1. The purpose of the project and the proposed activities

The purpose of the project is the evaluation of the accuracy of the PM2.5 and PM10 particulate matter concentration measurement performed with the *uRADMonitor A3* equipment produced by SC MAGNASCI SRL Timisoara; to achieve the purpose of the project, the following activities are being planned:

A1 - Obtaining input data to establish the accuracy of the measurements - requires the determination of PM10 and PM2.5 particulate matter concentrations in parallel using the uRADMonitor A3 equipment and applying the gravimetric reference method according to SR EN 12341: 2014; duration of measurements: 30 calendar days; Averaging time: 24 hours.

A2 - Statistic data processing and interpretation in order to evaluate the accuracy of the automated method and determine the correction coefficient / correlation if applicable;

A3 - Elaboration of the Research Report containing the data / information used and the results of the research.

2. Accuracy - general considerations

2.1 **Definition of terms** – *SR ISO* $5725_{1\div6}$*:2002 series of standards*

In accordance with *SR ISO* $5725_{1\div6}$*:2002*, the accuracy (trueness and precision) of measurement methods and measurement results, accuracy reflects the degree of concordance between the result of an attempt and the accepted reference value. In order to characterize the accuracy of a method, the *SR ISO* $5725_{1\div6}$*:2002* series of standards uses two terms, " trueness" and "precision". Trueness refers to the degree of closeness between the arithmetic mean of a large number of test results and the true or accepted reference value. It should be noted that the two arithmetic means are compared when certified reference materials are used. Precision refers to the degree of closeness or scattering of the test results.

The general term of accuracy is used to refer to trueness and precision, at the same time.

Evaluating the trueness of a method involves comparing the value of the acquired results by applying the tested method, which may be a certified reference material (if present) or may be the result of measurement by another method, preferably a reference one. It is usually expressed based on the error of trueness (the difference between the average of the results of a test and an accepted reference value).

Precision is the general term for the variability of the results of a repeated measurement; usually two conditions of precision are being calculated: repeatability and reproducibility that represent precision under repeatability conditions, respectively in reproducibility conditions. Precision is usually expressed based on the values of standard deviations obtained under repeatability / reproducibility conditions or as the repeatability / reproducibility limit - the value below which is located, with a probability of 95% , the absolute value of the difference between the two results of the same attempts obtained under repeatability / reproducibility conditions.

2.2 Demonstrating the equivalence of an alternative method (AM) by comparison with a reference method (RM)

The simplest and most general way to determine the accuracy of a method or the functioning of an equipment is to perform an experiment based on the repeated measurement of the concentration of a certified reference material to witch, its true conventional value and the associated uncertainty, it’s know. If, in the case of gaseous compounds, certified reference materials can be purchased and used in the form of gaseous mixtures under pressure, this is not yet possible in determining the concentration of particulate matter in the air.

Given the circumstances, the procedure that proves the equivalence with the reference method, can be used, to estimate the accuracy of an alternative method of determination or of an equipment operating on principles other than the standardized ones, ie gravimetric method according to SR EN 12341: 2014.

The procedure involves three steps:

- Obtaining the input data, ie making parallel determinations in the same environment, using the gravimetric reference method and using the two uRADMonitor A3 monitors provided by the beneficiary;
- Evaluation of the trueness and variability of the results;

➢ Establishing the equivalence relation between the results obtained by the reference method and the two monitors;

3. Evaluation of accuracy of PM2.5 and PM10 particulate matter concentration measurement performed with uRADMonitor A3 equipment of SC MAGNASCI SRL Timisoara

3.1 Presentation of equipment and test procedure

Monitor uRADMonitor A3 (Fig. 1) is a small size (enclosed in a 11cm box) and a weight of approx. 200g , fixed air quality monitoring station. The devices are installed in aluminum enclosure and show 4 variants of connectivity via: Ethernet cable, WiFi networks, GSM networks (2G / 3G) and LoRaWAN.

A3 detectors have a set of sensors that can measure the following air quality indicators: temperature, barometric pressure, humidity, volatile organic compounds (VOC), carbon dioxide, formaldehyde, particulate matter PM1, *PM2.5 si PM10,* ozone and noise levels.

Fig. 1 *uRADMonitor A3*, fixed air quality monitoring station

For measurement, the air, that is actively sucked by an electric pump, goes through a well defined route by the proximity of the sensors and is then eliminated in the atmosphere. The low consumption of approximately 1W, also allows powering with small solar panels. Monitors can be connected to the uRADMonitor global environmental monitoring network, based on several types of hardware, produced in Romanina, Europe.

For the test, PM2.5 and PM10 particulate matter were determined with two *uRADMonitor* monitors (Monitor A and Monitor B) in parallel with 2 Sven Leckel LVS3 type samplers, one equipped with PM2.5 and the other with PM10 according to the reference method for determination of PM2.5 and PM10 particulate matter concentration in air, SR EN 12341: 2014 (Figure 2); daily averaging of the particulate matter concentration was performed, the sampling being carried out with a flow rate of 2.3 m3 / h for a period of 24 hour. The gravimetric method involves determination by weighing with a balance of 0.001mg resolution of the mass of particulate matter retained on the filters and its ratio to the volume of air drawn; usually for indoor and ambient air, the concentration of particulate matter is expressed in μg / m3.

Fig. 2 *uRADMonitor A3* units and the sampling units Sven Leckel LVS3.

Tests ran from Nov 13, 2018 to Dec 11, 2018. The two Sven Lecke ILVS3 samplers, one for PM10 and the other for PM2.5, particulate matter extraction, were installed on the third floor of the ECOIND building; in the immediate vicinity (Fig. 2) were mounted both monitors, in a vertical position, on the wall.

The two monitors *uRADMonitor A3* (monitor A and monitor B) continuously measured and recorded the measurement results at 1 minute for both PM10 and PM2.5; the results of the measurements, the daily averages, are found in Table 1 together with the results obtained by the reference method. Determination of particulate matter concentration according to the reference method, SR EN 12341:2014, requires their sampling with dedicated samplers, equipped with impactor heads for separating the two dimensional fractions, PM10 and PM2.5, on uniquely identified quartz filters, Ø45 mm, conditioned beforehand by maintaining in controlled atmosphere at 20^0C and 50% humidity, brought to constant and weighed. Exposure is done for a period of 24 hours, followed by conditioning under the same conditions as before sampling, bringing to constant and weighing. The weight gain of filters is the mass of particulate matter retained from the volume of air drawn over a 24-hour period with a flow rate of 2.3 m3 / h.

Table 1. Results of parallel measurements of the PM10 and PM2.5 particulate matter concentration

Perioada	PM 2.5, µg/m^3					PM 10, µg/m^3				
	RM	A	B	D_A	D_B	RM	A	B	D_A	D_B
13-14.11.2018	18.2	17.7	19.5	0.5	-1.3	22.4	21	23.7	1.4	-1.3
14-15.11.2018	16.7	15.5	16.3	1.2	0.4	19.5	18.4	20.1	1.1	-0.6
15-16.11.2018	16.5	17.6	18	-1.1	-1.5	21.1	20.7	22	0.4	-0.9
16-17.11.2018	12.4	13.5	12.3	-1.1	0.1	15.6	16.1	15.4	-0.5	0.2
20-21.11.2018	18.2	16.75	17.3	1.5	0.9	19.7	19.92	21.18	-0.2	-1.5
21-22.11.2018	13.1	12.3	11.97	0.8	1.1	15.0	14.81	15.22	0.2	-0.2
22-23.11.2018	28.3	27.64	30.28	0.7	-2.0	33.2	32.2	35.87	1.0	-2.7
23-24.11.2018	25.1	24.43	26.51	0.7	-1.4	29.6	28.66	31.75	0.9	-2.2
26-27.11.2018	18.7	18.94	20.04	-0.2	-1.3	22.7	22.35	24.3	0.3	-1.6
27-28.11.2018	9.9	10.76	10.14	-0.9	-0.2	14.0	13.01	13.02	0.9	0.9
28-29.11.2018	8.9	9.6	8.51	-0.7	0.4	12.2	11.93	11.38	0.3	0.8
29-30.11.2018	9.6	10.5	9.45	-0.9	0.2	11.9	12.88	12.38	-1.0	-0.5
3-4.12.2018	54.0	50.35	56.17	3.7	-2.1	60.1	58	65.42	2.1	-5.3
4-5.12.2018	53.2	51.57	57.25	1.6	-4.1	62.3	59.33	66.41	3.0	-4.1
5-6.12.2018	47.2	45.5	51.53	1.7	-4.3	56.9	52.47	60.02	4.4	-3.1
6-7.12.2018	31.2	31.65	33.62	-0.4	-2.4	39.2	36.74	39.64	2.5	-0.4
10-11.12.2018	41.3	40.02	43.77	1.3	-2.5	48.2	46.28	51.16	1.9	-3.0
average	24.8	24.4	26.0	0.5	-1.2	29.5	28.5	31.1	1.1	-1.5
stdev	15.27	14.33	16.69	1.29	1.62	17.14	16.25	18.92	1.36	1.72
minimum	8.9	9.6	8.5	-1.1	-4.3	11.9	11.9	11.4	-1.0	-5.3
maximum	54.0	51.6	57.3	3.7	1.1	62.3	59.3	66.4	4.4	0.9

RM - the concentration obtained with the reference method, µg/m3
A - concentration obtained with Monitor A, µg/m3
B - concentration obtained with monitor B, µg/m3
D_A - the difference between the concentration obtained with the reference method and the concentration obtained with the monitor A, µg/m3
D_B- the difference between the concentration obtained with the reference method and the concentration obtained with the monitor B, µg/m3

In order to verify the accuracy of the measurements of the two monitors, the obtained results were analyzed by the Pearson statistical correlation method and were compared with the results obtained by the gravimetric reference method.

The results of the statistical correlation analysis (Table 2) show a very good direct correlation between the results with values of the correlation coefficient r of 0.998 between the PM2.5 and the monitor A and of 0.999 for all the other situations.

All analyzes and statistical tests in this paper were performed with SPSS 20.0 program.

Table 2. Results of the statistical correlation analysis between the values obtained for the particulate matter concentration by the reference method and the results of the measurements indicated by the monitors A and B.

		PM2.5	A2.5	B2.5	PM10	A10	B10
PM2.5	Pearson Correlation	1					
	Sig. (2-tailed)						
A2.5	Pearson Correlation	.998**	1				
	Sig. (2-tailed)	.000					
B2.5	Pearson Correlation	.999**	.999**	1			
	Sig. (2-tailed)	.000	.000				
PM10	Pearson Correlation	.997**	.999**	.999**	1		
	Sig. (2-tailed)	.000	.000	.000			
A10	Pearson Correlation	.998**	1.000**	.999**	.999**	1	
	Sig. (2-tailed)	.000	.000	.000	.000		
B10	Pearson Correlation	.999**	.999**	1.000**	.999**	.999**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	

**. Correlation is significant at the 0.01 level (2-tailed).
PM 2.5 ; PM10 – particulate matter concentrations determined by the reference method
A 2.5 ; A10 – Particulate matter concentrations indicated by monitor A
B 2.5 ; B10 – Particulate matter concentrations indicated by Monitor B

The same correlation analysis applied to the difference (D_A, D_B) between the concentration of particulate matter determined by the reference method and the values indicated by the two monitors, also indicates good and very good correlations between these data series (Table 3).

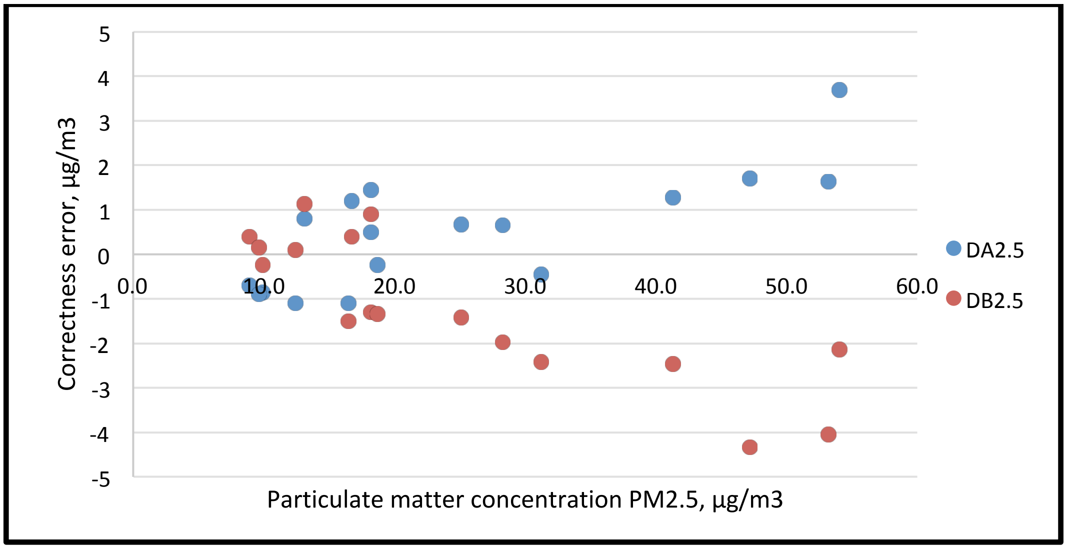
Table 3. The results of the statistical correlation analysis between the values obtained for the particulate matter concentration by the reference method and the differences (D_A, D_B) between the particulate matter concentration value determined by the reference method and the values indicated by the two monitors.

		PM2.5	DA2.5	DB2.5	PM10	DA10	DB10
PM2.5	Pearson Correlation	1					
	Sig. (2-tailed)						
DA2.5	Pearson Correlation	.764**	1				
	Sig. (2-tailed)	.000					
DB2.5	Pearson Correlation	-.850**	-.381	1			
	Sig. (2-tailed)	.000	.132				
PM10	Pearson Correlation	.997**	.721**	-.882**	1		
	Sig. (2-tailed)	.000	.001	.000			
DA10	Pearson Correlation	.825**	.547*	-.858**	.854**	1	
	Sig. (2-tailed)	.000	.023	.000	.000		
DB10	Pearson Correlation	-.905**	-.832**	.709**	-.879**	-.591*	1
	Sig. (2-tailed)	.000	.000	.001	.000	.012	

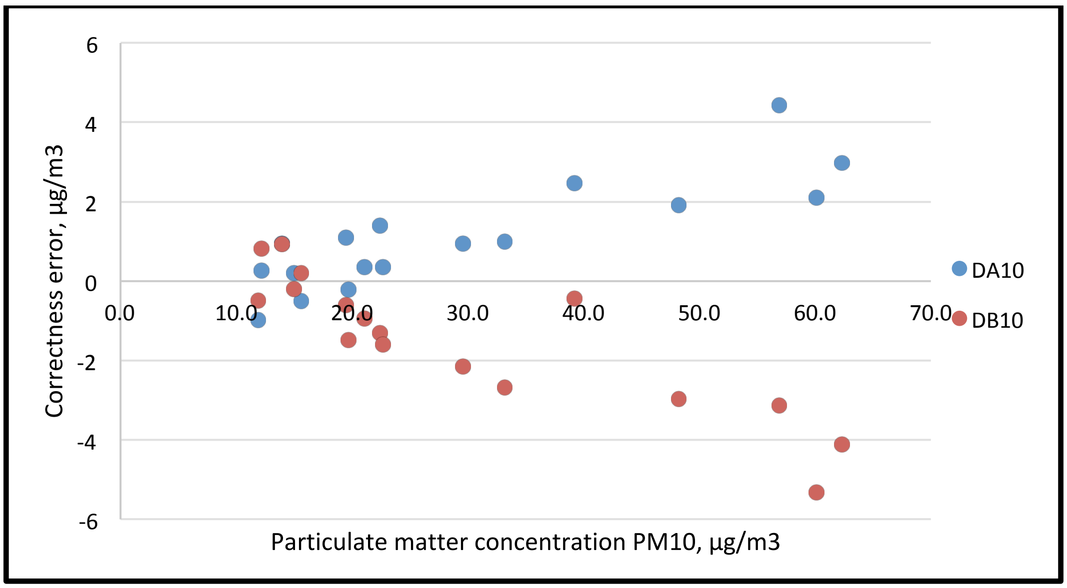
**. Correlation is significant at the 0.01 level (2-tailed) ; *. Correlation is significant at the 0.05 level (2-tailed).
PM 2.5 ; PM10 – particulate matter concentrations determined by the reference method
DA 2.5 ; DA10 – the difference between the particulate matter concentration determined by the reference method and the value determined by monitor A;
DB 2.5 ; DB10 – the difference between the particulate matter concentration determined by the reference method and the value determined by monitor B;

3.2 Determination of trueness and variability as components of accuracy and determination of the equivalence relation between the results obtained by the reference method and the indications of the two monitors

As described in Section 2.1, the value of trueness is usually expressed by the *trueness error*, ie the difference between the value obtained by the tested equipment and the value obtained by the reference method, values which are found in Table 1 on the columns D_A and D_B corresponding to the PM10 and PM2.5 particulate matters for each set of daily measurements. The diagram of trueness error variation in relation to the concentration of particulate matter determined by the reference method (Figure 3) reveals a random variation of trueness errors around 0 to about 20μg / m3 for both PM2.5 and PM10, for both monitors. For higher concentrations, an increase of the absolute value of the trueness error with the concentration for both monitors is predominantly observed, but in different directions; so if for the monitor A, the trueness error values increase as positive values, in the case of the monitor B, the trueness errors increase but in negative values.



(a)



(b)

Fig. 3 Variation of trueness errors based on the concentration obtained by the reference method for PM2.5 (a) and PM10 (b); DA, DB – the trueness error for monitor A and B respectively.

These observations are also supported by the values of Pearson correlation coefficients for trueness error (D_A and D_B in Table 3); thus, in the case of the monitor A, is noted a good direct correlation for PM2.5 ($r_{PM2.5}$= 0.764) and a very good direct correlation for PM10 (r_{PM10} = 0.854), respectively, on the tested concentration range, when the concentration of particulate matter grows, same does the error of trueness. In monitor B, however, we notice exactly the opposite behaviour, on the same concentration range; the correlation for the monitor B with the trueness error (D_A si D_B in Table 3) is inversely, very good ($r_{PM2.5}$=-0.850; r_{PM10}=-0.879), respectively, on the tested concentration range, for the increase of concentration of particulate matter in the air the error of trueness decreases to negative values.

3.2.1 Examination of acceptability conditions for accuracy

Accuracy acceptability conditions are:

1) *the variability condition: to be in line with the uncertainty established by the environmental regulations in force (SR EN 14181/2015 - Emissions from fixed sources. Ensuring the quality of the automatic measuring systems) for this test, namely 25% of the Limit Value (VL) established by Law 104/2011 - Law on the ambient air quality; according to this regulation VL for PM10 is 50µg / m3 for daily average. For PM2.5, European regulations do not establish VL for daily averaging; in these conditions, for examination we used a daily VL of 35µg / m3 established by US EPA .*
2) *r ≥ 0.97 according to SR EN 14793: 2017- Emissions from fixed sources. Demonstration of equivalence of an alternative method with a reference method, r representing the value of the correlation coefficient between the two compared methods, respectively between the measurments of the A and B monitors and the value obtained using the reference method;*

The results of these tests are found in Table 4. It can be seen that both conditions are satisfied both by monitor A and monitor B:

1) the modulus of the maximum values of the trueness errors are less than the absolute uncertainty value for k = 2 (U_{abs}, µg / m3) of 8.75 µg / m3 value for PM2.5 and 12.5 µg / m3 value for PM10;

2) the correlation coefficient values are greater than 0.97, respectively r = 0.99 for both monitors and dimensional fractions of particulate matter.

Table 4. The acceptance test results for trueness error

Parameter	PM 2.5, µg/m³		PM 10, µg/m³	
	D_A	D_B	D_A	D_B
minimum	-1.1	-4.3	-1.0	-5.3
maximum	3.7	1.1	4.4	0.9
Limit value, µg/m³	35		50	
U_{rel}, % din VL	±25 for k=2		±25 for k=2	
U_{abs}, µg/m³	±8.75 for k=2		±12.5 for k=2	
$\lvert maxD \rvert < U_{abs}$	3.7 < 8.75	4.3 < 8.75	4.4 <12.5	5.3 <12.5
correlation coeff., *r*	0.998	0.999	0.999	0.999

3.2.2 Establishing the relation of equivalence between the results of the two monitors and the trueness error value

Considering the good and very good correlation between the particulate matter concentration values indicated by the two monitors and the corresponding trueness error (Table 5a, b), the calculation relation coefficients values for the trueness error value(Y_{PM}) were determined by linear regression based on the value indicated by the monitor (x_{PM}).

Based on these relations, the trueness error value, µg / m3, corresponding to the indication of A and B monitors, can be calculated.

Table 5 Results of the statistical correlation analysis between the values indicated by the two monitors (A, B) and the corresponding trueness errors (D_A, D_B): a) for PM2.5 and b) for PM10

	A2.5	B2.5	DA2.5	DB2.5
A2.5	1			
B2.5	.999** .000	1		
DA2.5	.725** .001	.737** .001	1	
DB2.5	-.873** .000	-.876** .000	-.381 .132	1

(a)

	A10	B10	DA10	DB10
A10	1			
B10	.999** .000	1		
DA10	.830** .000	.839** .000	1	
DB10	-.892** .000	-.899** .000	-.591* .012	1

(b)

The linear regression analysis results, respectively the regression coefficients values(B in Fig. 3) and their statistical significance (Sig.) as well as the trueness error estimation relation according to the value indicated by the monitors are found in Fig.3.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.107	.452		-2.448	.027
	A2.5	.066	.016	.725	4.076	.001

a. Dependent Variable: DA2.5

$$\mathbf{Y_{PM2.5\text{-}A} = 0.066 \times_{PM2.5\text{-}A} - 1.107}$$

(a)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.042	.372		2.804	.013
	B2.5	-.085	.012	-.876	-7.028	.000

a. Dependent Variable : DB2.5

$$\mathbf{Y_{PM2.5\text{-}B} = -\,0.085 \times_{PM2.5\text{-}B} + 1.042}$$

(b)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.879	.392		-2.243	.040
	A10	.069	.012	.830	5.768	.000

a. Dependent Variable : DA10

$$\mathbf{Y_{PM10\text{-}A} = 0.069 \times_{PM10\text{-}A} - 0.879}$$

(c)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.033	.370		2.790	.014
	B10	-.081	.010	-.899	-7.941	.000

a. Dependent Variable : DB10

$$\mathbf{Y_{PM10\text{-}B} = -\,0.081 \times_{PM10\text{-}B} + 1.033}$$

(d)

Fig. 4 The linear regression analysis result and the trueness error estimation relashionshp according to the value indicated by the monitors for: a) PM2.5 measured with monitor A; b) PM2.5 measured with Monitor B; c) PM10 measured with Monitor A; d) PM10 measured with Monitor B;

In these circumstances, given the computational relashionship, for each value indicated by the monitor, an appropriate trueness error value can be calculated and assigned, a value that can be referred to as a trueness error or with which corrections of the indicated value can be performed.

Thus, for an indication of the monitor A of 16.7 µg / m3 of PM10 particulate matter, we can mention a trueness error calculated with the equation from Fig. 4c, , $\mathbf{Y_{PM10\text{-}A} = 0.069\ x_{PM10\text{-}A} - 0.879}$, of 0.2733 µg / m3, or, the reported result can be corrected with a trueness error reporting a new value of 16.97 µg / m3.

3.2.3 Establish the correction relation between the results of the two monitors and the reference method

Starting from the very good correlation between the particulate matter concentration values determined by the reference method and the values indicated by the two *uRADMonitor A3* monitors correction relations were obtained by the linear regression method. The results of the analysis and correction equations of the form $\boldsymbol{Y = C_1\ x + C_0}$ are presented in Fig. 5, where Y represents the corrected values of the monitors indications, x, and *C0, C1* represents the regression coefficients, respectively the ordinate at origin (*C0*) and the slope of the regression curve (*C1*).

By using these correction relations, in the case where reporting the accuracy is not required, the corrected value can be calculated in relation to the reference method.

In the previous example for a monitor A indication of 16.7 µg / m3 PM10 particulate matter, the corrected value is 16.98 µg / m3 calculated with the relation from Fig. 5c, $\mathbf{Y_{PM10\text{-}A} = 1.069\ x_{PM10\text{-}A} - 0.863}$.

For automated monitoring systems, as is the case of *uRADMonitor A3* monitors , these correction relations can be included in the software's equipment, the monitors indicate the corrected values and the trueness error is compensated in this case.

We mention that these relations are applicable only on the tested concentration ranges with an extrapolation of maximum 10%; domain limits are given by the minim, respectively maxim in Table 1, for each dimensional fraction of particulate matter and monitor.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.110	.448		-2.475	.026
	A2.5	1.065	.016	.998	66.665	.000

a. Dependent Variable: PM2.5

$$\mathbf{Y_{PM2.5\text{-}A} = 1.065 \; x_{\;PM2.5\text{-}A} - 1.110}$$

(a)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.031	.371		2.775	.014
	B2.5	.915	.012	.999	75.521	.000

a. Dependent Variable: PM2.5

$$\mathbf{Y_{PM2.5\text{-}B} = 0.915 \; x_{\;PM2.5\text{-}B} + 1.031}$$

(b)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.863	.395		-2.187	.045
	A10	1.069	.012	.999	88.292	.000

a. Dependent Variable: PM10

$$\mathbf{Y_{PM10\text{-}A} = 1.069 \; x_{\;PM10\text{-}A} - 0.863}$$

(c)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.059	.368		2.876	.012
	B10	.918	.010	.999	90.071	.000

a. Dependent Variable: PM10

$$\mathbf{Y_{PM10\text{-}B} = 0.918 \; x_{\;PM10\text{-}B} + 1.059}$$

(d)

Fig. 5 Analysis results of linear regression and the correlation relation between the two monitor indications for: a) PM2.5 measured with monitor A; b) PM2.5 measured with Monitor B; c) PM10 measured with Monitor A; d) PM10 measured with monitor B.

CONCLUSIONS

Based on the conducted tests and the obtained results, we can assume that the two uRADMonitor A3 monitors produced by SC MAGNASCI SRL Timisoara, subjected to tests for accuracy measurements evaluation, can be used for the continuous monitoring of the PM2.5 and PM10 particulate matter in the air, their performances aiming at measuring accuracy, fit in acceptability conditions, as follows:

1) *meets the variability condition: it falls within the uncertainty established by the environmental regulations in force*, below 25% of the Limit Value (VL) for PM10 of 50µg / m3 for daily averaging and, 25% of the Limit Value (VL) for PM2.5 of 35µg / m3 according to USEPA.
2) *the correlation coefficient between* the A and B monitor indications and the obtained value using the reference method r ≥ 0.97, respectively r = 0.99 for both monitors and dimensional fractions of particulate matter. The results of these tests are found in Table 1.

Table 1. Results of acceptability tests

Parameter	**PM 2.5, µg/m³**		**PM 10, µg/m³**	
	D_A	**D_B**	**D_A**	**D_B**
minimum	-1.1	-4.3	-1.0	-5.3
maximum	3.7	1.1	4.4	0.9
Limit value, µg/m³	35		50	
U_{rel}, % din VL	±25 for k=2		±25 for k=2	
U_{abs}, µg/m³	±8.75 for k=2		±12.5 for k=2	
ImaxDI<U_{abs}	3.7 < 8.75	4.3 < 8.75	4.4 <12.5	5.3 <12.5
correlation coeff., *r*	0.998	0.999	0.999	0.999

D_A; D_B – the difference between the particulate matter concentration determined by the reference method and the results indicated by the A, B monitor;
U_{rel} – relative uncertainty,% of VLE
U_{abs} – absolute uncertainty, µg / m3
ImaxDI – the modulus of maximum value of the difference between the values obtained by the reference method and the result indicated by A, B monitor;

Considering the good and very good correlation between the particulate matter concentration values indicated by the two monitors and the corresponding trueness error, the calculation relation coefficients values for the trueness error value (Y_{PM}) were determined by linear regression based on the value indicated by the monitor (x_{PM}).

Based on these equations (Table 2) the trueness error value, µg/m3, corresponding to the indication of A and B monitors, can be calculated.

Table 2. Equations for calculating the trueness error for the concentration measurement of particulate matter with *uRADMonitor A3* monitors

Trueness error coresponding the concentration measurement of :	Equation
PM2.5 with monitor A	$Y_{PM2.5-A} = 0.066\ x_{PM2.5-A} - 1.107$
PM10 with monitor A	$Y_{PM10-A} = 0.069\ x_{PM10-A} - 0.879$
PM2.5 with monitor B	$Y_{PM2.5-B} = -\ 0.085\ x_{PM2.5-B} + 1.042$
PM10 with monitor B	$Y_{PM10-B} = -\ 0.081\ x_{PM10-B} + 1.033$

Similarly, the correction relations (Table 3) indicated by the two monitors, were obtained, by linear regression. By using these correction relations, the corrected value can be calculated in relation to the reference method.

Table 3. Equations for calculating the trueness error, corresponding to particulate matter measurement concentration, with monitors *uRADMonitor A3*

The corrected value indicated by the monitors for :	Correction relations
PM2.5 with monitor A	$Y_{PM2.5-A} = 1.065\ x_{PM2.5-A} - 1.110$
PM10 with monitor A	$Y_{PM10-A} = 1.069\ x_{PM10-A} - 0.863$
PM2.5 with monitor B	$Y_{PM2.5-B} = 0.915\ x_{PM2.5-B} + 1.031$
PM10 with monitor B	$Y_{PM10-B} = 0.918\ x_{PM10-B} + 1.059$

For automated monitoring systems, as is the case of *uRADMonitor A3* monitors, these correction relations can be included in the equipment's software, the monitors indicating the corrected values and the trueness error being compensated, in this case.

We mention that these relations are applicable only on the tested concentration ranges with an extrapolation of maximum 10%; domain limits are given by the minim , respectively maxim values for each dimensional fraction of particulate matter and monitor.