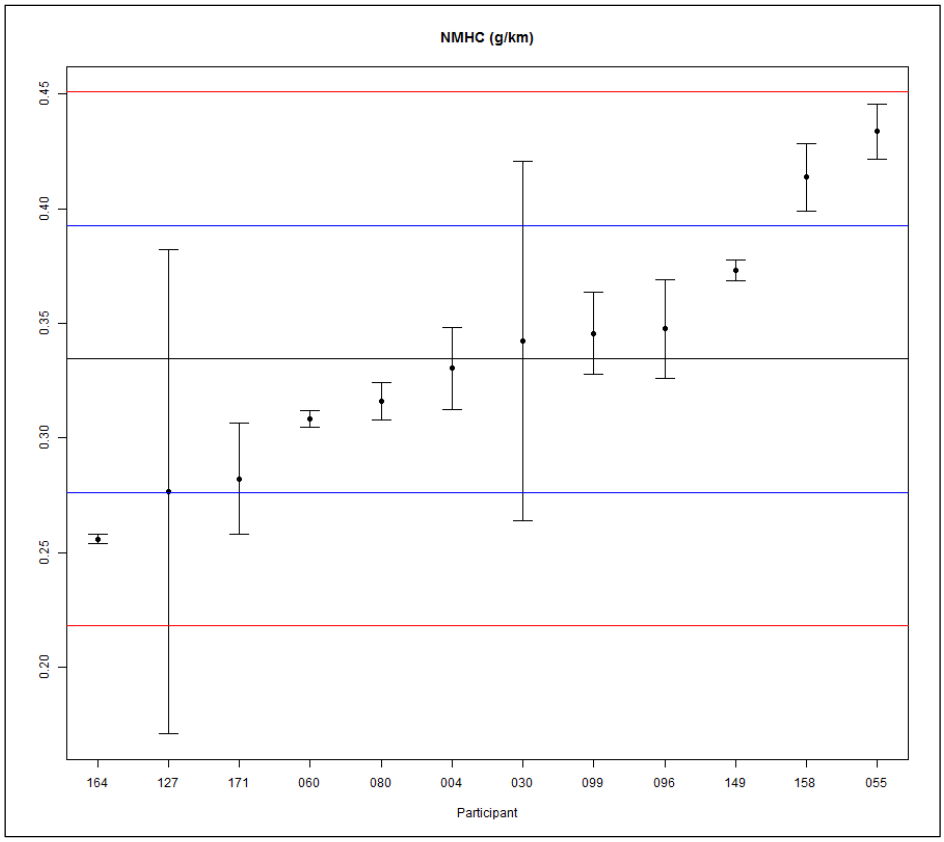

Figure 5 – Scatter plot of the participants' measurement results for NMHC – urban and road cycle.

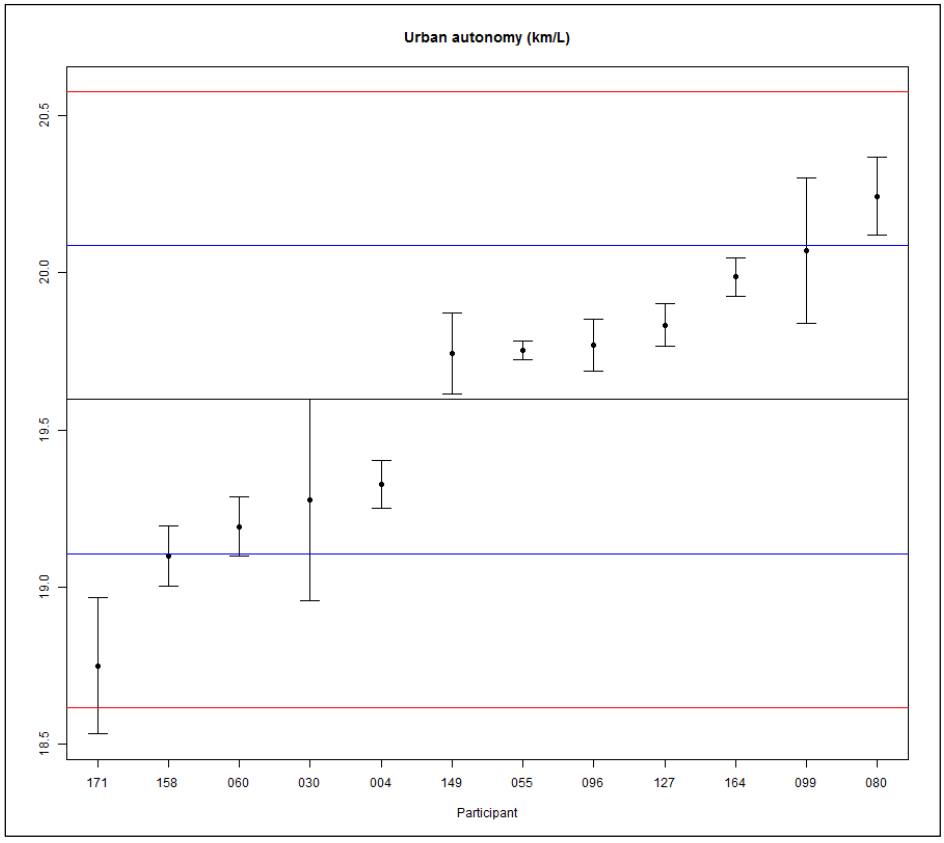

Figure 6 – Scatter plot of the participants' measurement results for urban autonomy – urban and road cycle.

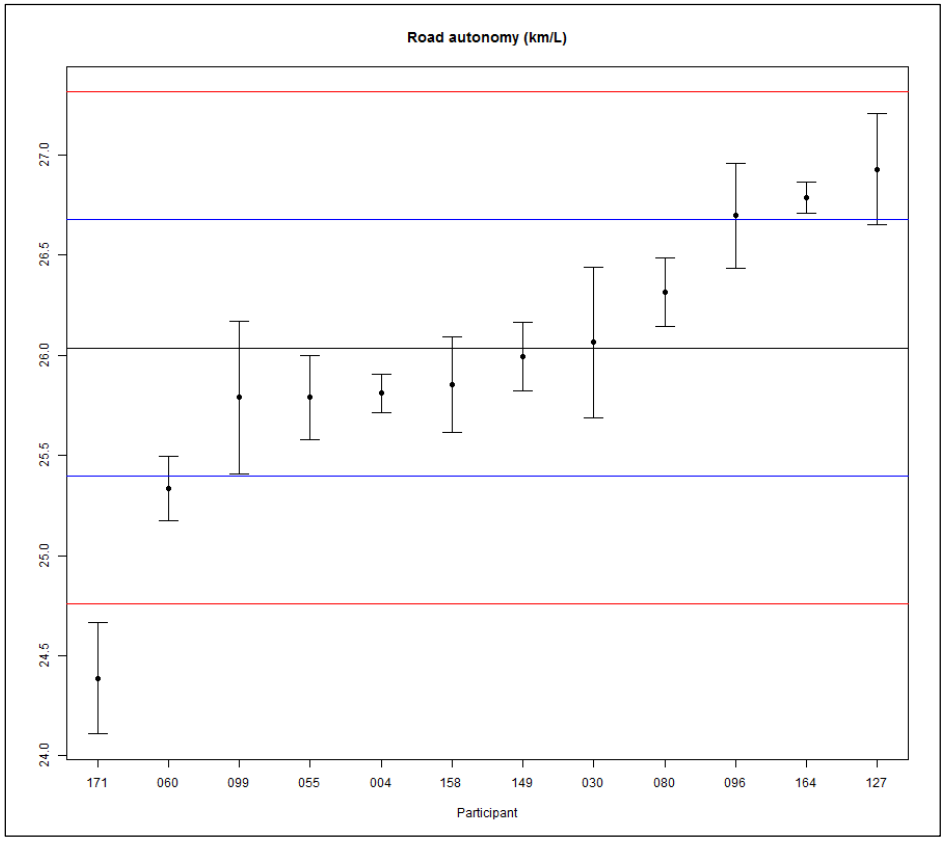

Figure 7 – Scatter plot of the participants' measurement results for road autonomy (km/L) – urban and road cycle.

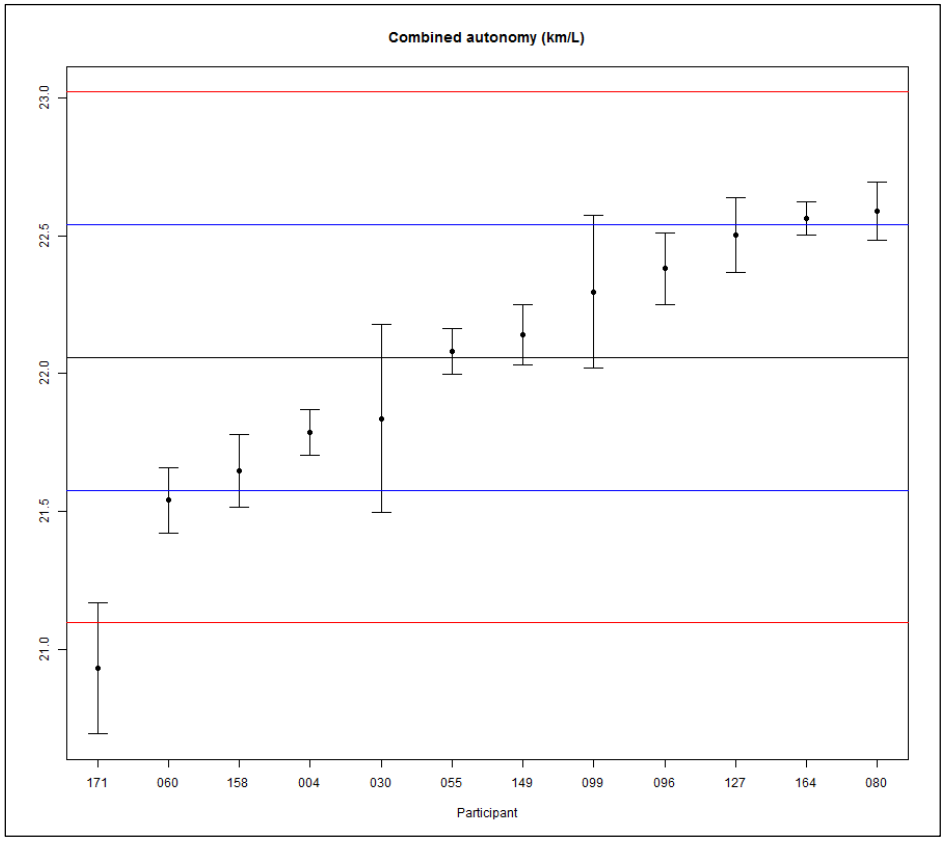

Figure 8 – Scatter plot of the participants' measurement results for combined autonomy (km/L) – urban and road cycle.

Through the graphs, it can be seen that:

CO (g/km): Among all 12 participants that reported results within the Ref ± 2s interval, participants 060, 171 and 127 presented the greatest dispersions.

CO_2 (g/km): Among all 12 participants that reported results within the Ref ± 2s interval, participants 099, 030 and 171 presented the greatest dispersions.

THC (g/km): Among all 12 participants that reported results within the Ref ± 2s interval, participant 127 presented the greatest dispersions.

NMHC (g/km): Among all 12 participants that reported results within the Ref ± 2s interval, participants 127 e 030 presented the greatest dispersions.

Urban Autonomy (km/L): Among all 12 participants that reported results within the Ref ± 2s interval, participants 171, 030 e 099 presented the greatest dispersions.

Road Autonomy (km/L): 11 participants that reported results within the Ref ± 2s interval. Participant 171 was out of Ref ± 2s interval. Participants 171, 030 e 099 presented the greatest dispersions.

Combined Autonomy (km/L): 11 participants that reported results within the Ref ± 2s interval. Participant 171 was out of Ref ± 2s interval. Participants 171, 030 e 099 presented the greatest dispersions.

6.2. Particulate Matter

Figure 9 graphically presents the means and robust standard deviations of the reported results for particulate matter by participants for each analyzed parameter.

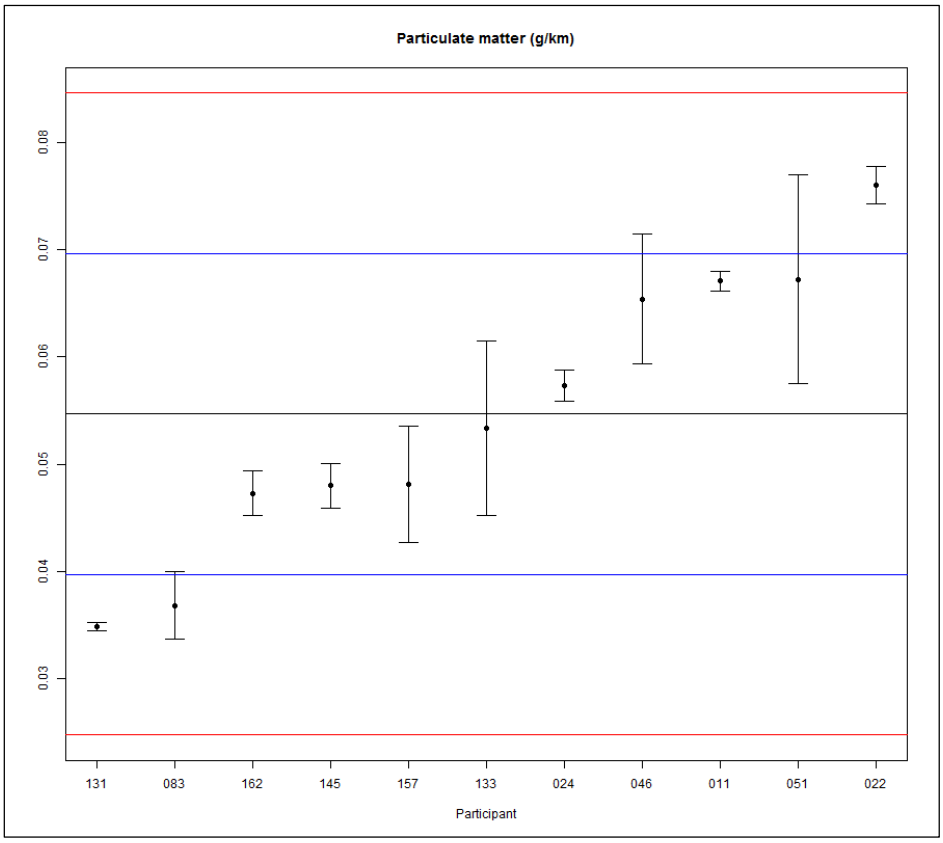

Figure 9 – Scatter plot of the participants' measurement results for particulate matter.

Through the graphs, it can be seen that:

Particulate matter: 8 participants that reported results within the Ref ± 1s interval. Participants 131, 083 e 022 reported results within the Ref ± 2s interval. Participants 157, 133, 046 e 051 presented the greatest dispersions.

6.3. NO_x

Figure 10 graphically presents the means and robust standard deviations of the reported results for parameter particulate Matter by participants.

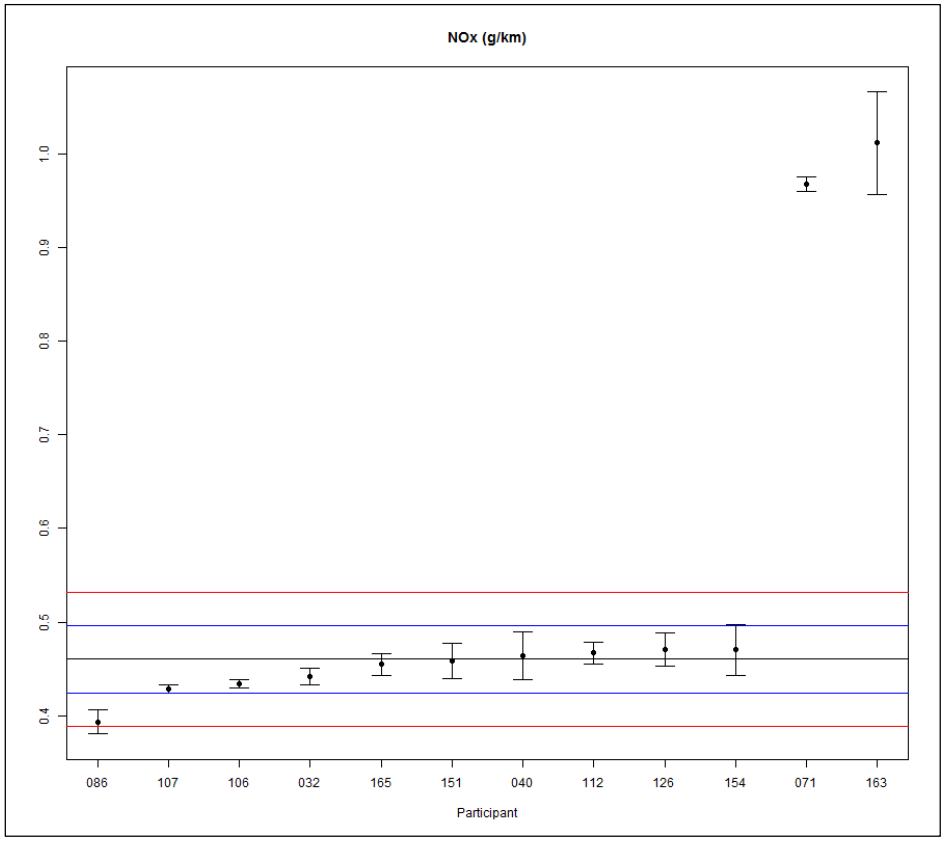

Figure 10 – Scatter plot of the participants' measurement results for NO_X.

Through the graphs, it can be seen that:

NO_x (g/km): 9 participants that reported results within the Ref ± 2s interval. Participants 066, 071 and 163 reported results out of this interval. Participant 163 presented the greatest dispersion.

6.4. Opacity

Figure 11 graphically presents the means and robust standard deviations of the reported results for parameter opacity by participants.

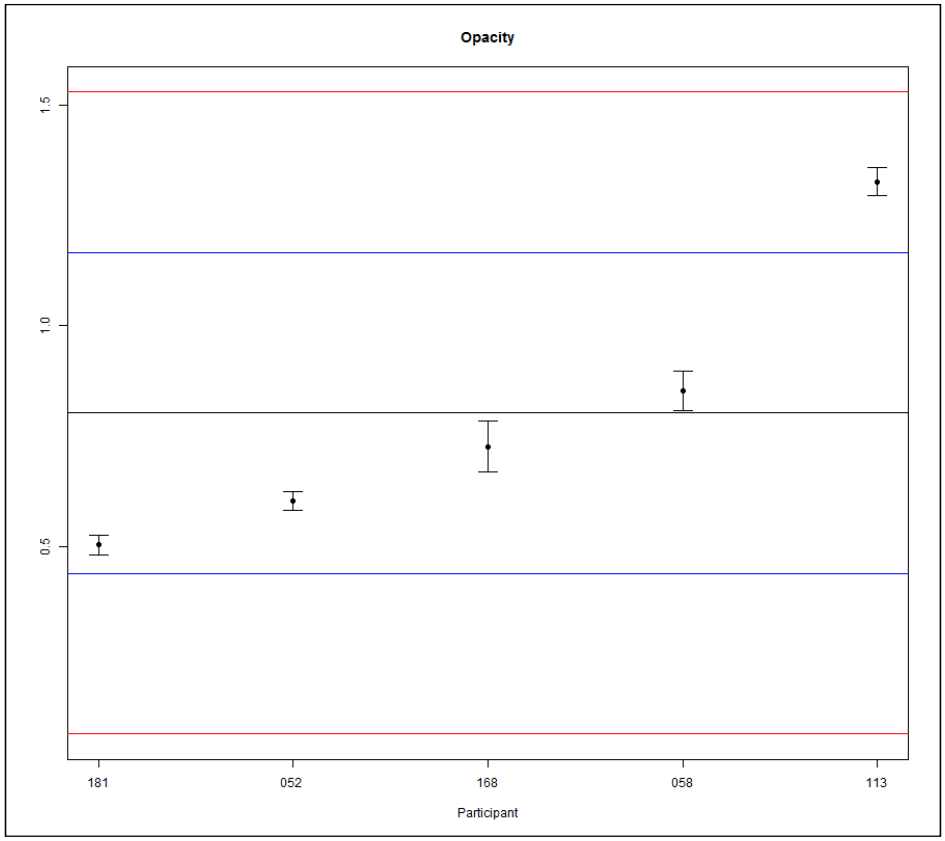

Figure 11 – Scatter plot of the participants measurement results for opacity.

Through the graphs, it can be seen that:

Opacity: 4 participants that reported results within the Ref ± 1s interval. Participant 113 reported results within the Ref ± 2s interval.

7. Participants' Results

Measurement results reported by participants in this PT are presented in sections 7.1 to 7.4.

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

7.1. Average and Standard Deviations Results

7.1.1. Urban and Road Cycle Emissions

Tables 5 and 6 present the replicates average and standard deviations of each participant, for urban and road cycle emission data by participants for each analyzed parameter.

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

Table 5 – Average and standard deviation of participants for CO, CO_2, THC e NMHC (g/km) parameters – urban and road cycle.

Code	CO (g/km)		CO_2 (g/km)		THC (g/km)		NMHC (g/km)	
	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
004	1.854	0.034	132.3	0.5	0.336	0.018	0.330	0.018
030	1.956	0.039	132.3	2.3	0.404	0.019	0.342	0.078
055	2.445	0.083	128.1	0.3	0.446	0.012	0.434	0.012
060	2.000	0.102	133.0	0.7	0.317	0.004	0.308	0.004
080	2.018	0.022	126.0	0.8	0.325	0.008	0.316	0.008
096	2.196	0.017	128.7	0.5	0.358	0.022	0.348	0.022
099	1.870	0.075	127.0	1.3	0.408	0.020	0.346	0.018
127	2.440	0.239	128.1	0.9	0.282	0.105	0.277	0.106
149	2.043	0.065	128.1	0.8	0.396	0.005	0.373	0.005
158	2.384	0.015	134.4	0.7	0.424	0.014	0.414	0.015
164	2.336	0.017	128.5	0.4	0.268	0.003	0.256	0.002
171	2.008	0.112	136.5	1.5	0.293	0.023	0.282	0.024

Table 6 – Average and standard deviation of participants for urban autonomy (km/L), road autonomy (km/L) and combined autonomy (km/L) – urban and road cycle.

Code	Urban autonomy (km/L)		Road autonomy (km/L)		Combined autonomy (km/L)	
	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
004	19.33	0.08	25.81	0.10	21.79	0.08
030	19.28	0.32	26.06	0.38	21.84	0.34
055	19.75	0.03	25.79	0.21	22.08	0.08
060	19.19	0.09	25.33	0.16	21.54	0.12
080	20.24	0.12	26.32	0.17	22.59	0.11
096	19.77	0.08	26.70	0.26	22.38	0.13
099	20.07	0.23	25.79	0.38	22.30	0.28
127	19.83	0.07	26.93	0.28	22.50	0.13
149	19.74	0.13	25.99	0.17	22.14	0.11
158	19.10	0.10	25.85	0.24	21.65	0.13
164	19.99	0.06	26.79	0.08	22.56	0.06
171	18.75	0.22	24.39	0.28	20.93	0.24

7.1.2. Particulate Matter

Table 7 present the replicates average and standard deviations of each participant, for particulate matter parameter.

Table 7– Average and standard deviation of participants for particulate matter parameter.

Code	Particulate matter	
	Average	Standard deviation
011	0.0671	0.0009
022	0.0760	0.0017
024	0.0573	0.0014
046	0.0654	0.0061
051	0.0672	0.0097
083	0.0368	0.0032
131	0.0349	0.0004
133	0.0533	0.0081
145	0.0480	0.0021
157	0.0481	0.0054
162	0.0473	0.0021

7.1.3. NO_x

Table 8 present the replicates average and standard deviations of each participant for NO_x parameter.

Table 8– Average and standard deviation of participants for NO_x parameter.

Code	NO_x	
	Average	Standard deviation
032	0.442	0.009
040	0.464	0.025
071	0.967	0.008
086	0.393	0.013
106	0.434	0.004
107	0.429	0.005
112	0.467	0.011
126	0.471	0.018
151	0.459	0.019
154	0.471	0.027
163	1.011	0.054
165	0.455	0.012

7.1.4. Opacity

Table 9 present the replicates average and standard deviations of each participant for opacity parameter.

Table 9 – Average and standard deviation of participants for opacity parameter.

Code	Opacity	
	Average	Standard deviation
052	0.60	0.02
058	0.85	0.05
113	1.33	0.03
168	0.73	0.06
181	0.50	0.02

7.2. z Score

7.2.1. Urban and Road Cycle Emissions - z Score

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 urban and road cycle emission parameter as assigned value and its standard deviation. Tables 10 and 11 and figures 12 to 18 show these results.

Table 10 – z score values for the CO, CO_2, THC and NMHC parameters – urban and road cycle.

Code	CO (g/km)	CO_2 (g/km)	THC (g/km)	NMHC (g/km)
	z score	z score	z score	z score
004	-1.10	0.60	-0.28	-0.07
030	-0.70	0.59	0.73	0.13
055	1.27	-0.57	1.35	1.70
060	-0.52	0.79	-0.56	-0.45
080	-0.44	-1.17	-0.44	-0.32
096	0.27	-0.42	0.05	0.23
099	-1.04	-0.88	0.79	0.19
127	1.25	-0.58	-1.07	-0.99
149	-0.34	-0.59	0.61	0.66
158	1.02	1.20	1.02	1.36
164	0.83	-0.46	-1.28	-1.35
171	-0.49	1.79	-0.91	-0.90

* Satisfactory result
* Questionable result
* Unsatisfactory result

Table 11 – z score values for the urban autonomy (km/L), road autonomy (km/L) e combined autonomy (km/L) parameters – urban and road cycle.

Code	Urban autonomy (km/L)	Road autonomy (km/L)	Combined autonomy (km/L)
	z score	z score	z score
004	-0.55	-0.35	-0.56
030	-0.65	0.04	-0.46
055	0.32	-0.39	0.05
060	-0.82	-1.10	-1.08
080	1.32	0.44	1.10
096	0.35	1.03	0.67
099	0.97	-0.39	0.50
127	0.49	1.40	0.92
149	0.30	-0.07	0.17
158	-1.02	-0.29	-0.85
164	0.80	1.17	1.05
171	-1.73	**-2.58**	**-2.34**

* Satisfactory result
* Questionable result
* Unsatisfactory result

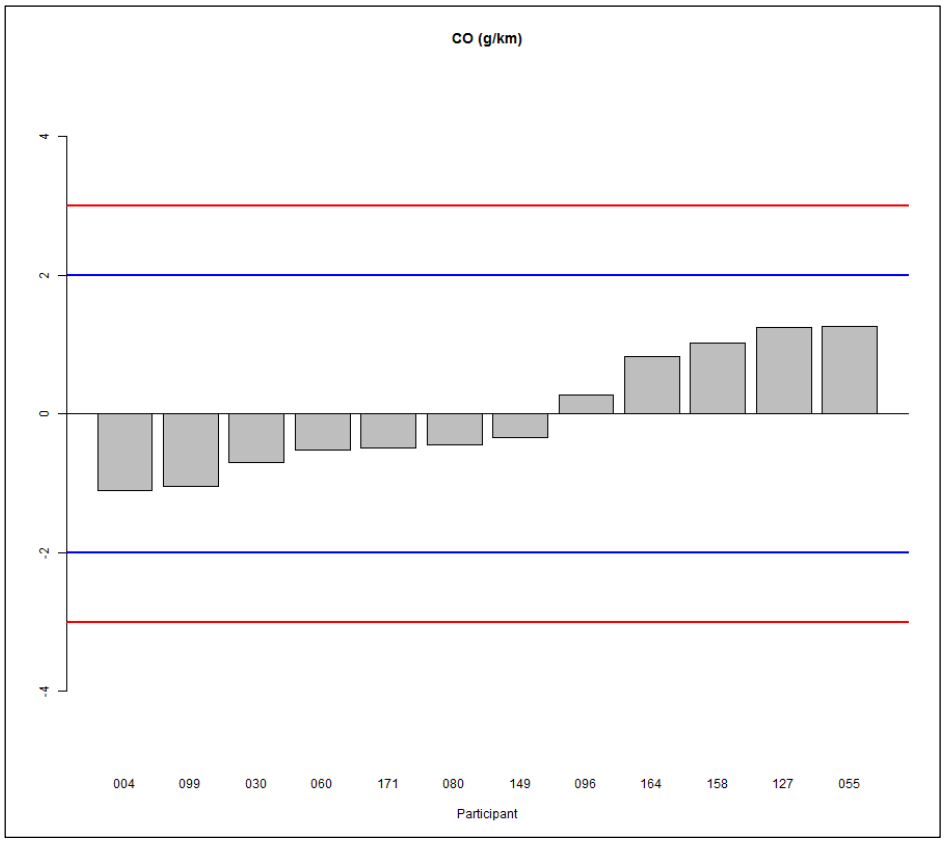

Figure 12 – z-score graph for CO – urban and road cycle.

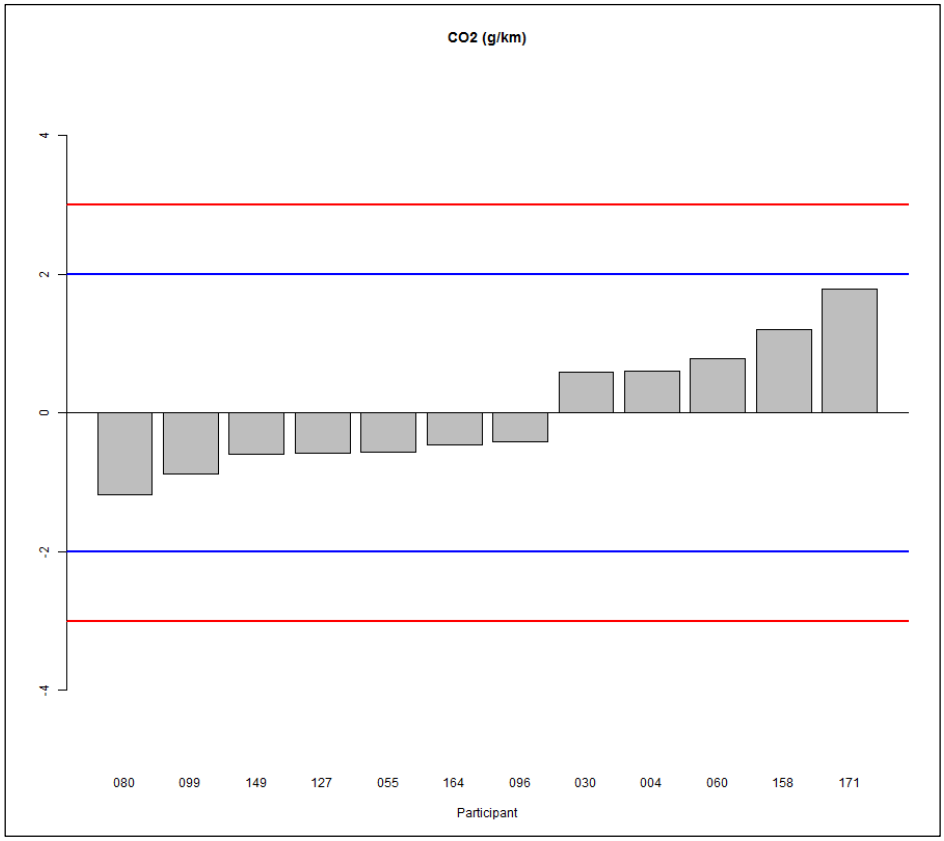

Figure 13 – z-score graph for de CO_2 – urban and road cycle.

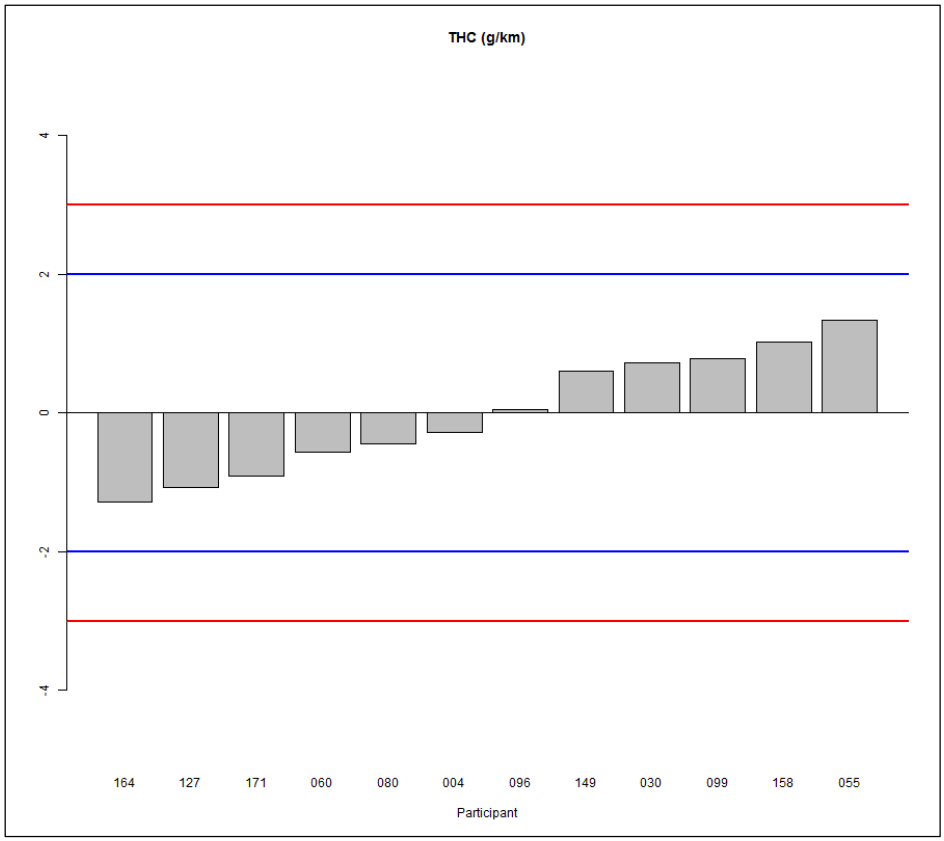

Figure 14 – z-score graph for THC – urban and road cycle.

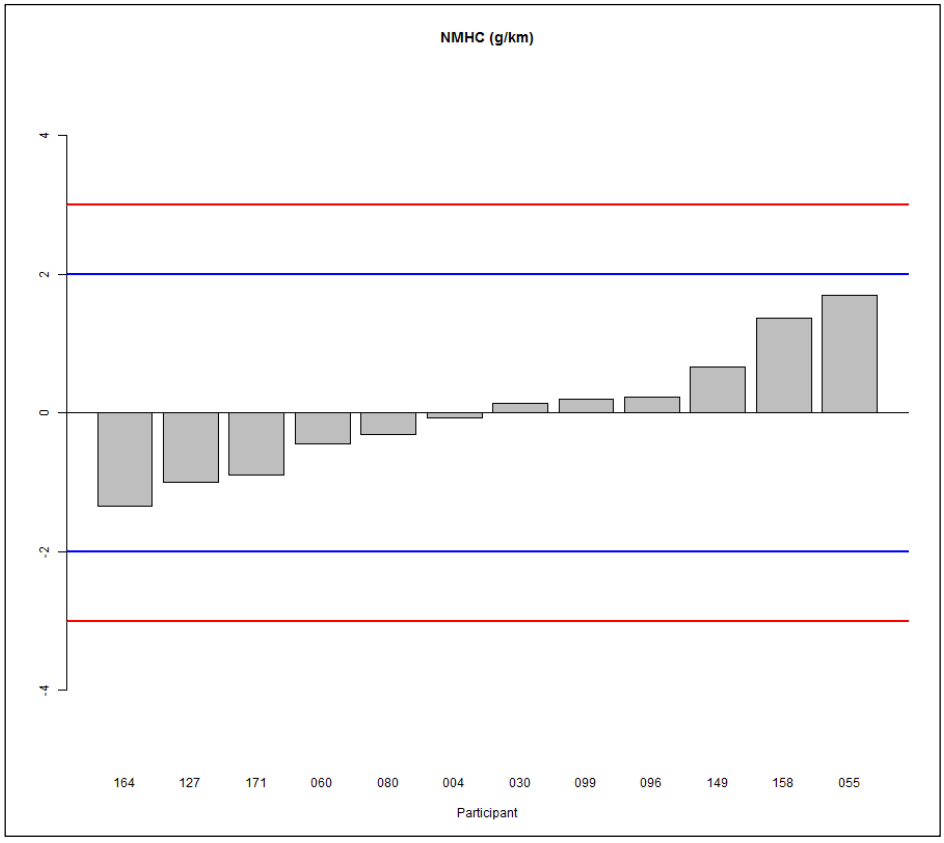

Figure 15 – z-score graph for NMHC – urban and road cycle.

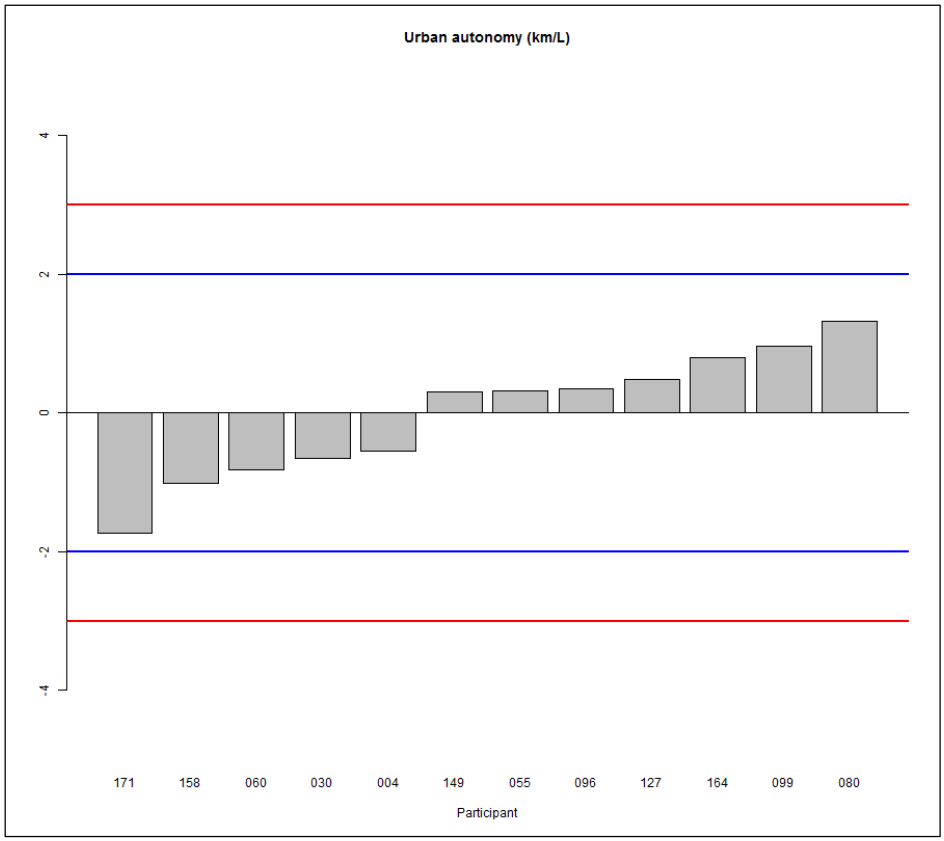

Figure 16 – z-score graph for urban autonomy – urban and road cycle.

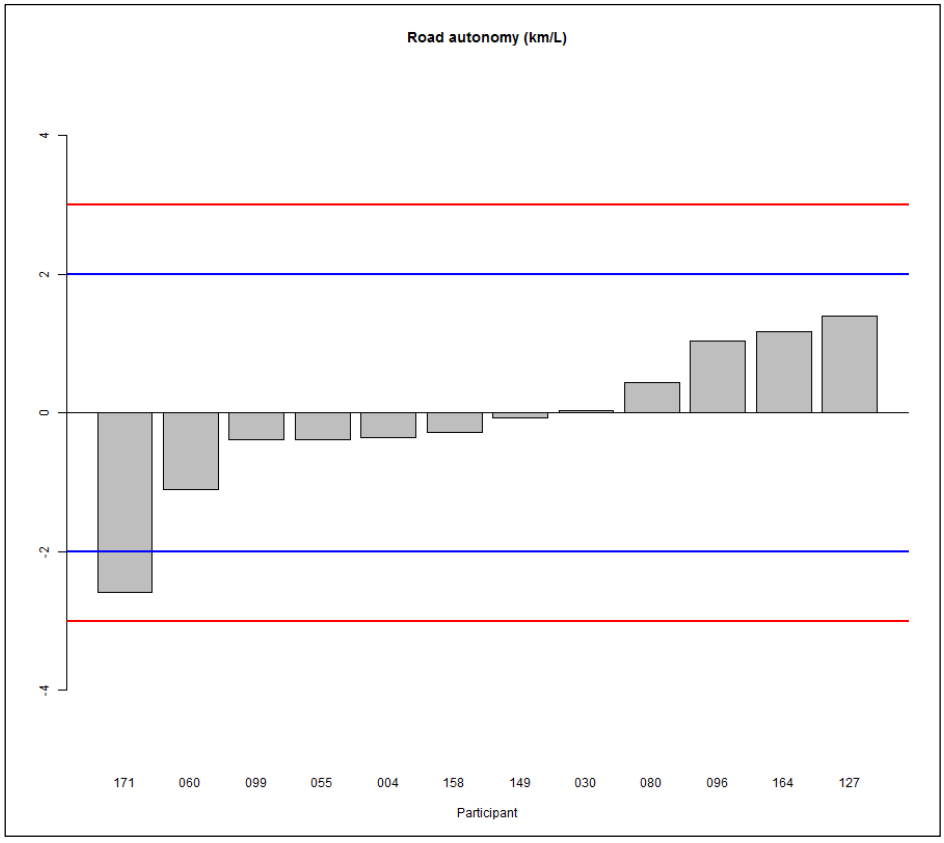

Figure 17 – z-score graph for road autonomy – urban and road cycle.

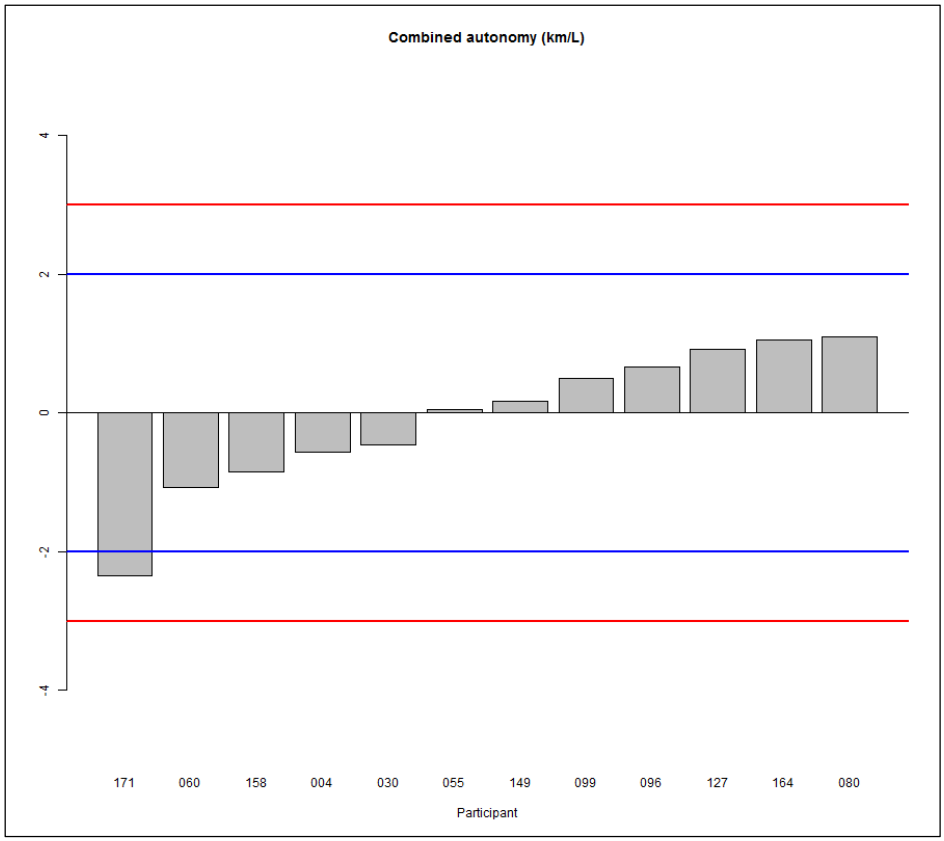

Figure 18 – z-score graph for combined autonomy– urban and road cycle.

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

CO (g/km): 12 participants presented satisfactory results;

CO_2 (g/km): 12 participants presented satisfactory results;

THC (g/km): 12 participants presented satisfactory results;

NMHC (g/km): 12 participants presented satisfactory results;

Urban Autonomy (km/L): 12 participants presented satisfactory results;

Road Autonomy (km/L): 11 participants presented satisfactory results. Participant 171 was out of Ref ± 1s interval, presented questionable result.

Autonomy Combined (km/L): 11 participants presented satisfactory results. Participant 171 was out of Ref ± 1s interval, presented questionable result.

7.2.2. Particulate Matter - *z* Score

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 particulate matter parameter. Table 12 and figure 19 show these results.

Table 12 – z score values for the particulate matter parameter.

Code	Particulate matter
	z score
011	0.83
022	1.43
024	0.18
046	0.72
051	0.84
083	-1.19
131	-1.32
133	-0.09
145	-0.45
157	-0.44
162	-0.49

* Satisfactory result
* Questionable result
* Unsatisfactory result

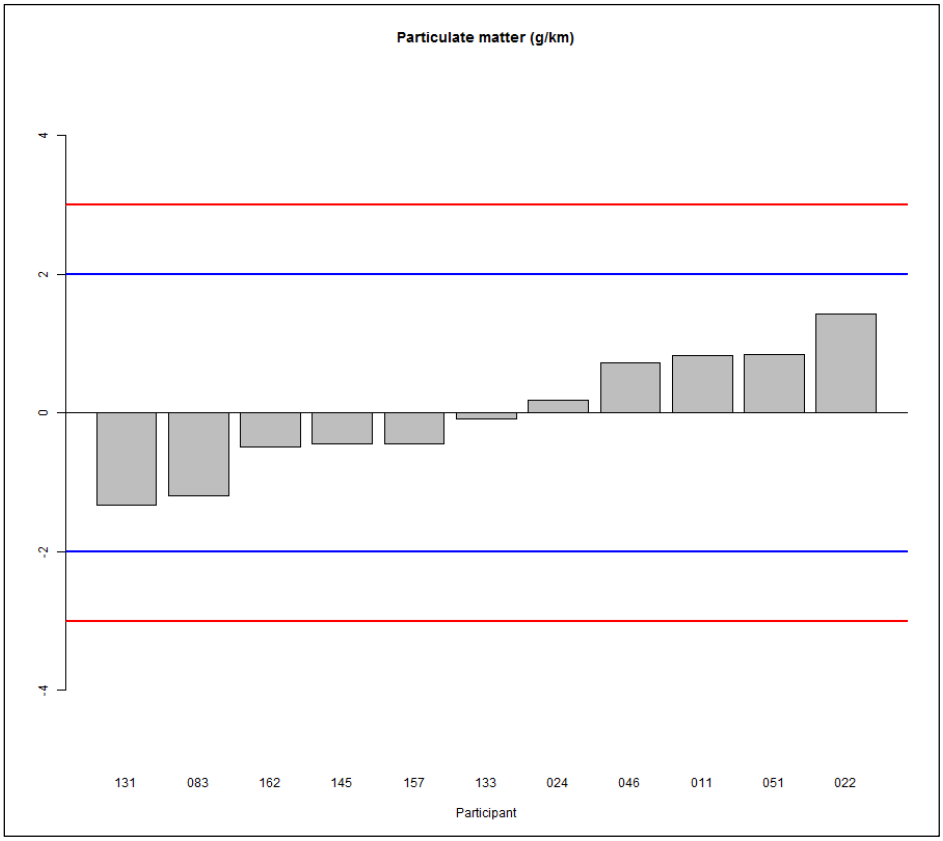

Figure 19 – *z* score graph for particulate matter.

Through the *z* score graphs, it can be seen that:

Particulate Matter**:** 11 participants presented satisfactory results.

7.2.3. NO_x

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 NO_x parameter. Table 13 and figure 20 show these results.

Table 13 – z score values for the NO_x parameter.

Code	NO_x
	z score
032	-0.43
040	0.61
071	**24.26**
086	**-2.73**
106	-0.81
107	-1.04
112	0.75
126	0.93

Code	NO_x
	z score
151	0.37
154	0.93
163	**26.33**
165	0.18

* Satisfactory result
* Questionable result
* Unsatisfactory result

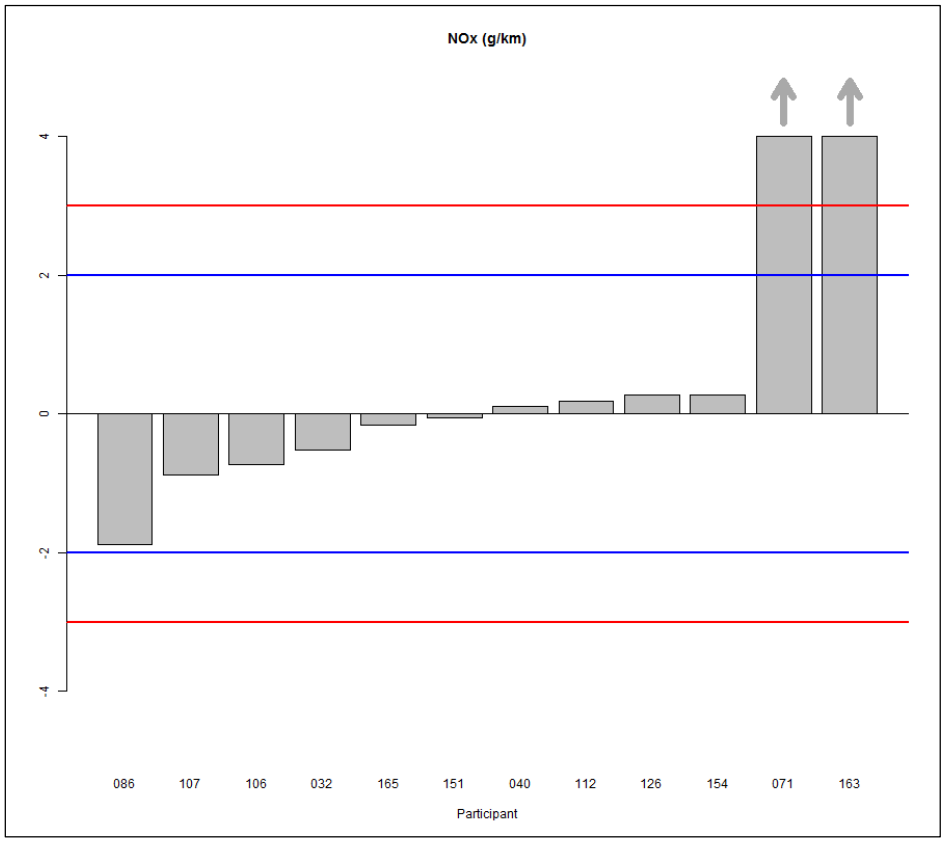

Figure 20 – z-score graph for NO_x

NO_x (g/km): 9 participants presented satisfactory results. Participant 086 presented result out of Ref ± 1s interval, presented questionable result. Participants 071 e 163 were out of Ref ± 2s interval, presented unsatisfactory results.

7.2.4. Opacity

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 opacity parameter. Table 14 and figure 21 show these results.

Table 14 – z score values for the opacity parameter.

Code	Opacity
	z score
052	-0.55
058	0.14
113	1.44
168	-0.21
181	-0.82

* Satisfactory result
* Questionable result
* Unsatisfactory result

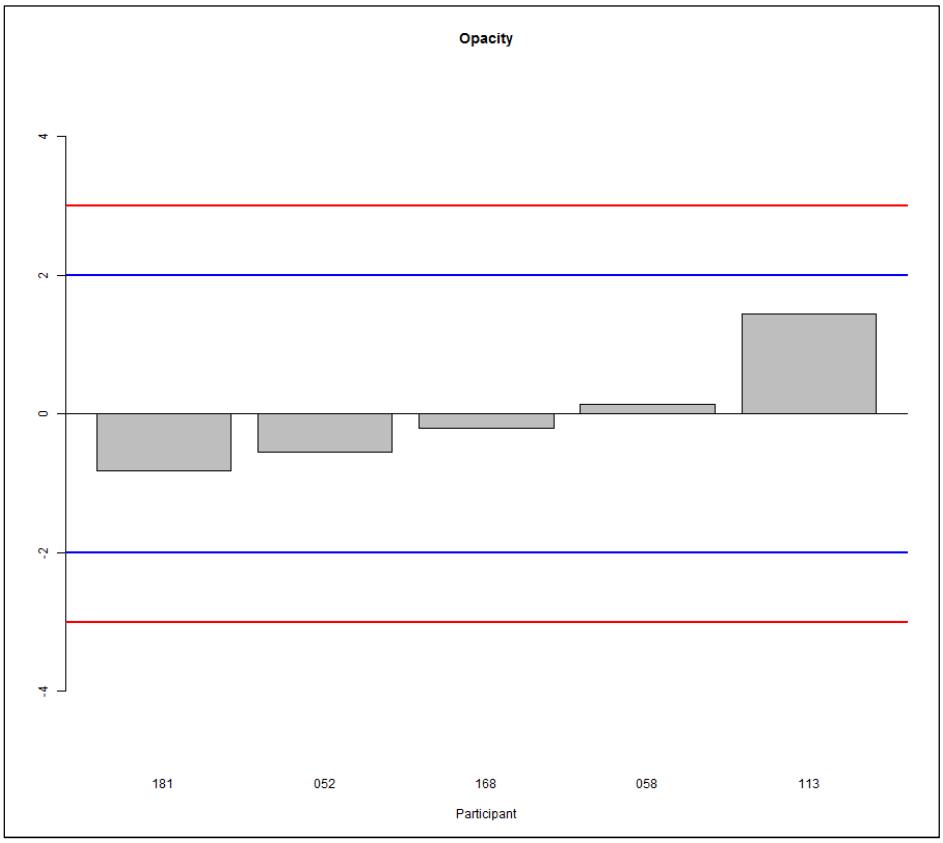

Figure 21 – z-score graph for opacity.

Opacity: 5 participants presented satisfactory results.

8. Analysis Testimony

As established in the proficiency testing protocol, Cetesb representative witnessed one of the PT three measurements at each laboratory participant.

Cetesb sent a conclusion regarding its testimony result to the PT Coordination by email, indicating there was no occurrence of non-compliance, not being necessary sending the witnessed results reports to the PT Coordination.

It should be noted that, in case Cetesb register the occurrence of non-compliance to the PT Coordination, the participant's results would be invalidated and, thus, its data would not figure in the PT report.

9. Confidenciality

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 the General Accreditation 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 diesel 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 quite satisfactory and this initiative is very important to the industry and society along these ten rounds held in collaboration between Inmetro and AEA.

This PT round involved 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 and unsatisfactory performance to critically evaluate their measurement methods.

It is worth mention that this 10th PT round was the first time a diesel car was used and the results can be considered quite satisfactory. Previous works were fundamental to achieve this PT results. In general, results continue to improve in relation to the last round results.

Among 252 results of urban and road cycle evaluated by z score, 97.61 % presented satisfactory results, 2.38 % presented questionable results in two distinct parameters. Among 33 results for particulate Matter, 100 % presented satisfactory results. Among 27 results for NO_x, 75 % presented satisfactory results, 8.30 % presented questionable results e 16.70 % presented unsatisfactory results. Among 15 results for opacity, 100 % presented satisfactory results.

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. Participants

Fourteen participants were registered in the 10th round of the Proficiency Testing in Vehicles Emissions, but two participants did not send their results report because of equipment problems and informed it to the PT coordination. Thus, 12 participants remained.

The list of laboratories that sent results to this PT coordination is presented in Table 15. It is important to note that the numbering of laboratories in the table only indicates the number of PT participants, under no circumstances it is associated to laboratory identification in presenting their results.

Table 15 – Participants.

	Institution
1.	CAOA Montadora de Veículos Centro de Pesquisas e Eficiência Energética
2.	Cetesb Companhia Ambiental do Estado de São Paulo Laboratório de Emissão Veicular - São Bernardo
3.	Continental Brasil Indústria Automotiva Ltda. Laboratório de Emissões Veiculares
4.	Faculdades Católicas Centro de Desenvolvimento em Energia e Veículos
5.	FCA Fiat Chrysler Automóveis Brasil Ltda. Laboratório de Emissões e Consumo
6.	Ford Motor Company Brasil Ltda. Laboratório de Emissões do Campo de Provas de Tatuí

	Institution
7.	General Motors do Brasil Ltda. Laboratório de Emissões do Campo de Provas de Cruz Alta
8.	Hyundai Motor Brasil Montadora de Automóveis Ltda. Centro de Pesquisa e Desenvolvimento HMB
9.	Instituto de Tecnologia para o Desenvolvimento – Institutos LACTEC LEME – Laboratório de Emissões Veiculares
10.	Toyota do Brasil Ltda. Laboratório de Emissões Indaiatuba
11.	Umicore Brasil Ltda. Laboratório de Emissões Veiculares - Umicore
12	Volkswagen do Brasil Ltda. Laboratório de Emissões Veiculares da Volkswagen do Brasil Ltda.

Total participants: 12.

12. References

- ABNT NBR ISO/IEC 17025:2005: Requisitos gerais para a competência de laboratórios de ensaio e calibração.
- ABNT NBR ISO/IEC 17043:2011: Avaliação de Conformidade – Requisitos Gerais para ensaios de proficiência.
- ISO 13528:2015 (E), *"Statistical methods for use in proficiency testing by interlaboratory comparisons"*.
- Vocabulário Internacional de Metrologia: conceitos fundamentais e gerais e termos associados (VIM 2012). 1ª Edição Luso–Brasileira.
- ABNT NBR 6601:2012: "Veículos rodoviários automotores leves — Determinação de hidrocarbonetos, monóxido de carbono, óxidos de nitrogênio, dióxido de carbono e material particulado no gás de escapamento".
- ABNT NBR 7024:2017: "Veículos rodoviários automotores leves - Medição do consumo de combustível - Método de ensaio".
- ABNT NBR 13037:2001: "Veículos rodoviários automotores - Gás de escapamento emitido por motor diesel em aceleração livre - Determinação da opacidade".
- ABNT NBR 8689:2012: "Veículos rodoviários automotores leves — Combustíveis para ensaio — Requisitos".

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