Reg. No. 226/S-188

AST Report

FROM THE VERIFICATION OF CONTINUOUS EMISSION MONITORING SYSTEM

Installed in

CHP-2, Steam Boiler No. 4

AB "Vilniaus Šilumos tinklai"

Report No. **515/2019**

In Slovakia, Košice, December 05, 2019

Approved by

Ignác Kožej	**Miloš Varga**
managing director	manager of the measurements
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signature	signature
.....	
stamp	

CONTENT

Symbols

a	intercept of the calibration function
b	slope of the calibration function
D_i	difference between measured SRM value y_i and calibrated CEMS values $\hat{y}$
D_{avg}	average of D_i
EL	emission limit
i	index
k_v	test value for variability test based on a χ^2-test, with a β-value of 50 %, for n number of paired measurements
max	maximal value (as index)
n	number of paired samples in parallel measurements
p	pressure
S_c	standard deviation of the SRM
S_A	standard deviation (CEMS), CEMS integral performance
S_D	standard deviation of the differences D_i in parallel measurements
$t_{0,95}$	students t-factor for a confidence level of 95 %
x	CEMS measured signal
y	SRM measured value
$\hat{y}$	best estimate for the "true value"; calculated from CEMS signal x by means of calibration function
z_i	difference (according to meaning)
σ_0	uncertainty derived from requirements of legislation

Abbreviations

AMS	Automated Measuring System, also CEMS
AST	Annual Surveillance Test
CEMS	Continuous Emission Monitoring System, also AMS
CEN	Comité Européen de Normalisation
(C)RM	(Certified) Reference Material
ELV	Emission Limit Value
QAL	Quality Assurance Level
ISO	International Organization for Standardization
SRM	Standard Reference Method

Annexes

1 PARTICIPANTS OF TEST

1.1 OPERATOR

Name:	AB “Vilniaus Šilumos tinklai”
Address:	Elektrinės g. 2, LT-03150, Vilnius, Lithuania
Address of the plant:	Elektrinės g. 2, LT-03150, Vilnius, Lithuania
Contact:	Miroslavas Mečkovskis
ID:	124135580

1.2 THE OBJECTIVE OF THE AST TESTS

The purpose of the AST test was to verify the compliance of the continuous emission monitoring system with the requirements of EN 14181. The following components of CEMS have been verified within the frame of the tests: concentration of CO, O_2, NO_X (as NO_2), SO_2, dust, volume flow and humidity of flue gases.

Records of preparation measurement is in Annex No. 1.

1.3 EMISSION SOURCE

Heating and Power Plant, Chimney No. 5, Steam Boiler No. 4.

1.4 REPRESENTATIVES OF THE OPERATOR

Name	Position
Rimvydas Kvedaravičius	E2 head manager

2 TESTING LABORATORY

2.1 NAME OF TESTING LABOARTORY

Name:	EKO-TERM SERVIS s.r.o.
Address:	Napájadlá 11, 040 12 Košice, Slovakia
Contact:	Ing. Ignác Kožej
ID:	316 95 671

2.2 ACCREDITATION OF TESTING LABORATORY

Testing laboratory EKO-TERM SERVIS s.r.o. is accredited by Slovak National Accreditation Service.

The testing laboratory is qualified to carry out measurement of selected components of waste gases emitted into the atmosphere from stationary air emission sources, take samples of exhaust gases and to express opinions and interpretations by the scope of the accreditation according to the certificate No. S-188.

The inspection body is qualified to carry out inspection of Continuous Emission Monitoring Systems (complete functional test, periodic functional test and functional test according to the customer's requirements) in the scope of the accreditation according to the certificate No. I-029.

Calibration laboratory which is competent to carry out of calibration of automated measuring systems of stack emissions within the accreditation scope according to the certificate No. K-071.

2.3 PERSONEL OF TESTING LABORATORY

Name	Position
Ignác Kožej	managing director
Miloš Varga	manager of the measurements
Juraj Bél	manager of the testing and calibration laboratory
František Eperješi	technician
Maroš Kožej	

3 OBJECT OF THE TEST

3.1 DESCRIPTION OF THE PLANT

Combustion plant: continuous burning process.

Installation: Steam boiler No.4.

The plant produces steam in steam boiler room No. 4. The steam boiler produces steam which is used in steam turbines for producing of electricity.

Characteristic operating parameters of boiler: fuel consumption, quantity of steam, temperature and pressure of steam.

3.1.1 OPERATIONAL CONDITIONS

The basic operating modes of the boiler are start-up, steady state and shutdown.

The condenser (two sections) was operating during AST verification.

3.1.2 FUELS

The biofuel (boiler No. 4) was fired during AST. This fuel is used during normal operation.

3.1.3 BOILER

Steam boiler:

Designation:	**4**
Type:	BKZ-75-39FB
Fuel	Biofuel
Rated thermal input in MW:	60

The summary table of operating parameters of the biofuel boiler is listed in Annex No. 2 to this protocol.

3.1.4 PURIFICATION SYSTEMS OF WASTE GASES

- electrostatic precipitator (dry and wet system)

3.1.5 WASTE GAS HUMIDITY DECREASING SYSTEM

- economizer

3.2 MEASURING SITE AND PLACE OF INSTALLATION OF CEMS

3.2.1 CHIMNEY AND MEASURING SITE

- Chimney: detached, steel, double layer.
- The cross section of the chimney is circular, measuring site is located at height of 27 m and distance from the top of the chimney is 33 m.
- The diameter of the chimney at the measuring site: external – 2,9 m; internal – 2,2 m.
- Number of sampling points and straight lines (axes): points (on one line) - 8; lines – 2.
- Number of sampling holes: 2.

3.2.2 WORKING PLATFORM AND SECURITY OF THE MEASURING SITE

- Location of working platform - see Art. 3.2.1.
- Width of the working platform: 0,8 m.
- Access to the working platform: ladder.
- Stabile electric power supply is installed.

3.2.3 SAMPLING

The sampling of the wet flue gas for the determination of gaseous and solid pollutants is performed with steady installed extractive sampling system. The sampling is not isokinetic, and it is performed from one sampling point.

The samples for the determination of the concentrations of CO, NO, SO_2 and O_2 are taken with a heated sample probe (installed at 27 m) equipped with dust filter. The sample gas is drawn from the measuring probe into a heated sample line routed to the measuring cabinet (at ground level). The length of the heated line is 37 m. The sampling system and the system of conditioning of the samples of gaseous substances meet the requirements of ISO 10396.

The sampling of the wet flue gas for the determination of solid pollutants is not isokinetic and it is performed from one sampling point. The speed of the flue gas in the measuring section of the chimney is in the range from 11 to 23 m/s. The whole sampling system is heated and there is no condensation and modification of chemical and physical properties of the sample gas. The sampling system meets the requirements of ISO 10155 and EN 13284-2 (meets the requirements for the operating characteristics according to QAL1).

3.3 DESCRIPTION OF THE CEMS

3.3.1 CEMS FOR MONITORING OF GASEOUS POLLUTANTS (CO, NO_X) AND OXYGEN

- Manufacturer: SICK MAIHAK GmbH, Hamburg, Germany
- Model: SIDOR
- Type of monitoring technique: Dry basis extractive
- Serial No.: 761 287
- Measuring principle: CO, NO – NDIR
  O_2 – paramagnetic
- Measuring range: CO – (0 to 3000) mg/m^3
  NO – (0 to 2000) mg/m^3
  O_2 – (0 to 25) % vol.
- Analogue output signals (from 4 mA to 20 mA) for all components; offset: 4 mA.

3.3.2 CEMS FOR MONITORING OF GASEOUS POLLUTANTS (SO_2)

- Manufacturer: SICK MAIHAK GmbH, Hamburg, Germany
- Model: SIDOR
- Type of monitoring technique: Dry basis extractive
- Serial No.: 761 294
- Measuring principle: SO_2 – NDIR
- Measuring range: SO_2 – (0 to 1000) mg/m^3
- Analogue output signals (from 4 mA to 20 mA); offset: 4 mA.

3.3.3 CEMS FOR MONITORING OF DUST

- Manufacturer: SICK MAIHAK GmbH, Hamburg, Germany
- Model: FWE200
- Type of monitoring technique: Extraction of a partial flow of gas from the duct
- Serial No.: 0949 8542
- Measuring principle: Scattered light
- Measuring range: Dust – (0 to 200) mg/m^3 actual conditions
- Diameter of test gas probe: DN (20)
- Analogue output signals (from 4 mA to 20 mA); offset: 4 mA.

3.3.4 CEMS FOR MEASURING OF THE VOLUME FLOW (VELOCITY)

- Manufacturer: SICK MAIHAK GmbH, Hamburg, Germany
- Model: Flowsic 100
- Type of monitoring technique: Measuring the transit time difference of ultrasonic pulses
- Serial No.: 7042053
- Measuring principle: Ultrasonic
- Measuring range: Volume flow – (0 to 400000) m^3/h actual conditions
- Analogue output signals (from 4 mA to 20 mA) for all components; offset: 4 mA.

3.3.5 CEMS FOR MEASURING OF THE HUMIDITY

- Manufacturer: SICK MAIHAK GmbH, Hamburg, Germany
- Model: GMA 035
- Type of monitoring technique: In-Situ gas analyser
- Serial No.: 0949 8025
- Measuring principle: Opto-electronic
- Measuring range: Humidity – (0 to 100) % vol.
- Analogue output signals (from 4 mA to 20 mA); offset: 4 mA.

Determination of the Humidity

Selection according to the current operational status.

- If the economizer is integrated into the system and operated, the flue gas humidity is calculated from the measured temperature in the chimney.
- If the economizer is not integrated into the system, the flue gas humidity is measured directly using humidity analyser.

3.3.6 CEMS FOR MONITORING OF TEMPERATURE

- Manufacturer: illegible
- Model: RT372
- Serial No.: 954
- Measuring range: temperature – (0 to 200) °C
- Analogue output signals (from 4 mA to 20 mA); offset: 4 mA.

3.3.7 CEMS FOR MONITORING OF PRESSURE

- Manufacturer: illegible
- Model: PM50
- Serial No.: D10001010FD
- Measuring range: pressure – (101,15 to 101,55) kPa
- Analogue output signals (from 4 mA to 20 mA); offset: 4 mA.

3.3.8 EMISSION DATA ACQUISITION SYSTEM

- The system of evaluation of emission parameters MEAC2000 consists of:
  - Data processing unit (data logger),
  - Emission PC,
  - Emission software.
- Manufacturer of software: Maihak AG, Hamburg, Germany.
- Software model: MEAC2000, version 1.28 EU.

3.3.9 ACTUAL CALCULATION CONSTANTS

Table No. 1: Summary of the actual conversion factors.

Conversion factors	Value of humidity
Calculation of moisture (expressed in %vol.) from the flue gas temperature (expressed in °C).	$\frac{t-30}{17}\times 4{,}59+2{,}72$ $\frac{t-60}{9}\times 11{,}1+15{,}4$ $\frac{t-69}{11}\times 30{,}2+26{,}5$
Recalculation of NO mg/m^3 to NO_2 mg/m^3	1,533

3.3.10 ACTUAL CALIBRATION FUNCTIONS

Table No. 2: Specified calibration functions in the system.

Component	Unit of raw values	$\hat{y} = a + b\,x + c\,x^2$			Calibrated range
		A	b	c	1,1 * $\hat{y}_{s,max}$
O_2	vol.%	-6,25	1,5625	0	12,5 [1)]
CO	mg/m^3	-750	187,5	0	2466 [1)]
NO_X	mg/m^3	-500	125	0	509 [1)]
SO_2	mg/m^3	-750	187,5	0	19 [1)]
Dust	mg/m^3	-50	12,5	0	43 [1)]
Volume flow	m^3/h	-25000	100000	0	141994 [2)]

[1)] Values are given under standard conditions in dry gas recalculated to the ref. oxygen content.
[2)] Values are given under standard conditions in dry gas.

4 MEASUREMENT RESULTS

4.1 TESTS OF PERFORMANCE CHARACTERISTICS

Table No. 3: Summary of the results of the performance characteristics of CEMS (monitoring of SO_2).

Performance characteristics	Measured component: "SO_2"				
	Standard / Requirement of the Standard		Results	Assessment	Note
Detection limit	ISO 7935	≤ 2 %R	0,16 %R	Compliance	1)
Lack of fit		≤ ± 2 %R	0,79 %R	Compliance	1)
Interferences		≤ ± 2 %R	0,27 %R	Compliance	1), 5)
Zero drift		≤ 2 %R	-	-	1), 6)
Span drift		≤ ± 4 %RM	-	-	2), 6)
Response time		≤ 200 s	88 s	Compliance	-
Standard deviation		≤ ± 2,5 %R	- %R	Compliance	8)
Systematic error		≤ ± 2 %R	0,18 %R	Compliance	1)
Variability test	EN 14181	≤ 29,881	1,626	Compliance	3), 4)
Calibration test		≤ 21,148	1,798	Compliance	3)
Correlation coefficient		≥ 0,90	0,71	Non – Compliance	3), 7)

Table No. 4: Summary of the results of the performance characteristics of CEMS (monitoring of NO).

Performance characteristics	Measured component: "NO"				
	Standard / Requirement of the Standard		Results	Assessment	Note
Detection limit	ISO 10849	≤ 2 %R	0,15 %R	Compliance	1)
Lack of fit		≤ ± 2 %R	0,19 %R	Compliance	1)
Interferences		≤ ± 4 %R	0,11 %R	Compliance	1), 5)
Zero drift		≤ 2 %R	-	-	1), 6)
Span drift		≤ ± 4 %RM	-	-	2), 6)
Response time		≤ 200 s	51 s	Compliance	-
Standard deviation		≤ ± 5 %R	0,08 %R	Compliance	1)
Systematic error		≤ ± 2 %R	0,29 %R	Compliance	1)
Variability test	EN 14181	≤ 44,821	2,935	Compliance	3), 4)
Calibration test		≤ 31,947	6,98	Compliance	3)
Correlation coefficient		≥ 0,90	0,998	Compliance	3)

Table No. 5: Summary of the results of the performance characteristics of CEMS (monitoring of Dust).

Performance characteristics	Measured component: "Dust"				
	Standard / Requirement of the Standard		Results	Assessment	Note
Linearity	ISO 10155	≤ 3 %R	0,13 %R	Compliance	-
Standard deviation		-	0,06 %R	-	1)
Systematic error		-	0,08 %R	-	1)
Confidence coefficient		± 10 %ELV	± 1,24 %ELV	Compliance	-
Tolerance coefficient		± 25 %ELV	± 1,30 %ELV	Compliance	-
Variability test	EN 14181	≤ 6,31	0,075	Compliance	3), 4)
Calibration test		≤ 4,662	1,467	Compliance	3)
Correlation coefficient		≥ 0,95	0,5	Non – Compliance	3)

Table No. 6: Summary of the results of the performance characteristics of CEMS (monitoring of CO).

Performance characteristics	Measured component: "CO"				
	Standard / Requirement of the Standard		Results	Assessment	Note
Detection limit	ISO 12039	≤ 2 %R	0,18 %R	Compliance	1)
Lack of fit		≤ 2 %R	0,41 %R	Compliance	1)
Interferences		≤ 4 %R	0,07 %R	Compliance	1), 5)
Zero drift		≤ 2 %R	-	-	1), 6)
Span drift		≤ 4 %RM	-	-	2), 6)
Response time		≤ 200 s	51 s	Compliance	-
Lag time		≤ 180 s	31 s	Compliance	-
Rise time		≤ 20 s	20 s	Compliance	-
Fall time		≤ 20 s	20 s	Compliance	-
Standard deviation		≤ ± 5 %R	0,29 %R	Compliance	1)
Systematic error		≤ ± 2 %R	0,89 %R	Compliance	1)
Variability test	EN 14181	≤ 184,247	8,628	Compliance	3), 4)
Calibration test		≤ 129,763	26,771	Compliance	3)
Correlation coefficient		≥ 0,90	1,0	Compliance	3)

Table No. 7: Summary of the results of the performance characteristics of CEMS (monitoring of O_2).

Performance characteristics	Measured component: "O_2"				
	Standard / Requirement of the Standard		Results	Assessment	Note
Detection limit	ISO 12039	≤ 2 %R	0,36 %R	Compliance	1)
Lack of fit		≤ 2 %R	0,12 %R	Compliance	1)
Interferences		≤ 4 %R	0,12 %R	Compliance	-
Zero drift		≤ 2 %R	-	-	1), 6)
Span drift		≤ 4 %RM	-	-	2), 6)
Response time		≤ 200 s	43 s	Compliance	-
Lag time		≤ 180 s	23 s	Compliance	-
Rise time		≤ 20 s	20 s	Compliance	-
Fall time		≤ 20 s	20 s	Compliance	-
Standard deviation		≤ ± 5 %R	0,2 %R	Compliance	1)
Systematic error		≤ ± 2 %R	0,51 %R	Compliance	1)
Variability test	EN 14181	≤ 1,21	0,052	Compliance	3), 4)
Calibration test		≤ 0,789	0,128	Compliance	3)
Correlation coefficient		≥ 0,90	0,993	Compliance	3)

Table No. 8: Summary of the results of the performance characteristics of CEMS (monitoring of Volume flow rate).

Performance characteristics	Measured component: "Velocity"				
	Standard / Requirement of the Standard		Results	Assessment	Note
Linearity	EN ISO 16911-2	≤ 3 %R	0,5 %R	Compliance	1), 7)
Standard deviation		≤ ± 5 %R	0,39 %R	Compliance	1)
Systematic error		≤ ± 3 %R	0,15 %R	Compliance	1)
Variability test	EN ISO 16911-2 EN 14181	≤ 8474,81	1543,389	Compliance	3), 4)
Calibration test		7638,76	606,713	Compliance	3)
Correlation coefficient		≥ 0,90	0,969	Compliance	3)

Comments – Notes

1) related to the entire measuring range
2) related to the measured value
3) related to each verified value
4) calculated according article 6.4 of EN 14181
5) related to the entire measuring range in case of gas mixture
6) audited control drifts, according Annex A.10 of EN 14181
7) see Article 6.3
8) value is less than detection limit

The measured and calculated values of CEMS and SRM, *x-y* diagrams of calibrated CEMS against SRM and performance characteristics are listed in Annex No. 3 to this report.

4.2 TESTING OF THE SAMPLING SYSTEM

Table No. 9: Testing of the sampling system

Functional parameter	Sampling system CEMS			
	Regulation	Requirement	Reality	Evaluation
Change of the concentration of O_2 during leak test	–	–	0,04 % vol. O_2	–
Tightness of the sampling system	EN 13284-1	≤ 2 % of the flow	0,18 %	Compliance
Testing under pressure	–	–	22000 Pa	–
Dew point of gases	–	–	51 °C	Compliance
Temperature of the sampling system	ISO 10396	15 ° C above the dew point	125 °C	
Materials used in AMS		Chemical resistance	Teflon, stainless steel	Compliance

4.3 FUNCTIONAL TESTS

Requirement – parameter	Reference	Controlled	Notes
Alignment and cleanliness			
Visual inspection:			
• Internal control of analysers	**1**	**Yes**	**O.K.**
• Cleanliness of the optical components	**1**	**Yes**	**O.K.**
Documentation and records			
• Plan of the CEMS	**1**	**Yes**	**O.K.** (stored in special folder for CEMS)
• All manuals (maintenance, users, etc.)	**1**	**Yes**	**O.K.** (stored in special folder for CEMS)
• Log books (records of maintenance and operation of CEMS)	**1**	**Yes**	**O.K.** (stored in special folder in CEMS housing)
• Management system procedures for maintenance, calibration and training	**1**	**Yes**	**O.K.** (in manuals)
• Training records	**1**	**Yes**	**O.K.** (stored in special folder for CEMS)
• Maintenance schedule	**1**	**Yes**	**O.K.** (stored in special folder in CEMS housing)
Sampling system			
Visual inspection of the sampling system:			
• Sampling probe	**1**	**Yes**	**O.K.** (the selection of the probe's diameter satisfies the recommendations of the manufacturer)
• Gas conditioning system	**1**	**Yes**	**O.K.**
• Pumps	**1**	**Yes**	**O.K.**
• All connections	**1**	**Yes**	**O.K.**
• Sample line	**1**	**Yes**	**O.K.**
• Power supplies	**1**	**Yes**	**O.K.**
• Filters	**1**	**Yes**	**O.K.**

Requirement – parameter	Reference	Controlled	Notes
• The sampling system shall be in good condition and free of any visible faults	**1**	**Yes**	**O.K.**
Leak test			
• Leak test	**1**	**Yes**	**O.K.**
Performance characteristics of CEMS			
• Lack of fit	**1**	**Yes**	**O.K.** See Article 4.1
• Zero and span drift	**1**	**Yes**	**O.K.** See Article 4.1
• Interference	**1**	**Yes**	**O.K.** See Article 4.1
Emission data acquisition system			
• Recording intervals	**-**	**Yes**	**O.K.**
• Data collection and recording	**-**	**Yes**	**O.K.** (The raw data are collected in a data logger, the recalculated data in a PC.)
• On line control	**-**	**Yes**	**O.K.**
• Data evaluation (calculation formulas, constants)	**-**	**Yes**	**O.K.**
• Excess of ELV	**-**	**Yes**	**O.K.** (indication on the monitor of emission PC, record in the emission protocol)
• Data storage (electronic, CD, paper version)	**-**	**Yes**	**O.K.** (in electronic version)
• Data security (access, deleting)	**-**	**Yes**	**O.K.** (data are protected against erasure)
• Update of software	**-**	**Yes**	**O.K.** (Significant changes are carried out by the manufacturer of CEMS. Modifications and changes (constants, formulas) performs the supply organization (Axis Industries). Changes in the configuration and settings are protected against unauthorized modification by password. All changes of setting are electronically recorded.)
Emission protocols			
• Emission protocols	**1**	**Yes**	**O.K.** (The system generates daily, monthly and annual emission protocols.)
• Units	**1**	**Yes**	**O.K.** (mg/m^3 for CO, NO_X, SO_2, dust, % vol. for O_2, humidity; °C for temperature, hPa for pressure, m^3/h for volume flow)
Serviceability			
• Safe and clean working environment with sufficient space and weather protections	**1**	**Yes**	**O.K.** (CEMS is installed in a separate building beside the chimney in the air-conditioned housing.)
• Easy and safe access to the CEMS itself	**1**	**Yes**	**O.K.**
• Adequate supplies of calibration materials, tools and spare parts	**1**	**Yes**	**O.K.** (For CO, NO, SO_2 analysers are available suitable gaseous reference materials - calibration gases. The test gases meet the requirements for stability, uncertainty and the concentration values. Oxygen analyser is verified by the ambient air.)
Measuring site			
• Location of the measuring site	**2**	**Yes**	**O.K.** (The measuring site is located on the chimney at height of 27 m. Access to the measuring site can be limited in case of bad weather conditions.)
• Measuring holes	**2**	**Yes**	**O.K.** (On the chimney are installed 2 circular measuring holes for 2 measuring lines.)

Requirement – parameter	Reference	Controlled	Notes
• Measuring ports	**2**	**Yes**	**O.K.** (Measuring flanges are installed on the chimney's wall at an angle.)
• Working platform	**2**	**Yes**	**O.K.** (See paragraph 6.3 of this Report for more information.)
• Protection from weather conditions	**2**	**Yes**	**O.K.** (The installed sampling probes are suitable for location in the external environment.)
Documentation and certificates			
• Project documentation of CEMS	**1**	**Yes**	**O.K.** It was controlled at AST.
• Certificates	**1**	**Yes**	**O.K.** It was controlled at AST.
QAL3			
• Certificate of analyses gas	**1**	**Yes**	**O.K.**
• QAL 3 documentation (actions taken as a result of out of control situations)	**1**	**Yes**	**O.K.** (QAL3 procedures are established.)
• Evaluation of the drift and precision	**1**	**Yes**	**O.K.**
• Recording of any faults	**1**	**Yes**	**O.K.**

References: 1 – EN 14181:2016
2 – EN 15259:2007

4.4 CORRECTIVE AND PREVENTIVE ACTIONS

Proposal for corrective and preventive action:

- To establish a control of the excess of the valid calibration ranges of the analysers according to the applicable requirements of Article 6.5 of EN 14181.
- Ensure the locking of the automated measuring system house.
- Changes valid calibration ranges of SO_2 and volume flow.

5 METHODS AND APPARATUS

5.1 METHODS USED

Table No. 10: List of the used methodologies.

Parameter	Methods	Name
Sampling	ISO 10396	Stationary source emissions - Sampling for the automated determination of gas emission concentrations for permanently-installed monitoring systems.
measuring site	EN 15259	Air quality - Measurement of stationary source emissions - Requirements for measurement sections and sites and for the measurement objective, plan and report
CO, CO_2, O_2	ISO 12039	Stationary source emissions - Determination of carbon monoxide, carbon dioxide and oxygen - Performance characteristics and calibration of automated measuring systems.
O_2	EN 14789	Stationary source emissions - Determination of volume concentration of oxygen (O_2) - Reference method - Paramagnetism.
CO	EN 15058	Stationary source emissions - Determination of the mass concentration of carbon monoxide (CO) - Reference method: Non-dispersive infrared spectrometry.
SO_2	EN 14791	Stationary source emissions - Determination of mass concentration of sulphur dioxide - Reference method
	ISO 7935	Stationary source emissions. Determination of SO_2. Performance characteristics and calibration of automated measuring systems.
NO and NO_2	EN 14792	Stationary source emissions. Determination of NO_X. Reference method – CL.
	ISO 10849	Stationary source emissions - Determination of the mass concentration of nitrogen oxides - Performance characteristics of automated measuring systems
Certification	EN 15267-3	Stationary source emissions - Certification of automatic monitoring systems. Performance characteristics and calibration of automated measuring systems.
Dust	ISO 10155	Stationary source emissions - Sampling for the automated determination of gas emission concentrations for permanently-installed monitoring systems.
	EN 13284-1	Stationary source emissions - Determination of low range mass concentration of PM - Part 1: Manual gravimetric method.
	EN 13284-2	Stationary source emissions - Determination of low range mass concentration of PM - Part 2: Automated measuring systems
velocity and volume flow rate of gas streams	ISO 14164	Stationary source emissions - Determination of the volume flow rate of gas streams in ducts - Automated method.
	EN ISO 16911-1	Stationary source emissions - Measurement of velocity and volume flow rate of gas streams in ducts. - Part 1: Manual reference method.
	EN ISO 16911-2	Stationary source emissions - Measurement of velocity and volume flow rate of gas streams in ducts. - Part 2: Automatic monitoring system.
water vapour	EN 14790	Stationary Source Emissions - Determination of The Water Vapour in Ducts.
verification test, data evaluation	EN 14181	Stationary source emissions. Quality assurance of automated measuring systems

5.1.1 SAMPLING AND DEVIATIONS FROM THE METHODS USED

The sampling of waste gas in parallel measurements was carried out in accordance with the methodology listed in Art. 8 without deviations.

5.2 DESCRIPTION OF THE SRM

The measurements of the concentration of gases pollutants were performed using an external sampling (extractive) emission measurement system according to internal methodologies and internal working procedures in accordance with ISO 10396. The measuring system has a valid certification under QAL1.

For the comparative (parallel) measurements were used as the reference methods for the individual components the following external measuring equipment's.

The determination of the concentrations of dust, status variables (gas temperature, static pressure, water vapour) and flow rate was carried out by means of apparatus Kalman Systems - isokinetic gravimetric with filtration in the pipeline – method according to in chapter 5.1.

Concentration of CO, O_2, NO_X as NO_2, SO_2: PG 350 E with the physical principle of measurement according to in chapter 5.1.

The summary tables of used equipment, accessories, and reference materials are listed in Annex No. 4 of this report.

Graphical record of measurement of gaseous pollutants and O_2 is given in Annex No. 5

We used for measure of SRM methods filtration system with porosity 0,1 microns (solid particles of these dimensions behave like gas).

6 CONFIDENCE TO MEASUREMENTS AND DISCUSSION OF RESULTS

6.1 TIMETABLE OF MEASUREMENTS AND TESTS

Measurements of gaseous pollutants and oxygen were performed continuously for three days.

Table No. 11: Timing of measurements

Date of measurement	Parallel measurements	Date of tests	Functional tests
18.11.2019	start: 14:00	19.11.2019	performance characteristics
19.11.2019	end: 14:20	-	-

6.2 DATA EVALUATION

From the measured data were calculated averages to calculate the variability and the total deviation.

Performance characteristics were calculated according to methods given in Table No. 10.

The variability tests were carried out according to the procedures described in EN 14181. Emission limit values and uncertainties are listed in Table No. 12.

Table No. 12: ELV and uncertainties of measured components

Component	Fuel	ELV [mg/m³]	Legal requirement for uncertainty of monitoring [%]	Actual uncertainty of monitoring [%]
SO_2	Biomass	200	20	1,8 %
NO_X as NO_2		400	20	2,0 %
CO		700	10	1,0 %
Dust		50	30	1,0 %
O_2		Undetermined [1)]	6	0,4 %
Volume flow		Undetermined [2)]	7,84	2,1 %

[1)] The emission limit value used to calculate the variability value is used validated range calibration function. Variability assessed from the use of oxygen when converted to the reference oxygen content. Bringing oxygen measurement error in the comparison of the emission limit value.
[2)] Variability being evaluated by the method specified EN 16911-2.

6.3 OPINIONS AND INTERPRETATIONS

The findings correspond to the actual state at the time of the measuring and test.

The correlation coefficient is less than the requirement of the measured values (SO_2, dust) were at the level of detection limit of the used reference method and simultaneously near the detection limit of the installed CEMS. Therefore, any assessment of this parameter is not relevant. This parameter does not affect the accuracy of the measurement.

The door lock of the house where the measuring system is installed is broken.

To determine tightness of the sampling of the sampling rout of the automated emission system at the next test, it is necessary to extend the teflon hose before the heated probe.

At the next revision of the working platform, make the changes as shown in the Annex No. 6.

7 STATEMENT OF COMPLIANCE

7.1 EVALUATION OF COMPLIANCE WITH THE SPECIFICATIONS

Testing and calibration laboratory EKO-TERM SERVIS s.r.o. performed the AST verification of continuous emission monitoring system installed at the air pollution source, Steam Boiler House in Vilnius, Lithuania. The verification was performed from November 18, 2019 to November 19, 2019.

Based on the results of parallel measurements and functional tests EKO-TERM SERVIS s.r.o. confirms the following statement:

SUMMARY STATEMENT OF CONFORMITY
THE CONTINUOUS EMISSION MONITORING SYSTEM

SICK MAIHAK SIDOR	**SN. 761 287**
SICK MAIHAK SIDOR	**SN. 761 294**
SICK MAIHAK FWE 200	**SN. 0949 8542**
SICK MAIHAK FLOWSIC 100	**SN. 7042053**

HAS FULFILLED THE REQUIREMENTS
OF AST ACCORDING TO EN 14181:2016

INSTALLED IN AB "VILNIAUS ŠILUMOS TINKLAI",
CHP-2, STEAM BOILER NO. 4,

Under the European directive 2010/75/EC the AST procedure shall be performed at least every year.