



**Chimica
Applicata
Depurazione
Acque S.n.c.**
di Filippo Giglio & C

**Area Matrici Aeriformi
-
Settore Emissioni
Convogliate**



LAB N° 0439

D3 POWER GENERATION LTD

Delimara Power Station Administration, Triq il Power House,
Marsaxlokk MXK 1220, Malta

AST REPORT ON AUTOMATED MEASURING SYSTEM INSTALLED FOR CONTINUOUS MONITORING OF EMISSIONS OF STACK 6D

performed on behalf of

SUN LAB GROUP Ltd


Area Technical Manager
C.A.D.A. snc
Dott. Giorgio Rocchia

July, 2017



INDEX

INDEX	1
1 INTRODUCTION	3
2 REFERENCE	4
2.1 Normative Reference	4
2.2 Terms of Reference	4
3 DESCRIPTION OF THE PLANT	5
4 STANDARD REFERENCE METHOD (SRM)	7
5 AUTOMETED MEASURING SYSTEM (AMS)	9
6 FUNCTIONAL TEST	10
6.1 Test of linearity	12
7 ANNUAL SURVEILLANCE TEST (AST)	14
7.1 Parallel measurements with the srm	14
7.2 Data evaluation	15
8 RESULTS	17
9 CONCLUSIONS and COMMENTS	18
10 ANNEX 1 – FUNCTIONAL TEST	19
11 ANNEX 2 – TEST LINEARITY RESULTS	22
11.1 Test Linearity of Carbon Monoxide	22
11.2 Test Linearity of Nitrogen Oxide	23
11.3 Test Linearity of Nitrogen Dioxide	24
11.4 Test Linearity of Sulfur Dioxide	25
11.5 Test Linearity of Oxygen	26
11.6 Test Linearity of Carbon Dioxide	27
11.7 Test Linearity of Ammonia	28
12 ANNEX 3 – TEST REPORT	29
12.1 Determination of the velocity profile	29
12.2 Dust Report	30
12.3 Combustion gas report	32
12.4 Ammonia Report	34
13 ANNEX 4 – AST REPORT	35
13.1 Carbon monoxide - AST	35
13.2 Nitrogen Oxide - AST	36
13.3 Sulfur dioxide - AST	37
13.4 Dust - AST	38



13.5	Ammonia	39
14	ANNEX 5 – QAL1 CERTIFIED SRM ANALYZER	40
15	ANNEX 6 – DILUTION SYSTEM CALIBRATION CERTIFICATE	50
16	ANNEX 7 - CERTIFICATE OF ACCREDITATION TO UNI CEI EN ISO / IEC 17025: 2005.....	53
17	ANNEX 8 - CERTIFICATES REFERENCE MATERIAL	54



1 INTRODUCTION

SUNLAB Ltd commissioned to CADA snc di F.Giglio & C. the Annual Surveillance Test (AST) in accordance to the EN 14181:2015 on Automated Measuring System (AMS) installed for continuous monitoring of Stack 6D emissions at the Delimara Power Station, Marsaxlokk, Malta .

In this technical report, we describe the AST test performed on AMS Stack 6D. AST is a procedure which is used to evaluate whether the uncertainty of measured values obtained from AMS still meet the uncertainty criteria as demonstrated in previous QAL2 test. It also determines whether the calibration function obtained during the previous QAL2 test is still valid.

The report describes all the activities required by the technical standard EN 14181:2015 in particular:

- ⇒ The functional test (Annex A of EN 14181:2015),
- ⇒ AST procedure created on 5 parallel measurements.

The technical activity has been performed on 13th May 2017.



2 REFERENCE

2.1 NORMATIVE REFERENCE

- ⇒ EN 14181:2015: *"Automatic measurement systems quality Assurance"*;
- ⇒ Legislative Decree 3 April 2006 n. 152: *"Rules in enviroing matter"*;
- ⇒ Legislative Decree 11 May 2005 n. 133: *"Implementation of Direttive 200/76/CE, in waste incineration field"*;
- ⇒ Tecnical Guide for administrator of continuous monitoring systems for emissions in atmosphere *ISPRA 69/2011*;
- ⇒ Tecnical Guide for administrator of continuous monitoring systems for emissions in atmosphere *ISPRA 87/2013*;
- ⇒ Environmental Protection Agency Office of Environmental Enforcement (OEE) - Air Guidance Note on the Implementation of I.S. EN 14181 (AG3).
- ⇒ Method Implementation Document (MID 14181). *EN 14181: Stationary source emissions Quality assurance of automated measuring systems*. Environment Agency Version 3 April 2014.
- ⇒ Technical Guidance Note (Monitoring). *M20 Quality assurance of continuous emission monitoring systems - application of EN 14181 and BS EN 13284-2*. Environment Agency Version 3 June 2015.

2.2 TERMS OF REFERENCE

- ⇒ **AMS** (Automatic Measurement System): measurement system installed permanently in the place for emissions continuous monitoring;
- ⇒ **In-situ AMS**: AMS having the detection unit in the gas stream or in a part of it;
- ⇒ **Extractive AMS**: AMS having the detection unit physically separated from the gas stream by means a sampling system;
- ⇒ **SRM** (Standardized Reference Method): standardized and described method to define an air quality feature;
- ⇒ **ELV**: Emission Limit Value of a determined parameter.



3 DESCRIPTION OF THE PLANT

The phase 3 of the power electrical generation plant at the Delimara Power Station was been converted from HFO to natural gas, for all eight diesel engines. Four of these eight engines (1 to 4) will be capable of running only on natural gas (NG) as single fuel, whilst the remaining four (5 to 8) were been converted as dual fuel engines, running on natural gas as the main fuel or diesel in emergency situations.

From the 4 chimneys the exhaust gases of engines are transported into the atmosphere, each chimney taking up the exhaust gases of 2 engines and for continuous emission monitoring an AMS (Automatic Measurement System) is installed at each chimney.

Table 1 - Data Sheet of Customer

Data Sheet of Customer		
Company	D3 POWER GENERATION LIMITED LTD	
Adress	Enemalta Building, Triq Belt il-Hazna	
City	Marsa MRS 1571	
Location of Sampling	Delimara Power Station	
Emission Point	6D	
Responsible	David Griscti	
Description of the plant	Power plant	
Process characteristics	Electricity production	
Source of emission	Diesel Engines N°45 & 46	
Majority fuel	Natural Gas (Diesel is emergency fuel)	
GPS Coordinates (N - E)	35°49'57.12"	14°33'27.87"
Pollution abatement system	SCR/Denox + Filter	
Authorization decree	IPPC IP 0002/07/Fii	
Reference Oxygen for Correction of Results	15 % Vol.	

The emission limits with Diesel Fuel are as follows.

Table 2 - Emission Limit Value - IPPC IP 0002/07/C

Emission Limit Value		
Parameter	Unit of Measurement	Value
Dust	mg/Nm ³	55
Nitrogen Oxides	mg/Nm ³	176
Sulfur Dioxide	mg/Nm ³	132
Carbon Monoxide	mg/Nm ³	264
Ammonia	mg/Nm ³	2,6
Note: All values shall be corrected to 273.15 K, 101,3 Pa, dry gas volume and to an Oxygen content of 15% vol.		



Below, Information of Emission Point “6D” and Sampling Security Information.

Table 3 - Information of Emission Point

Data Sheet of Emission Point	
Height of Stack [m]	65
Height of the ground of sampling point	25
Distance of perturbation upstream of sampling point	25
Distance of perturbation downstream of sampling point	25
Flow direction	Vertical
Direct outlet in Atmosphere	Yes
Diameter [m]	200
Stack Area [m ²]	3,14
Number of Sampling Lines (Access Ports)	2
Conformance of the Sampling Platform	
Sampling platform area > 5 m ² and support > 400 kg	Yes
Presence of artificial lighting	Yes
Appropriate electrical installation	Yes
Secure platform	Yes
Sampling platform conformance	Yes

During the parallel measurements the plant loads was kept constant as shown in the table below.

Table 4 - Plant Load during the measurements

Plant Load during the measurements				
Fuel	Natural Gas	Other Fuel	/	
Day	Time	Source of emission	Load	
13/05/2017	08:00 - 22:00	Diesel Engine 47 (DE 48 Shut down)	16 MW	50%



4 STANDARD REFERENCE METHOD (SRM)

Flow, dust and ammonia measurements are made directly to the chimney. The combustion gases are transported through a heated probe to the analyzer. The gases before being analyzed pass into a chiller that removes water.

Below is the SRM specification used for parallel measurements.

Table 5 - SRM Sampling and Analysis Method

Parameter	Method	Description of the method
Dust	UNI EN 13284-1:2003	Stationary source emissions. Determination of low range mass concentration of dust. Manual gravimetric method.
NH ₃	EPA CTM 027:1997	Procedure for collection and analysis of ammonia in stationary sources.
NO _x	UNI EN 14792:2006	Stationary source emissions. Determination of mass concentration of nitrogen oxides (NO _x). Reference method: Chemiluminescence.
SO ₂	ISO 11042-1:1996	Gas turbines - Exhaust gas emission - Part 1: Measurement and evaluation. Principle of Measurement: Non-dispersive infrared (NDIR).
CO	UNI EN 15058:2006	Stationary source emissions. Determination of the mass concentration of carbon monoxide (CO). Reference method: Non-dispersive infrared spectrometry.
CO ₂	ISO 11042-1:1996	Gas turbines - Exhaust gas emission - Part 1: Measurement and evaluation. Principle of Measurement: Non-dispersive infrared (NDIR).
O ₂	UNI EN 14789:2006	Determination of volume concentration of oxygen (O ₂). Reference method - Paramagnetism.
H ₂ O	UNI EN 14790:2006	Stationary source emissions. Determination of the water vapour in ducts.
Flow, Velocity	UNI EN 16911:2013 Annex A	Stationary source emissions. Manual and automatic determination of velocity and volume flow rate in ducts. Part 1: Manual reference method.
Temperature, Pressure	UNI EN 16911:2013 Annex A	



Below are the technical specifications of the instrumentation used during the sampling.

Table 6 - SRM Specification

Parameter	Manufacturer / Model	Measuring principle	Range of Measurement
Dust	Dado Lab - ST5	Sampling	Only Sampling
Flow, Velocity	Dado Lab - ST5	Differential Pressure	-100 ÷ 1000 Pa
Temperature	Dado Lab - ST5	Thermocouples - Type K	0 - 1200 °C
Pressure	Dado Lab - ST5	Static/Barometric Pressure	10 ÷ 105 kPa (1050 mBar)
NH ₃	Dado Lab - ST5	Sampling	
NOx	Horiba / PG - 350 E	CLD chemiluminescence	0-25/50/100/250/ 500/1000/2500 ppm
SO ₂	Horiba / PG - 350 E	ND-IR	0-50/100/200/500 ppm
CO	Horiba / PG - 350 E	ND-IR	0-60/100/200/500/1000 ppm
CO ₂	Horiba / PG - 350 E	ND-IR	0-10/20/30 %
O ₂	Horiba / PG - 350 E	Paramagnetic	0-/10/25 %
H ₂ O	Tecora - Ayrton	Sampling	Only Sampling

In Annex 5 and 6, QAL1 certificates of SRM and Dilution System.



5 AUTOMATED MEASURING SYSTEM (AMS)

AMS has been supplied by SICK and consists in an independent flue gas analyzer placed in a cabin at the base of the stack 6D.

Inside the cabin there are two types of instruments:

- ⇒ In situ analyzers, for measurement of dust, temperature, pressure;
- ⇒ extraction analyzers, for measurement of carbon monoxide (CO), Sulfur dioxide (SO₂), nitrogen monoxide (NO), nitrogen dioxide (NO₂), carbon dioxide (CO₂), ammonia (NH₃) and water vapor (H₂O).

The in situ analyzers, measure directly in the chimney the parameter or the physical characteristic of the flue gas. In particular, the concentration of the dust is measured with the Optical Extinction technique, temperature and pressure with heat resistance and electro pneumatic transducer system respectively.

Extract analyzers are connected to the AMS analysis-cabin through a heated line. Heated line brings the flue gas under the same sampling conditions of temperature, humidity and to avoid condensation along the sampling line. All parameters are measured by IR Non-Dispersive technique(NDIR), while oxygen is measured with zirconium oxides.

Table 7 - AUTOMATED MEASURING SYSTEM (AMS) FEATURES

Supplier	Certification	Analyzer	Measuring Principle	Parameter	Full-scale set
SICK	TÜV Technischer Überwachungsverein	SB 100	Optical - Extinction	Dust	0 - 200 mg/Nm ³
		MCS 100 E	ZrO ₂	O ₂	0 - 21 %
			IR Non-Dispersive (NDIR)	CO	0 - 300 mg/Nm ³
				CO ₂	0 - 25 %
				NO	0 - 300 mg/Nm ³
				NO ₂	0 - 100 mg/Nm ³
				SO ₂	0 - 2000 mg/Nm ³
				NH ₃	0 - 30 mg/Nm ³



6 FUNCTIONAL TEST

The functional tests are a mandatory requirement within EN 14181. Suitably trained personnel from either the test laboratory, process operator or AMS supplier may perform the functional tests. The functional test is intended to verify that the AMS is installed in accordance with the requirements of the industry standard.

The functional test has the aim to ensure:

- ⇒ AMS is installed at a representative sampling point,
- ⇒ AMS is working and in good condition,
- ⇒ AMS is maintained properly as required by the user manuals,
- ⇒ AMS has the same performance as stated in QAL 1 certificate.

In addition, the technical standard EN 14181: 2015 also provides for checks to be carried out during the operation of the analyzer. Among the most important are:

- ⇒ Zero and SPAN Test with Certified Gas (QAL3 Controls). These controls are the responsibility of the Plant operator,
- ⇒ Zero and Span Drift in time. These controls are the responsibility of the Plant operator.

The checks performed by certified laboratory in accordance with technical standard EN ISO / IEC 17025 are:

- ⇒ Verify the functionality of the entire system (Leak Test, Response Time),
- ⇒ Zero and SPAN test with certified material,
- ⇒ Linearity Checking.



Table 2 specifies the individual steps of the functional test of AMS to be performed during QAL2 and AST for extractive and in-situ AMS.

Table 8 - Functional Test Step

Functional Test to be performed during QAL2 / AST activities on AMS (EN 14181 : 2015 - Annex A)				
N.	Type of Verification	Extractive AMS	In-situ AMS	Responsibility
1	Alignment and cleanliness	-	X	Supplier/Manufacturer
2	Sampling system	X	-	Laboratory
3	Documentation and records	X	X	Plant operator
4	Functionality	X	X	Plant operator
5	Leak test	X	-	Laboratory
6	Zero and span check	X	X	Laboratory
7	Linearity	X	-	Laboratory
8	Interferences	X	X	Laboratory / Supplier / Installer
9	Zero and span drift (audit)	X	X	Plant operator
10	Response time	X	X	Laboratory
11	Report	X	X	Laboratory

The functional test was carried out at 9th May and the results are given in Annex N. 1 of the report.



6.1 TEST OF LINEARITY

Analyzers measurement linearity is tested in according to the UNI EN 14181:2015 Annex B - Test of Linearity. In this test procedure, a regression line is established between the instrument reading of the AMS (x - values) and the reference material values (y -values). The regression line is achieved at five different levels, including a zero concentrations. Different concentration levels have been obtained by means the use of a calibrated dilution system.

Concentration levels to realize the regression line at approximately 20%, 40%, 60% and 80% of a range which is at least the short-term ELV. For each levels concentration, at least three reading shall be made. The time period between the beginning each of the three readings were be separated by least four times the response time of the analyzer.

From measurement made it is determined the function linear regression:

$$x_i = A' + B(y_i - y_z) \quad (1)$$

The coefficient A' is obtained with the Formula (2):

$$A' = \frac{1}{n} \sum_{i=1}^n x_i \quad (2)$$

where

A' is the average value of the x -value, i.e. the average of the AMS instrument reading;

x_i is the individual AMS instrument reading;

n is the number of measuring point (at least 18, three for each levels).

The coefficient B is obtained with the Formula (3):

$$B = \frac{\sum_{i=1}^n x_i (y_i - y_z)}{\sum_{i=1}^n (y_i - y_z)^2} \quad (3)$$

y_z is the average of the y -values, i.e. the average of the reference material concentration;

y_i is the individual value of the reference material concentration.

Secondly the fuction in Formula (1) is converted to

$$x_i = A + B y_i \quad (3.1)$$



Through the calculation of A according to Formula (4)

$$A = A' - By_z \quad (4)$$

For each concentration level the average of AMS readings at one and the same concentration level c according to Formula (5):

$$\overline{x}_c = \frac{1}{m_c} \sum_{i=1}^{m_c} x_{c,i} \quad (5)$$

where

\overline{x}_c is the average x -value (AMS-reading) at concentration level c ;

$x_{c,i}$ is the individual x -value (AMS reading) at concentration level c ;

m_c is the number of repetitions at one and the same concentration level c .

Calculate the residual d_c of each average according to Formula (6)

$$d_c = \overline{x}_c - (A + Bc) \quad (6)$$

where

c is the concentration level.

Finally, convert d_c in concentration units to a relative unit $d_{c,rel}$ by dividing d_c by the upper limit c_u of the range used in the linearity test according to Formula (7):

$$d_{c,rel} = \frac{d_c}{c_u} 100\% \quad (7)$$

All residual shall pass this test in according to Formula (8):

$$d_{c,rel} < 5\% \quad (8)$$

The Linearity Test results are given in Annex N. 2 of the report.



7 ANNUAL SURVEILLANCE TEST (AST)

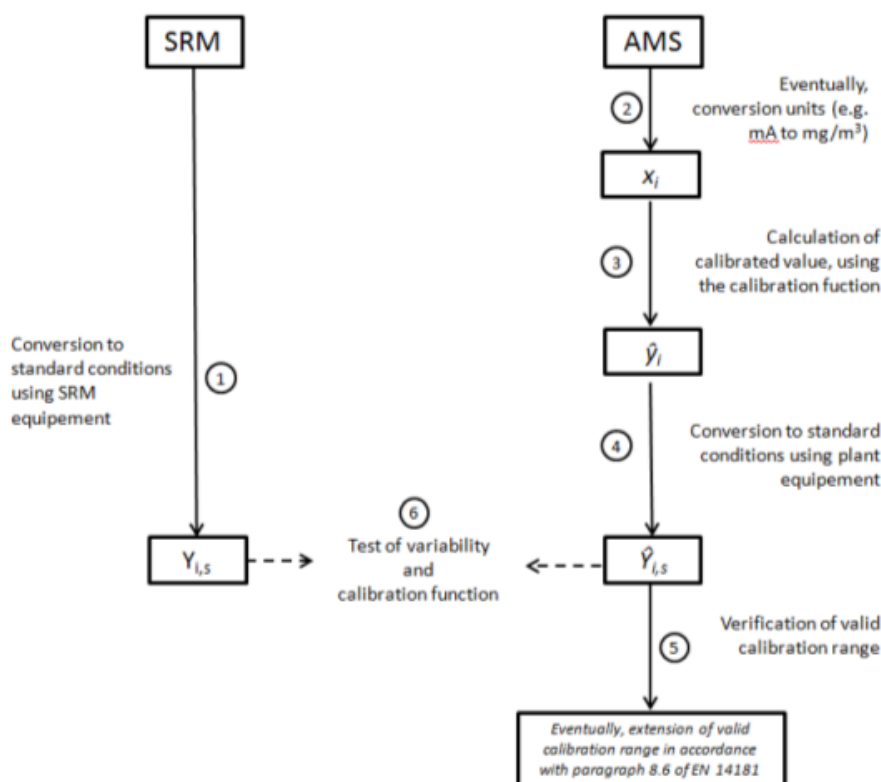
7.1 PARALLEL MEASUREMENTS WITH THE SRM

During AST at least five parallel measurements with an SRM shall be performed. The purpose of comparison measurements is to verify if the calibration function of the AMS is still valid and if the precision of the AMS is still within the required limits. If this is the case, and if these measurements include results outside the valid calibration range, the valid calibration range may be increased with use of these results.

AST covers the following items:

- ⇒ functional test of the AMS;
- ⇒ parallel measurements with the SRM;
- ⇒ data evaluation;
- ⇒ calculation of variability of the AMS measured value;
- ⇒ test of variability of the AMS measured values and validity of the calibration function

Figure 1 - Flowchart of AST process





7.2 DATA EVALUATION

The standard requires at least five valid data points for an AST. Calculate the AMS measured values \hat{y}_i (calibrated values) from the AMS measured signals x_i using the established calibration function determined by the last QAL2 procedure. Then use the peripheral AMS equipment to convert \hat{y}_i to standard conditions and to calculate the standardised measured values $\hat{y}_{i,s}$. The converted and standardized data must be compared with the data of the SRM y_i (point 6 of figure 1). The results from the comparative measurements (AST) shall not be used together with the measurements from the most recent calibration to determine a new calibration function (QAL2), but they may be used to extend the valid calibration range.

The first step is calculate variability, identifying the maximum permissible uncertainty specified by legislation (σ_0).

$$D_i = y_{i,s} - \hat{y}_{i,s} \quad (9)$$

Where

$y_{i,s}$ is the result i^{th} of the SRM at standard conditions,

$\hat{y}_{i,s}$ is the result i^{th} of the AMS, calibrated at standard conditions,

Mean differences, Formula 10:

$$\bar{D} = \frac{1}{N} \sum_{i=1}^N D_i \quad (10)$$

Standard deviation of differences, Formula 11:

$$S_D = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (D_i - \bar{D})^2} \quad (11)$$

The AMS passes the variability test when:

$$S_D \leq 1,5 \sigma_0 k_v \quad (12)$$

where



σ_0 is standard deviation derived from the range of confidence at 95%. In some EU Directive (EU 2010/75/CE) the uncertainty of the AMS measured values is expressed as half of the length of a 95% confidence interval as a percentage P of the emission value (ELV). Then, in order to convert this uncertainty to a standard deviation, the appropriate conversion factor is:

$$\sigma_0 = \frac{P \times ELV}{1,96} \quad (13)$$

the value of 1,96 represents the coverage factor of 95% of the confidence interval.

k_v is a value from χ^2 -test with a β -value of 50%. The k_v value depending on the number of tests conducted.

Table 9- k_v and $t_{0,95}$ values

Number of parallel measurement	$k_v(N)$	$t_{0,95; N-1}$
5	0,9161	2,132
6	0,9329	2,015
7	0,9441	1,943
8	0,9521	1,895

The calibration of the AMS is accepted if:

$$|D| \leq t_{0,95; N-1} \frac{S_D}{\sqrt{N}} + \sigma_0 \quad (14)$$

If either of the two above tests fails, the causes shall be identified and rectified. Subsequently new parallel measurements according to QAL2 shall be performed, reported and implemented within six months.

If the AST demonstrates that the existing calibration function is valid beyond the existing valid calibration range, the competent authority can allow the plant to extend the valid calibration range up to the maximum measured concentration of calibrated AMS measured values at standards conditions, determined during the AST, plus an extension of 10% of this value, but the valid calibration range shall not exceed 50% of ELV.

The QAL2 coefficients (slope/intercept) used to correct the data are in chapter 8 "Results" and the AST elaboration is in Annex 4.



8 RESULTS

Below a summary of the results obtained from the AST test performed on the analyzer (AMS) installed on the stack 6D.

In Annex 4, there are reports for single parameter.

Table 10 - Results of AST

Summary Report of AST							
Parameter	Slope	Intercept	Range of Validity (QAL2) Dry gas, Normalized and ref. O ₂	Valid calibration range extension (AST)	Emission Limit Value (ELV)	Test of variability	Test of validity of the calibration function
Dust	1,076	0	0 - 11 [mg/Nm ³ rif O ₂]	/	55	Positive	Positive
Nitrogen Oxide (NO)	1,292	0	0 - 118,4 [mg/Nm ³ rif O ₂]	/	176	Positive	Positive
Carbon Monoxide (CO)	0,916	0	0 - 143,9 [mg/Nm ³ rif O ₂]	/	132	Positive	Positive
Sulfur Dioxide (SO ₂)	0,805	0	0 - 90,5 [mg/Nm ³ rif O ₂]	/	264	Positive	Positive
Ammonia (NH ₃)	0,978	0,407	0 - 0,5 [mg/Nm ³ rif O ₂]	/	2,6	Positive	Positive



9 CONCLUSIONS AND COMMENTS

Taken note of analytical determinations performed on the gaseous effluents of the plant and the processing on the data carried out, it highlights the positive result of the procedure AST. The functional test performed showed the correct installation of the AMS system, the suitability of the installation site and the efficiency of the entire design.

For ammonia both SRM and AMS have measured values lower than the instrumental detection limit. For SRM was considered to be the Medium Bound criterion, ie the value of "0 mg/Nm³" was not included in the calculation, but half the instrumental detection limit that is 0,1 mg/Nm³ (0,05 mg/Nm³). The obtained value was compared with the raw data of the AMS (equal to 0 mg/Nm³ for the day of measurement) converted by Coefficients of QAL2, the normalized and corrected Oxygen as required by the annual surveillance test procedure.



10 ANNEX 1 – FUNCTIONAL TEST

1	ALIGNMENT AND CLEANLINESS (ONLY NON-EXTRACTIVE SYSTEM)	
	Type of Verification (visual)	Notes / Comments
a	Obstruction Optical path	<i>The operator performs the necessary maintenance and checks. The operator on 31/03/2017 instructed its supplier (DG Tech) to carry out the checks provided for in the user manuals of the instrument.</i>
b	Cleaning of Optical Components	
c	Alignment	
d	Presence of Air Purge	
		<i>The visual checks required by EN 14181 were positive.</i>

2	SAMPLING SYSTEM (ONLY EXTRACTIVE SYSTEM)			
	Type of Verification (visual)	State		
		Great	Sufficient	Inadequate
a	Sampling probe	X		
b	Calibration gas conditioning system	X		
c	Pumps	X		
d	Pneumatic connections	X		
e	Sample line	X		
f	Generators/current stabilizers	X		
g	Filters	X		
Notes / Comments: //				

3	DOCUMENTATIONS AND RECORDS		
	Type of Documents	Location	Reference
a	P & I of the AMS (Plan of the AMS pneumatic system)	Technical Office	David Griscti
b	Details of the performance testing and certification of the AMS	Technical Office	David Griscti
c	AMS user manual (Including the maintenance part)	Technical Office	David Griscti
d (*)	Logbooks with records of malfunctions and maintenance performed	Technical Office	David Griscti
e (*)	Service reports	Technical Office	David Griscti
f (*)	QAL3 Documentation	Technical Office	David Griscti
g	AMS management system procedure for maintenance, calibration and training	Not Informed	/
h	Training records	Not Informed	/
i	Maintenance schedules	Not Informed	/
l	Auditing plans and records	Not Informed	/
Notes / Comments: (*) D3 POWER GENERATION LIMITED has performed a functional test on 30/03/2017 by Danks Gasanalyse Teknik (DG TEK)			



4 SERVICEABILITY				
Type of Verification		State		
		Great	Sufficient	Inadequate
a	Safe and clean working environment with sufficient space and weather protection	X		
b	Easy and safe access to the ASM	X		
c (*)	Adequate supplies of reference material, tool and spare part		X	
Notes / Comments: (*) D3 POWER GENERATION LIMITED has performed a functional test on 30/03/2017 by Danks Gasanalyse Teknik (DG TEK)				

5 LEAK TEST (ONLY EXTRACTIVE SYSTEM)		
	Description of the test	Result
a	Checking for leaks in extractive systems shall be conducted by disconnecting the sampling line at the probe exit, plugging the line, and adjusting the vacuum to 50 kPa using the bypass valve. (rif. 7.1 Checking for leaks - ISO 10396:2007)	Positive

6	Zero and Spa check ⁽¹⁾					
Parameter	u.d.m.	Full Scale set	Reference Value ZERO	AMS Measure ZERO	Reference Value SPAN	AMS Measure SPAN
CO	mg/Nm3	0	0	0,1	288,57	290,1
				0		290,6
				0		291
NO	mg/Nm3	0	0	0	256,98	257,9
				0		259,2
				0,3		259,4
SO ₂	mg/Nm3	0	0	0	140,77	139
				0,3		138
				0,2		139
O ₂	% Vol	0	0	0	16,707	16,38
				0,1		16,4
				0		16,4
CO ₂	% Vol	0	0	0,1	16,78	16,3
				0		16,3
				0		16,3
NH ₃	mg/Nm3	0	0	0	17,93	18
				0,1		17,7
				0		17,6
NO ₂	mg/Nm3	0	0	0	83,73	88,9
				0		86,4
				0		86,4
Notes / Comments: (*) Values recorded by linearity tests.						



7	<i>Linearity (*)</i>				
Parameter	Full Scale set	Slope (B)	Intercept (A)	d _{c,rel} [%]	Results
CO	0 - 300 mg/Nm3	1,002	-2,020	1,1	Positive
NO	0 - 300 mg/Nm3	0,999	-1,412	1,3	Positive
SO ₂	0 - 2000 mg/Nm3	0,996	0,662	0,2	Positive
O ₂	0 - 21 %vol	0,985	0,012	0,4	Positive
CO ₂	0 - 25 %vol	0,991	-0,297	1,3	Positive
NH ₃	0 - 30 mg/Nm3	0,944	0,234	2,0	Positive
NO ₂	0 - 100 mg/Nm3	0,920	-0,071	3,6	Positive
Notes / Comments: (*) Test recordings are in Annex 2.					

8	<i>Interferences</i>	
	Type of Verification	Result
a	The same interference reported in the QAL1 certificate has been evaluated. Interferences are evaluated by DG Tech by placing different concentrations of water vapor.	Positive

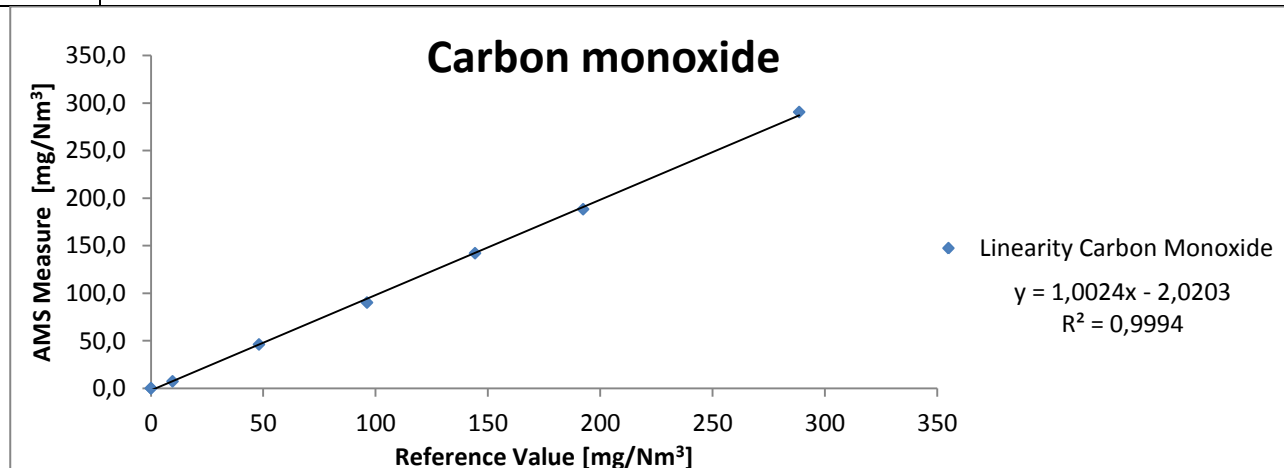
9	<i>Response time</i>	
	Type of Verification (visual)	Result
a	Response times were verified by directly setting the reference gas in the AMS and comparing the timing with those stated in QAL1.	Positive



11 ANNEX 2 – TEST LINEARITY RESULTS

11.1 TEST LINEARITY OF CARBON MONOXIDE

Stack			6D			Data materials used			
Customer			D3 POWER GENERATION LIMITED			Cylinder Producer		SAPIO	
Parameter			CO			Serial/Certificate		P69313YDEN	
Analyzer			SICK MCS 100 E			Concentration		231	ppm
Full Scale set			0- 300	mg/Nm3		Expiration		30/03/2019	
Date measurements			09/05/2017			Diluter		Beta CAP30RK	
Measurements and calculations									
CO mg/Nm3	Level	Reference Value (Y _i)	AMS Measure			X _c	Residual d _c	Relative Residual - % d _{c,rel}	Result
			Reply 1 (X _i)	Reply 2 (X _i)	Reply 3 (X _i)				
	0	0	0,1	0	0	0,0	2,05	0,7	Positive
	1	9,62	6,7	8,1	7,3	7,4	-0,26	-0,1	Positive
	2	48,09	45,2	46,3	47	46,2	-0,02	0,0	Positive
	3	96,18	90,1	90,5	90	90,2	-4,19	-1,4	Positive
	4	144,28	142,3	141,9	142,1	142,1	-0,51	-0,2	Positive
	5	192,4	188,1	188,1	188,9	188,4	-2,48	-0,8	Positive
	6	288,57	290,1	290,6	291	290,6	3,32	1,1	Positive
	0	0	0	0	0,2	0,1	2,09	0,7	Positive
		Y _z	97,4	A'	95,6	B	1,002	A	-2,0203
Legend									
Y _i : concentration of reference material; X _i : AMS measure corresponding to the Reference Material Concentration Level; Y _z : average concentration of reference material; A ' : the mean value of the Instrument's readings (AMS); B: Linear regression line coefficient; A: Linear regression line intercept									

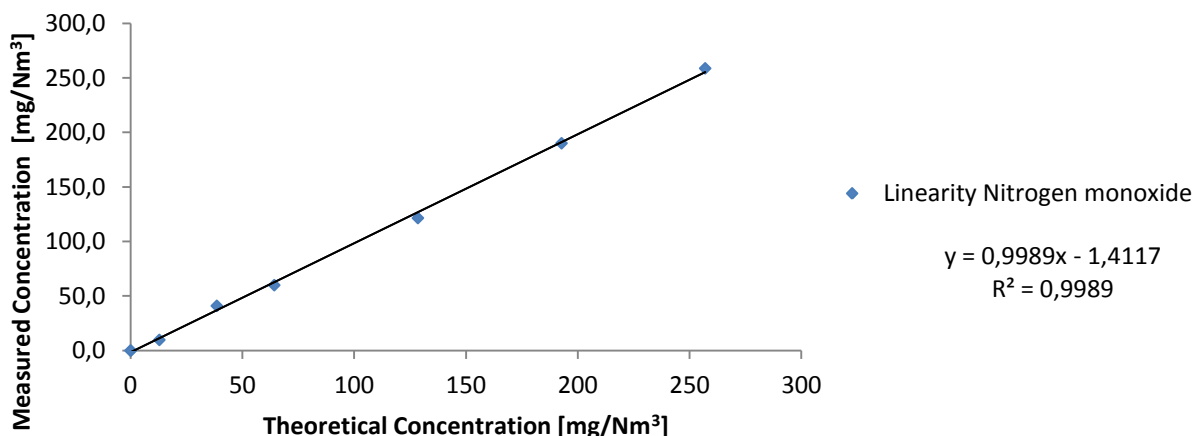




11.2 TEST LINEARITY OF NITROGEN OXIDE

Stack		6D		Data materials used					
Customer		D3 POWER GENERATION LIMITED		Cylinder Producer		SAPIO			
Parameter		NO		Serial/Certificate		P69313YDEN			
Analyzer		SICK MCS 100 E		Concentration		288 ppm			
Full Scale set		0- 300	mg/Nm3	Expiration		30/03/2019			
Date measurements		09/05/2017		Diluter		Beta CAP30RK			
Measurements and calculations									
NO mg/Nm3	Level	Reference Value (Y _i)	AMS Measure			X _c	Residual d _c	Relative Residual - % d _{c,rel}	Result
			Reply 1 (X _i)	Reply 2 (X _i)	Reply 3 (X _i)				
	0	0	0	0	0,3	0,1	1,51	0,5	Positive
	1	12,84	9,4	10,2	10	9,9	-1,55	-0,5	Positive
	2	38,54	40,8	41,8	40,7	41,1	4,01	1,3	Positive
	3	64,24	59,9	60,1	60,2	60,1	-2,69	-0,9	Positive
	4	128,49	120,1	122,3	122,4	121,6	-5,34	-1,8	Positive
	5	192,74	190,3	190,1	190,1	190,2	-0,96	-0,3	Positive
	6	256,98	257,9	259,2	259,4	258,8	3,54	1,2	Positive
	0	0	0,1	0,1	0	0,1	1,48	0,5	Positive
		Y _z	86,7	A'	85,2	B	0,999	A	-1,4117
	Legend								
Y _i : concentration of reference material; Xi: AMS measure corresponding to the Reference Material Concentration Level; Y _z : average concentration of reference material; A': the mean value of the Instrument's readings (AMS); B: Linear regression line coefficient; A: Linear regression line intercept									

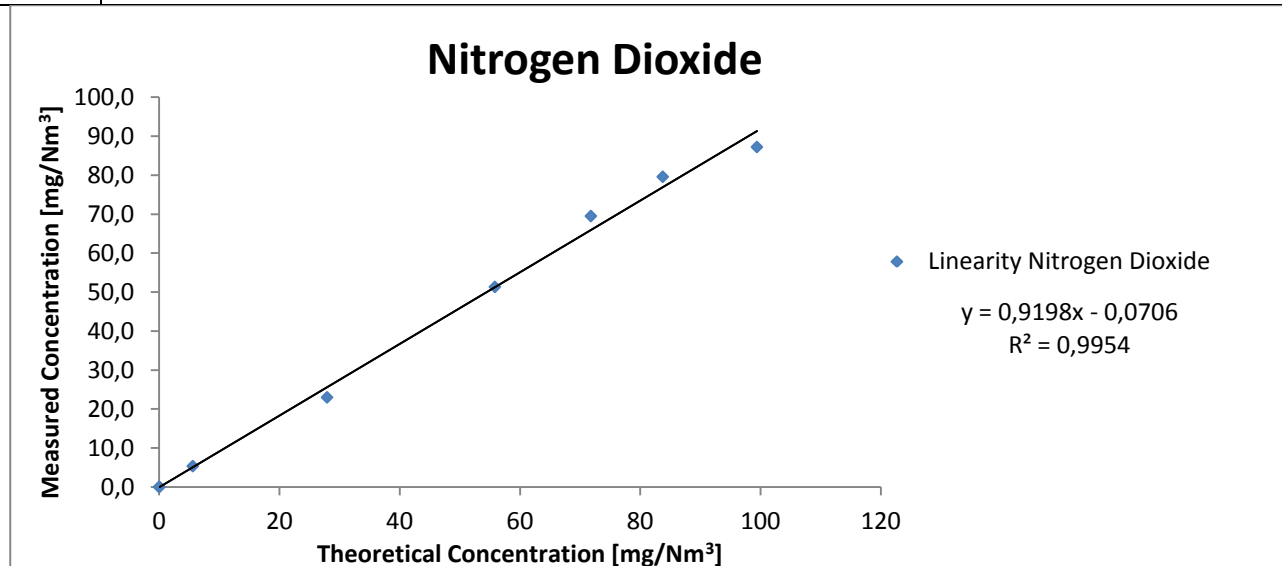
Nitrogen monoxide





11.3 TEST LINEARITY OF NITROGEN DIOXIDE

Stack			6D			Data materials used			
Customer			D3 POWER GENERATION LIMITED			Cylinder Producer		SAPIO	
Parameter			NO ₂			Serial/Certificate		P61YZ3YDFN	
Analyzer			SICK MCS 100 E			Concentration		81,6	ppm
Full Scale set			0- 100		mg/Nm3	Expiration		30/03/2018	
Date measurements			09/05/2017			Diluter		Beta CAP30RK	
Measurements and calculations									
NO2 mg/Nm3	Level	Reference Value (Y _i)	AMS Measure			X _c	Residual d _c	Relative Residual - % d _{c,rel}	Result
			Reply 1 (X _i)	Reply 2 (X _i)	Reply 3 (X _i)				
	0	0	0	0	0	0,0	0,07	0,1	Positive
	1	5,58	5,41	5,34	5,29	5,3	0,28	0,3	Positive
	2	27,91	23,17	22,89	22,91	23,0	-2,61	-2,6	Positive
	3	55,82	51,2	50,9	51,91	51,3	0,06	0,1	Positive
	4	71,78	69,38	69,45	69,7	69,5	3,56	3,6	Positive
	5	83,73	79,37	79,4	80,01	79,6	2,65	2,6	Positive
	6	99,39	88,9	86,38	86,4	87,2	-4,12	-4,1	Positive
	0	0	0,1	0	0	0,0	0,10	0,1	Positive
		Y _z	43,0	A'	39,5	B	0,920	A	-0,0706
Legend									
Y _i : concentration of reference material; X _i : AMS measure corresponding to the Reference Material Concentration Level; Y _z : average concentration of reference material; A ' : the mean value of the Instrument's readings (AMS); B: Linear regression line coefficient; A: Linear regression line intercept									





11.4 TEST LINEARITY OF SULFUR DIOXIDE

Stack	6D		Data materials used	
Customer	D3 POWER GENERATION LIMITED		Cylinder Producer	SAPIO
Parameter	SO ₂		Serial/Certificate	P69313YDEN
Analyzer	SICK MCS 100 E		Concentration	49,3 ppm
Full Scale set	0- 2000	mg/Nm ³	Expiration	30/03/2019
Date measurements	09/05/2017		Diluter	Beta CAP30RK

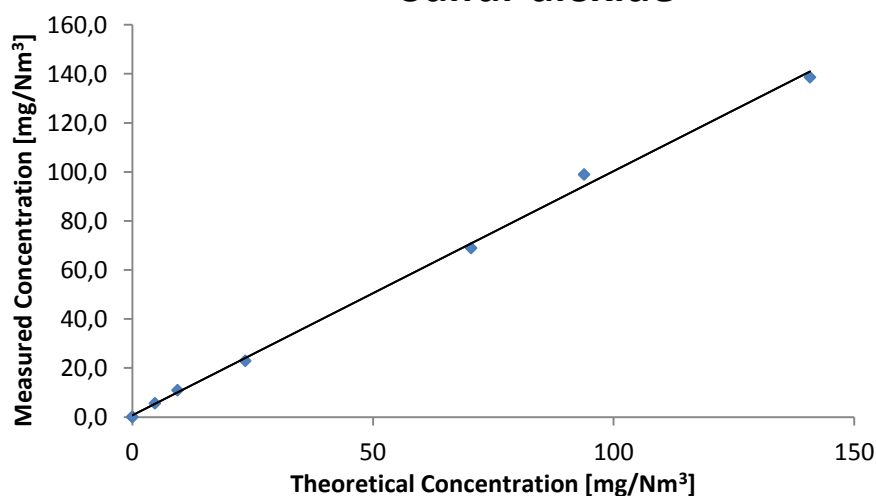
Measurements and calculations

SO ₂ mg/Nm ³	Level	Reference Value (Y _i)	AMS Measure			X _c	Residual d _c	Relative Residual - % d _{c,rel}	Result
			Reply 1 (X _i)	Reply 2 (X _i)	Reply 3 (X _i)				
	0	0	0	0,3	0,2	0,2	-0,50	0,0	Positive
	1	4,7	5	7	5	5,7	0,32	0,0	Positive
	2	9,39	10	11	12	11,0	0,98	0,0	Positive
	3	23,46	22	23	24	23,0	-1,03	-0,1	Positive
	4	70,38	68	69	70	69,0	-1,78	-0,1	Positive
	5	93,85	99	99	99	99,0	4,84	0,2	Positive
	6	140,77	139	138	139	138,7	-2,24	-0,1	Positive
	0	0	0,1	0	0,1	0,1	-0,60	0,0	Positive
		Y _z	42,8	A'	43,3	B	0,996	A	0,6618

Legend

Y_i: concentration of reference material;
X_i: AMS measure corresponding to the Reference Material Concentration Level;
Y_z: average concentration of reference material;
A': the mean value of the Instrument's readings (AMS);
B: Linear regression line coefficient;
A: Linear regression line intercept

Sulfur dioxide



◆ Linearity Sulfur Dioxide
 $y = 0,9963x + 0,6618$
 $R^2 = 0,9982$



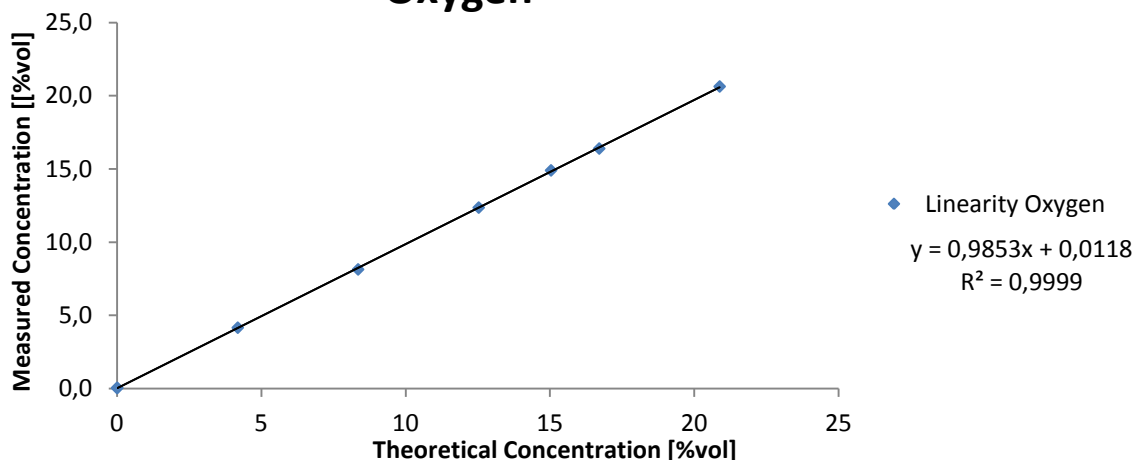
11.5 TEST LINEARITY OF OXYGEN

Stack	6D		Data materials used	
Customer	D3 POWER GENERATION LIMITED		Cylinder Producer	SAPIO
Parameter	O ₂		Serial/Certificate	P61LB2BDFN
Analyzer	SICK MCS 100 E		Concentration	25,06 %vol
Full Scale set	0- 21	%vol	Expiration	30/03/2020
Date measurements	09/05/2017		Diluter	Beta CAP30RK

Measurements and calculations

O ₂ %vol	Level	Reference Value (Y _i)	AMS Measure			X _c	Residual d _c	Relative Residual - % d _{c,rel}	Result
			Reply 1 (X _i)	Reply 2 (X _i)	Reply 3 (X _i)				
	0	0	0	0,1	0	0,0	0,02	0,1	Positive
	1	4,18	4,12	4,15	4,18	4,2	0,02	0,1	Positive
	2	8,35	8,2	8,1	8,1	8,1	-0,11	-0,5	Positive
	3	12,53	12,32	12,4	12,35	12,4	0,00	0,0	Positive
	4	15,036	14,9	15	14,8	14,9	0,07	0,4	Positive
	5	16,707	16,38	16,4	16,4	16,4	-0,08	-0,4	Positive
	6	20,88	20,6	20,7	20,6	20,6	0,05	0,2	Positive
	0	0	0	0	0,1	0,0	0,02	0,1	Positive
		Y _z	9,7	A'	9,6	B	0,985	A	0,0118
Legend									
<p>Y_i: concentration of reference material; X_i: AMS measure corresponding to the Reference Material Concentration Level; Y_z: average concentration of reference material; A': the mean value of the Instrument's readings (AMS); B: Linear regression line coefficient; A: Linear regression line intercept</p>									

Oxygen

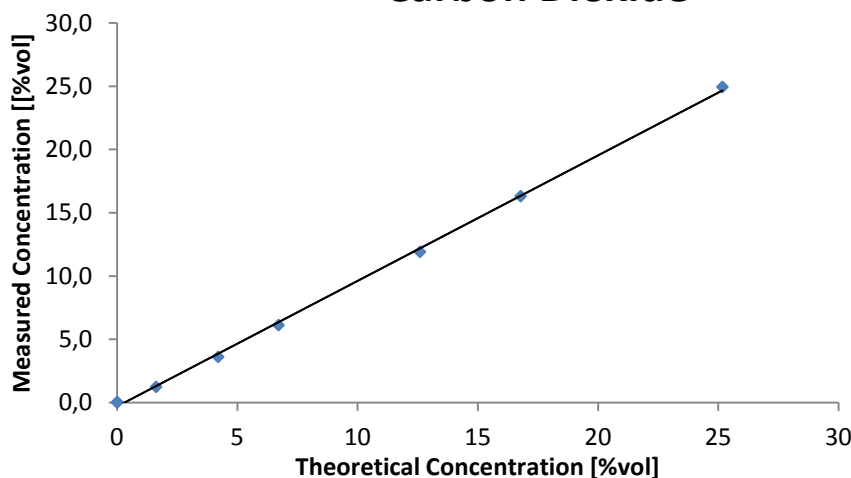




11.6 TEST LINEARITY OF CARBON DIOXIDE

Stack			6D			Data materials used			
Customer			D3 POWER GENERATION LIMITED			Cylinder Producer		SAPIO	
Parameter			CO ₂			Serial/Certificate		P69313YDEN	
Analyzer			SICK MCS 100 E			Concentration		25,17	%vol
Full Scale set			0- 25		%vol	Expiration		30/03/2019	
Date measurements			09/05/2017			Diluter		Beta CAP30RK	
Measurements and calculations									
CO ₂ %vol	Level	Reference Value (Y _i)	AMS Measure			X _c	Residual d _c	Relative Residual - % d _{c,rel}	Result
			Reply 1 (X _i)	Reply 2 (X _i)	Reply 3 (X _i)				
	0	0	0,1	0	0	0,0	0,33	1,3	Positive
	1	1,62	1,2	1,2	1,3	1,2	-0,08	-0,3	Positive
	2	4,2	3,6	3,6	3,6	3,6	-0,27	-1,1	Positive
	3	6,71	6,09	6,12	6,12	6,1	-0,24	-1,0	Positive
	4	12,59	11,9	11,9	11,9	11,9	-0,28	-1,1	Positive
	5	16,78	16,3	16,3	16,3	16,3	-0,04	-0,1	Positive
	6	25,17	25	24,9	24,9	24,9	0,28	1,1	Positive
	0	0	0	0	0	0,0	0,30	1,2	Positive
		Y _z	8,4	A'	8,0	B	0,991	A	-0,2965
	Legend								
Y _i : concentration of reference material; Xi: AMS measure corresponding to the Reference Material Concentration Level; Y _z : average concentration of reference material; A ' : the mean value of the Instrument's readings (AMS); B: Linear regression line coefficient; A: Linear regression line intercept									

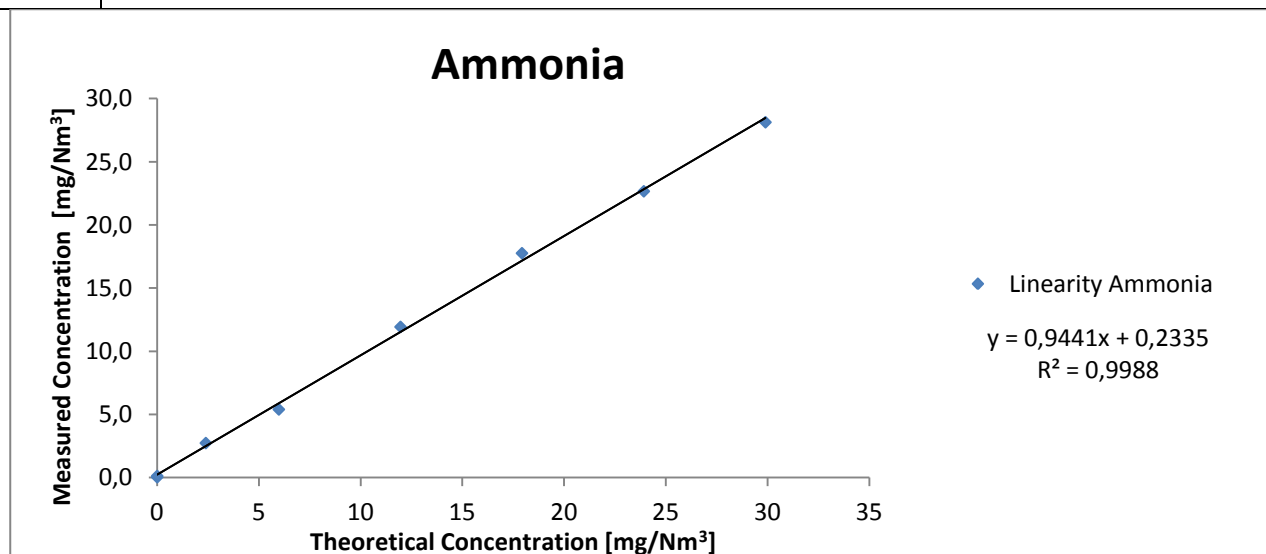
Carbon Dioxide





11.7 TEST LINEARITY OF AMMONIA

Stack		6D		Data materials used					
Customer		D3 POWER GENERATION LIMITED		Cylinder Producer		SAPIO			
Parameter		NH ₃		Serial/Certificate		P61AR3YDFN			
Analyzer		SICK MCS 100 E		Concentration		47,3	ppm		
Full Scale set		0- 30	mg/Nm3	Expiration		30/09/2017			
Date measurements		09/05/2017		Diluter		Beta CAP30RK			
Measurements and calculations									
NH3 mg/Nm3	Level	Reference Value (Y _i)	AMS Measure			X _c	Residual d _c	Relative Residual - % d _{c,rel}	Result
			Reply 1 (X _i)	Reply 2 (X _i)	Reply 3 (X _i)				
	0	0	0	0,1	0	0,0	-0,20	-0,7	Positive
	1	2,39	2,85	2,71	2,65	2,7	0,25	0,8	Positive
	2	5,98	5,4	5,3	5,5	5,4	-0,48	-1,6	Positive
	3	11,96	11,95	11,85	12	11,9	0,41	1,4	Positive
	4	17,93	18	17,7	17,6	17,8	0,60	2,0	Positive
	5	23,92	22,5	22,6	22,9	22,7	-0,15	-0,5	Positive
	6	29,9	28,1	28	28,3	28,1	-0,33	-1,1	Positive
	0	0	0,2	0,2	0	0,1	-0,10	-0,3	Positive
		Y _z	11,5	A'	11,1	B	0,944	A	0,2335
Legend									
<p>Y_i: concentration of reference material; X_i: AMS measure corresponding to the Reference Material Concentration Level; Y_z: average concentration of reference material; A': the mean value of the Instrument's readings (AMS); B: Linear regression line coefficient; A: Linear regression line intercept</p>									





12 ANNEX 3 – TEST REPORT

12.1 DETERMINATION OF THE VELOCITY PROFILE

Sampling and Analysis Report - Velocity Profile	
Determination of Velocity	UNI EN ISO 16911-1:2013 Annex A
Auxiliary Parameters	
Oxygen (O ₂)	UNI EN 14789:2006
Temperature	UNI EN ISO 16911-1:2013 Annex A
Pressure	UNI EN ISO 16911-1:2013 Annex A
Water vapor	UNI EN 14790:2006

Information on the instrumentation and materials used for sampling and analysis							
Instrumentation							
Speed and Flow Meter		DADO LAB	ST55AA20160199	DADO LAB - ST5 V8.5			
Gas Analyzer		Horiba	MY25EG2X	Analizzatore Horiba PG-350E			
Pitot Tube		Zambelli	91126	k =0,8304; Type Pitot (S)			
Emission Point Information							
Stack Diameter [m]		2,00	Height from Ground[m]			65	
Stack Surface [m ²]		3,14	Height from sampling point to the ground [m]			25	
Technical personnel who performed the sampling							
Dott. Giorgio Rocchia							
Ing. Calogero Romano							
Determination of the velocity profile							13/05/2017
Point	Diameter	Grid Sampling	Temperatura [°C]	Δpi [Pa]	Velocity [m/s]	Auxiliary Parameter	
1	1	9	161	108,1	13,6	Oxygen [% vol]	12,7
2	1	29	160	108,2	13,6		
3	1	59	161	108,6	13,6		
4	1	141	160	108,1	13,6	Carbon dioxide [%vol]	6,3
5	1	171	161	108,2	13,6		
6	1	191	161	108,1	13,6		
7						Water vapor [% vol]	5,80
8							
9							
10						Density - ρ (Kg/m ³)	1,316
11	2	9	162	108,1	13,6		
12	2	29	162	108,2	13,6		
13	2	59	161	108,1	13,6	Pressione Emissione [kPa]	101
14	2	141	160	108,1	13,6		
15	2	171	161	108,3	13,6		
16	2	191	160	108,2	13,6	Ambient Temperature [°C]	31
17							
18							
19						Ambient Pressure [hPa]	1011
20							



12.2 DUST REPORT

Sampling and Analysis Report - Dust							
Dust				UNI EN 13284 - 1 : 2003			
Auxiliary Parameters							
Velocity and Flow				UNI EN ISO 16911-1:2013 Annex A			
Oxygen (O ₂)				UNI EN 14789:2006			
Temperature				UNI EN ISO 16911-1:2013 Annex A			
Pressure				UNI EN ISO 16911-1:2013 Annex A			
Water vapor				UNI EN 14790:2006			
Information on the instrumentation and materials used for sampling and analysis							
Instrumentation							
Isokinetic Sampler		DADO LAB	ST55AA20160199	DADO LAB - ST5 V8.5			
Gas Analyzer		Horiba	MY25EG2X	Analizzatore Horiba PG-350E			
Pitot Tube		Zambelli	91126	k =0,8304; Type Pitot (S)			
Sampling material							
Filter Material		Glass Fiber Filter		Diameter [mm]		47	
Filtration Temperature		Stack Temperature		Conditioning Temperature [° C]		180	
Technical personnel who performed the sampling							
Dott. Giorgio Rocchia							
Ing. Calogero Romano							
Dust - Sampling and analysis Data							1
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Filter Code	Dust mass on the filter [mg]	Dust mass in the Rinsing solution [mg]	Sampling Volume [Nm ³] ⁽¹⁾
Method Blank		13/05/2017	/	FF51	0,00	0,06	1,000
2123749-001	Reply 1	13/05/2017 09:59	30	FF52	2,66	0,06	0,518
2123749-002	Reply 2	13/05/2017 10:59	30	FF53	2,38	0,06	0,526
2123749-003	Reply 3	13/05/2017 11:59	30	FF54	2,81	0,06	0,534
2123749-004	Reply 4	13/05/2017 12:59	30	FF55	2,55	0,04	0,524
2123749-005	Reply 5	13/05/2017 13:59	30	FF56	2,66	0,04	0,532
⁽¹⁾ For Blanks of the method is considered a volume of 1 m ³							



Dust - Sampling and analysis Data							2
I.D. Sample	Stack Speed [m/s]	Temperature [°C]	Pressure [kPa]	H ₂ O [%v/v]	O ₂ [%v/v]	Dust Concentration [mg/Nm ³] ⁽²⁾	Dust Concentration correct with O ₂ [mg/Nm ³] ⁽³⁾
Method Blank	/	161,00	101,0	6,38	15,00	0,06	0,06
2123749-001	13,33	161,10	101,1	7,13	12,68	5,25	3,79
2123749-002	13,47	161,55	101,2	6,46	12,65	4,64	3,33
2123749-003	13,61	161,84	101,2	5,97	12,62	5,37	3,84
2123749-004	13,27	161,71	101,3	6,56	12,60	4,95	3,53
2123749-005	13,44	162,24	101,3	5,78	12,91	5,09	3,77
⁽²⁾ Dust Concentration (Wet).							
⁽³⁾ Dust Concentration (Dry), normalized for temperature and pressure and corrected for reference oxygen.							
Dust - Quality Control (QC)							3
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Iso rate [%] ⁽⁴⁾	Result	Dust Concentration correct with O ₂ [mg/Nm ³] - Blank	Result ⁽⁵⁾
Method Blank		13/05/2017	/			0,06	Positive
2123749-001	Reply 1	13/05/2017 09:59	30	0,1	Positive		
2123749-002	Reply 2	13/05/2017 10:59	30	0	Positive		
2123749-003	Reply 3	13/05/2017 11:59	30	0	Positive		
2123749-004	Reply 4	13/05/2017 12:59	30	0	Positive		
2123749-005	Reply 5	13/05/2017 13:59	30	0,1	Positive		
⁽⁴⁾ Dust sampling must be done in isocinetics. The isocinet value must be within the Range -5% <G <+ 15%.							
⁽⁵⁾ Dust concentration in Method Blank must be less than 10% of the emission limit - ELV (paragraph 10.6 of UNI EN 13284-1: 2003 standard).							



12.3 COMBUSTION GAS REPORT

Nitrogen Oxides, Carbon Monoxide, Sulfur Dioxide, Oxygen and Carbon Dioxide - Sampling and Analysis Report					
Oxygen (O ₂)					UNI EN 14789:2017
Nitrogen Oxide (NO)					UNI EN 14792:2017
Carbon Monoxide (CO)					UNI EN 15058:2017
Sulfur Dioxide (SO ₂)					ISO 11042-1:1996
Carbon Dioxide (CO ₂)					ISO 11042-1:1996
Information on the instrumentation used for sampling and analysis					
Instrumentation					
Analizzatore Gas		Horiba	MY25EG2X	Analizzatore Horiba PG-350E	
Technical personnel who performed the sampling					
Dott. Giorgio Rocchia					
Ing. Calogero Romano					
Determination of Nitrogen Oxide (NO) - Sampling and analysis Data					1
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Nitrogen Oxide (NO) - [mg/Nm³] (2)	Oxygen (O₂) - [%vol] ⁽¹⁾
2123749-001	Reply 1	13/05/2017 12:29	30	53,18	12,32
2123749-002	Reply 2	13/05/2017 15:59	30	46,04	12,74
2123749-003	Reply 3	13/05/2017 16:59	30	45,36	12,93
2123749-004	Reply 4	13/05/2017 18:59	30	10,75	12,51
2123749-005	Reply 5	13/05/2017 19:59	30	16,59	12,30
Notes: (1) The oxygen value reported refers to the same measurement period of the parameter on which AST (NO _x) is performed. (2) The Nitric Oxide (NO) value is corrected for the reference oxygen, is normalized by temperature and pressure and is expressed on a dry basis.					



Determination of Carbon Monoxide (CO) - Sampling and analysis Data	2
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I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Carbon Monoxide (CO) - [mg/Nm ³]	Oxygen (O ₂) - [%vol] ⁽¹⁾
2123749-001	Reply 1	13/05/2017 09:59	30	0,22	12,68
2123749-002	Reply 2	13/05/2017 10:59	30	0,35	12,65
2123749-003	Reply 3	13/05/2017 11:59	30	0,25	12,62
2123749-004	Reply 4	13/05/2017 12:59	30	0,18	12,60
2123749-005	Reply 5	13/05/2017 13:59	30	68,51	12,91

Notes:

(1) The oxygen value reported refers to the same measurement period of the parameter on which AST (CO) is performed.

(2) The carbon monoxide (CO) value is corrected for the reference oxygen, is normalized by temperature and pressure and is expressed on a dry basis.

Determination of Sulfur Dioxide (SO₂) - Sampling and analysis Data	3
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I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Sulfur Dioxide (SO ₂) - [mg/Nm ³]	Oxygen (O ₂) - [%vol] ⁽¹⁾
2123749-001	Reply 1	13/05/2017 09:59	30	15,76702884	12,68316667
2123749-002	Reply 2	13/05/2017 10:59	30	17,71563236	12,65291667
2123749-003	Reply 3	13/05/2017 11:59	30	18,56949376	12,61833333
2123749-004	Reply 4	13/05/2017 12:59	30	18,97091147	12,59833333
2123749-005	Reply 5	13/05/2017 13:59	30	34,86975654	12,90716667

Notes:

(1) The oxygen value reported refers to the same measurement period of the parameter on which AST (SO₂) is performed.

(2) The sulfur dioxide (SO₂) value is corrected for the reference oxygen, is normalized by temperature and pressure and is expressed on a dry basis.



12.4 AMMONIA REPORT

Sampling and Analysis Report - Ammonia							
Ammonia				EPA CTM 027:1997			
Auxiliary Parameters							
Velocity and Flow				UNI EN ISO 16911-1:2013 Annex A			
Oxygen (O ₂)				UNI EN 14789:2006			
Temperature				UNI EN ISO 16911-1:2013 Annex A			
Pressure				UNI EN ISO 16911-1:2013 Annex A			
Water vapor				UNI EN 14790:2006			
Information on the instrumentation and materials used for sampling and analysis							
Instrumentation							
Isokinetic Sampler		DADO LAB	ST55AA20160199	DADO LAB - ST5 V8.5			
Gas Analyzer		Horiba	MY25EG2X	Analizzatore Horiba PG-350E			
Pitot Tube		Zambelli	91126	k = 0,8304; Type Pitot (S)			
Sampling material							
Filter Material		Glass Fiber Filter		Absorption solution		H ₂ SO ₄ - 0,1 N	
Filtration Temperature		Stack Temperature		Conditioning Temperature [° C]		180	
Technical personnel who performed the sampling							
Dott. Giorgio Rocchia							
Ing. Calogero Romano							
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Sampling Volume [Nm ³] ⁽¹⁾	Impinger G1 [mg]	Impinger G2 [mg]	Concentration [mg/Nm ³]
Method Blank		13/05/2017		1,000	0,000	0,000	/
2123749-001	Reply 1	13/05/2017 09:59	30	0,518	0,000	0,000	< 0,1
2123749-002	Reply 2	13/05/2017 10:59	30	0,526	0,000	0,000	< 0,1
2123749-003	Reply 3	13/05/2017 11:59	30	0,534	0,000	0,000	< 0,1
2123749-004	Reply 4	13/05/2017 12:59	30	0,524	0,000	0,000	< 0,1
2123749-005	Reply 5	13/05/2017 13:59	30	0,532	0,000	0,000	< 0,1

⁽¹⁾ For Blanks of the method is considered a volume of 1 m³





13 ANNEX 4 – AST REPORT

13.1 CARBON MONOXIDE - AST

Parameter		CO		
N. Test	DATE/TIME	SRM (Y) [mg/Nm ³ Rep. O ₂]	AMS (X) [mg/Nm ³ Rep. O ₂]	Difference (Xi)
1	13/5/17 9:59	0,22	1,32	-1,11
2	13/5/17 10:59	0,35	1,42	-1,06
3	13/5/17 11:59	0,25	1,47	-1,22
4	13/5/17 12:59	0,18	1,49	-1,31
5	13/5/17 13:59	68,51	61,93	6,58
Average		13,90	13,53	0,38
Standard deviation(S ₀)		3,47		
Y max -Y min		68,33		
Emission Limit Value [mg/Nm ³ rif O ₂]		264		
Confidence Internal limit value 95%		10		
Test value for variability kv		0,916		
Uncertainty σ ₀		13,47		
t student 0,95 (N-1)		2,13		
Test of variability S _D ≤ 1,5σ ₀ kv		Positive		
Test of Validity of the calibration function $\left \bar{D} \right \leq t_{0,95(N-1)} \frac{SD}{\sqrt{N}} + \sigma_0$		Positive		



13.2 NITROGEN OXIDE - AST

Parameter		NO		
N. Test	DATE/TIME	SRM (Y) [mg/Nm ³ Rep. O ₂]	AMS (X) [mg/Nm ³ Rep. O ₂]	Difference (Xi)
1	13/5/17 12:29	53,18	74,58	-21,40
2	13/5/17 15:59	46,04	72,27	-26,23
3	13/5/17 16:59	45,36	69,07	-23,70
4	13/5/17 18:59	10,75	22,92	-12,17
5	13/5/17 19:59	16,59	21,84	-5,25
Average		34,38	52,13	-17,75
Standard deviation(S _D)		8,78		
Y max -Y min		42,43		
Emission Limit Value [mg/Nm ³ rif O ₂]		176		
Confidence Internal limit value 95%		20		
Test value for variability kv		0,916		
Uncertainty σ ₀		17,96		
t student 0,95 (N-1)		2,13		
Test of variability S _D ≤ 1,5σ ₀ kv		Positive		
Test of Validity of the calibration function $\left \bar{D} \right \leq t_{0,95(N-1)} \frac{SD}{\sqrt{N}} + \sigma_0$		Positive		



13.3 SULFUR DIOXIDE - AST

Parameter		SO ₂		
N. Test	DATE/TIME	SRM (Y) [mg/Nm ³ Rep. O ₂]	AMS (X) [mg/Nm ³ Rep. O ₂]	Difference (Xi)
1	13/5/17 9:59	15,77	33,25	-17,48
2	13/5/17 10:59	17,72	28,39	-10,68
3	13/5/17 11:59	18,57	28,84	-10,27
4	13/5/17 12:59	18,97	28,71	-9,74
5	13/5/17 13:59	34,87	21,39	13,48
Average		21,18	28,12	-6,94
Standard deviation(S _D)		11,84		
Y max -Y min		19,10		
Emission Limit Value [mg/Nm ³ rif O ₂]		132		
Confidence Internal limit value 95%		20		
Test value for variability kv		0,916		
Uncertainty σ ₀		13,47		
t student 0,95 (N-1)		2,13		
Test of variability S _D ≤ 1,5σ ₀ kv		Positive		
Test of Validity of the calibration function $ \bar{D} \leq t_{0,95}(N-1) \frac{SD}{\sqrt{N}} + \sigma_0$		Positive		



13.4 DUST - AST

Parameter		Dust		
N. Test	DATE/TIME	SRM (Y) [mg/Nm ³ Rep. O ₂]	AMS (X) [mg/Nm ³ Rep. O ₂]	Difference (Xi)
1	13/5/17 9:59	3,79	6,53	-2,74
2	13/5/17 10:59	3,33	6,40	-3,06
3	13/5/17 11:59	3,84	6,47	-2,62
4	13/5/17 12:59	3,53	6,45	-2,91
5	13/5/17 13:59	3,77	6,99	-3,22
Average		3,65	6,57	-2,91
Standard deviation(S _D)		0,24		
Y max -Y min		0,51		
Emission Limit Value [mg/Nm ³ rif O ₂]		55		
Confidence Internal limit value 95%		30		
Test value for variability kv		0,916		
Uncertainty σ ₀		8,42		
t student 0,95 (N-1)		2,13		
Test of variability S _D ≤ 1,5σ ₀ kv		Positive		
Test of Validity of the calibration function $ \bar{D} \leq t_{0,95(N-1)} \frac{SD}{\sqrt{N}} + \sigma_0$		Positive		



13.5 AMMONIA

Parameter		NH ₃		
N. Test	DATE/TIME	SRM (Y) [mg/Nm ³ Rep. O ₂]	AMS (X) [mg/Nm ³ Rep. O ₂]	Difference (Xi)
1	13/5/17 9:59	0,05	0,28	-0,23
2	13/5/17 10:59	0,05	0,28	-0,23
3	13/5/17 11:59	0,05	0,28	-0,23
4	13/5/17 12:59	0,05	0,28	-0,23
5	13/5/17 13:59	0,05	0,28	-0,23
Average		0,05	0,28	-0,23
Standard deviation(S _D)		0,00		
Y max -Y min		0,00		
Emission Limit Value [mg/Nm ³ rif O ₂]		2,6		
Confidence Internal limit value 95%		40		
Test value for variability kv		0,916		
Uncertainty σ ₀		0,53		
t student 0,95 (N-1)		2,13		
Test of variability S _D ≤ 1,5σ ₀ kv		Positive		
Test of Validity of the calibration function $\left \bar{D} \right \leq t_{0,95(N-1)} \frac{SD}{\sqrt{N}} + \sigma_0$		Positive		



14 ANNEX 5 – QAL1 CERTIFIED SRM ANALYZER

	
<h1>CERTIFICATE</h1> <p>on Product Conformity (QAL1)</p>	
Certificate No.: 0000032301	
Certified AMS:	PG-350E for NO _x , SO ₂ , CO, CO ₂ and O ₂
Manufacturer:	HORIBA Europe GmbH Julius-Kronenberg-Str. 9 42799 Leichlingen Germany
Test Institute:	TÜV Rheinland Energie und Umwelt GmbH
<p>This is to certify that the AMS has been tested and found to comply with:</p> <p>EN 15267-1: 2009, EN 15267-2: 2009, EN 15267-3: 2007 and EN 14181: 2004</p> <p>Certification is awarded in respect of the conditions stated in this certificate (see also the following pages).</p>	
	
<ul style="list-style-type: none">• EN 15267-3 tested• QAL1 certified• TÜV approved• Annual inspection	
Publication in the German Federal Gazette (BAnz.) of 05 March 2013	This certificate will expire on: 04 March 2018
German Federal Environment Agency Dessau, 22 March 2013	TÜV Rheinland Energie und Umwelt GmbH Cologne, 21 March 2013
 i. A. Dr. Marcel Langner	 ppa. Dr. Peter Wilbring
www.umwelt-tuv.de / www.eco-tuv.com teu@umwelt-tuv.de Tel. +49 221 806-2756	TÜV Rheinland Energie und Umwelt GmbH Am Grauen Stein 51105 Cologne
Accreditation according to EN ISO/IEC 17025 and certified according to ISO 9001:2008.	
qal1.de	info@qal1.de
page 1 of 10	



Certificate:
0000032301 / 22 March 2013



Test report: 936/21217617/A of 05 October 2012
Initial certification: 05 March 2013
Expiry date: 04 March 2018
Publication: BAnz AT 05 March 2013 B10, chapter I, No. 5.2

Approved application

The tested AMS is suitable for use at combustion plants according to EC Directive 2001/80/EC, at waste incineration plants according to EC directive 2000/76/EC and other plants requiring official approval. The measured ranges have been selected considering the wide application range of the AMS.

The suitability of the AMS for this application was assessed on the basis of a laboratory test and a sevenmonth field test at a waste incineration plant.

The AMS is approved for an ambient temperature range of +5 °C to +40 °C.

Any potential user should ensure, in consultation with the manufacturer, that this AMS is suitable for the installation at which it will be installed.

Basis of the certification

This certification is based on:

- test report 936/21217617/A of 05 October 2012 of TÜV Rheinland Energie und Umwelt GmbH
- suitability announced by the German Federal Environment Agency (UBA) as the relevant body
- the ongoing surveillance of the product and the manufacturing process
- publication in the German Federal Gazette: BAnz AT 05 March 2013 B10, chapter I, No. 5.2



Certificate:
0000032301 / 22 March 2013



AMS designation:

PG-350E for NO_x, SO₂, CO, CO₂ and O₂

Manufacturer:

Horiba Europe GmbH, Leichlingen

Field of application:

Measurement at plants requiring official approval as well as plants within the scope of 2000/76/EC (waste incineration directive) and 2001/80/EC (large combustion plants directive)

Measuring ranges during the suitability test:

Components	Certification ranges	Supplementary ranges	Unit
NO _x	0 - 205 ¹⁾	0 - 2050 ²⁾	mg/m ³
SO ₂	0 - 143	0 - 1430	mg/m ³
CO	0 - 75	0 - 1250	mg/m ³
CO ₂	0 - 20	-	Vol.-%
O ₂	0 - 25	0 - 10	Vol.-%

¹⁾ as NO₂, this corresponds to apx 0 - 134 mg/m³ NO

²⁾ as NO₂, this corresponds to apx. 0 - 1340 mg/m³ NO

Software version:

P2000788001D / 1.11

Restrictions:

None

Notes:

1. The maintenance interval is four weeks.
2. The certification range for the component SO₂ is not suited to monitor the daily mean value at plants pursuant to 2000/76/EC.
3. The internal dryer should be by-passed for the test gas flow inside the PG-350E.
4. For measuring SO₂ the PD-100 permeation dryer manufactured by Horiba should be used.

Test report:

TÜV Rheinland Energie und Umwelt GmbH, Köln
Report No.: 936/21217617/A dated 05 October 2012



Certificate:
0000032301 / 22 March 2013



Certified product

This certificate applies to automated measurement systems conforming to the following description:

The PG-350E measuring system is a multi-channel gas analyser which uses different measuring principles according to the specific measured component. The following table lists the different measuring principles:

Measured component	Measuring principle
NO _x	Chemiluminescence
CO, SO ₂ , CO ₂	Non-dispersive absorption (NDIR) Infrared
O ₂	Paramagnetism

The HORIBA PG-350E measuring system is comprised of the main parts described below:

Sampling

Sampling probe: M&C Type PSP 4000-H/C

Heated sample gas filter Type SP-2K ceramic material, pore size 2µm

Sampling hose: M&C Type PSP-W 4M 4/6 (length for performance testing apx. 5 m)
(max. 120 °C)

Analyser

Horiba: PG-350E

Sample gas dryer

Horiba permeation dryer, type PD-100 with 100 permeation tubes

or


M&C Analysentechnik condensing dryer, type PSS-5

The measuring system may be operated with the PD-100 permeation dryer manufactured by Horiba or with the PSS-5 condensing dryer manufactured by M&C Analysentechnik.

Sample gas is led to the measuring system via a heated probe. The probe is equipped with an internal filter made of ceramic material with a pore size of 2µm. The sample gas is transported via a heated PTFE-line to a sample dryer before continuing via an unheated PTFE-line to the analyser. The pump is situated behind the measuring cell.


Integrating several measuring cells, the AMS performs simultaneous measurement of multiple components. The sample gas continuously flows through the respective measuring cell of the AMS.





Umwelt
Bundes
Amt
For our Environment

Certificate:
0000032301 / 22 March 2013



TÜVRheinland®
Precisely Right.

General notes
This certificate is based upon the equipment tested. The manufacturer is responsible for ensuring that on-going production complies with the requirements of the EN 15267. The manufacturer is required to maintain an approved quality management system controlling the manufacture of the certified product. Both the product and the quality management systems shall be subject to regular surveillance.

If a product of the current production does not conform to the certified product, TÜV Rheinland Energie und Umwelt GmbH must be notified at the address given on page 1.

A certification mark with an ID-Number that is specific to the certified product is presented on page 1 of this certificate. This can be applied to the product or used in publicity material for the certified product.

This document as well as the certification mark remains property of TÜV Rheinland Energie und Umwelt GmbH. With revocation of the publication the certificate loses its validity. After the expiration of the certificate and on requests of the TÜV Rheinland Energie und Umwelt GmbH this document shall be returned and the certificate mark must not be employed anymore.

The relevant version of this certificate and its expiration is also accessible on the internet: qal1.de.

Certification of PG-350E for NO_x, SO₂, CO, CO₂ and O₂ is based on the documents listed below and the regular, continuous monitoring of the Quality Management System of the manufacturer:



Initial certification according to EN 15267:
Certificate No. 0000032301: 22 March 2013
Expiry date of the certificate: 04 March 2018
Test report: 936/21217617/A dated 05 October 2012
TÜV Rheinland Energie und Umwelt GmbH, Cologne
Publication: BAnz AT 05 March 2013 B10, chapter I, No. 5.2
Announcement by UBA from 12 February 2013

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page 5 of 10



	<p align="center">Certificate: 0000032301 / 22 March 2013</p>	
<p align="center">Calculation of overall uncertainty according to EN 14181 and EN 15267-3</p>		
Measuring system		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB0 / XL7LTUL1	
Measuring principle	Chemiluminescence	
Test report	21217817/A	
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
Measured component	NO _x as NO	
Certification range	0 - 134 mg/m ³	
Evaluation of the cross sensitivity (CS) (system with largest CS)		
Sum of positive CS at zero point	0,84 mg/m ³	
Sum of negative CS at zero point	0,00 mg/m ³	
Sum of positive CS at reference point	0,00 mg/m ³	
Sum of negative CS at reference point	-0,70 mg/m ³	
Maximum sum of cross sensitivities	0,84 mg/m ³	
Uncertainty of cross sensitivity	0,487 mg/m ³	
Calculation of the combined standard uncertainty		
Tested parameter		u²
Standard deviation from paired measurements under field conditions *	u _D mg/m ³	0,797 (mg/m ³) ²
Lack of fit	u _{LF} mg/m ³	0,336 (mg/m ³) ²
Zero drift from field test	u _{0,z} mg/m ³	0,082 (mg/m ³) ²
Span drift from field test	u _{0,s} 2,035 mg/m ³	4,141 (mg/m ³) ²
Influence of ambient temperature at span	u _t 1,332 mg/m ³	1,774 (mg/m ³) ²
Influence of supply voltage	u _v 0,306 mg/m ³	0,094 (mg/m ³) ²
Cross sensitivity (interference)	u _i mg/m ³	0,238 (mg/m ³) ²
Influence of sample gas flow	u _g mg/m ³	0,013 (mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u _{rm} mg/m ³	1,173 (mg/m ³) ²
Converter efficiency for AMS measuring NO _x	u _{ce} mg/m ³	10,583 (mg/m ³) ²
* The larger value is used: * Repeatability standard deviation at span* or * Standard deviation from paired measurements under field conditions"		
Combined standard uncertainty (u _c)	$u_c = \sqrt{\sum (u_{max,j})^2}$	4,38 mg/m ³
Total expanded uncertainty	$U = u_c \cdot k = u_c \cdot 1.96$	8,59 mg/m ³
Relative total expanded uncertainty	U in % of the ELV 131 mg/m ³	6.6
Requirement of 2000/76/EC and 2001/80/EC	U in % of the ELV 131 mg/m ³	20.0
Requirement of EN 15267-3	U in % of the ELV 131 mg/m ³	15.0

qal1.de info@qal1.de page 6 of 10



Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system

Manufacturer Horiba Europe GmbH
Name of measuring system PG-350E
Serial number of the candidates VC4DFKB9 / XL7LTUL1
Measuring principle NDIR

Test report

Test laboratory TÜV Rheinland
Date of report 2012-10-08

Measured component

SO₂
Certification range 0 - 143 mg/m³

Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point 0.54 mg/m³
Sum of negative CS at zero point -0.69 mg/m³
Sum of positive CS at reference point 0.70 mg/m³
Sum of negative CS at reference point -2.60 mg/m³
Maximum sum of cross sensitivities -2.60 mg/m³
Uncertainty of cross sensitivity -1.503 mg/m³

Calculation of the combined standard uncertainty

Tested parameter

		u ²
Standard deviation from paired measurements under field conditions *	u ₀ mg/m ³	1.672 (mg/m ³) ²
Lack of fit	u _{lof} mg/m ³	0.334 (mg/m ³) ²
Zero drift from field test	u _{zdr} mg/m ³	3.881 (mg/m ³) ²
Span drift from field test	u _{sdr} mg/m ³	4.713 (mg/m ³) ²
Influence of ambient temperature at span	u _t 1.752 mg/m ³	3.070 (mg/m ³) ²
Influence of supply voltage	u _v 0.790 mg/m ³	0.624 (mg/m ³) ²
Cross sensitivity (interference)	u _i mg/m ³	2.258 (mg/m ³) ²
Influence of sample gas flow	u _p mg/m ³	0.067 (mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u _{rm} mg/m ³	1.336 (mg/m ³) ²

* The larger value is used:

"Repeatability standard deviation at span" or

"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_c) $u_c = \sqrt{\sum (u_{max,i})^2}$ 4.23 mg/m³
Total expanded uncertainty $U = u_c \cdot k = u_c \cdot 1.96$ 8.30 mg/m³

Relative total expanded uncertainty



U in % of the ELV 60 mg/m³ 13.8
Requirement of 2000/76/EC and 2001/80/EC 20.0

Requirement of EN 15267-3

U in % of the ELV 60 mg/m³



15.0



	<p align="center">Certificate: 0000032301 / 22 March 2013</p>	
<p align="center">Calculation of overall uncertainty according to EN 14181 and EN 15267-3</p>		
Measuring system		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB0 / XL7LTUL1	
Measuring principle	NDIR	
Test report	21217617/A	
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
Measured component	CO	
Certification range	0 - 75 mg/m ³	
Evaluation of the cross sensitivity (CS) (system with largest CS)		
Sum of positive CS at zero point	0.00 mg/m ³	
Sum of negative CS at zero point	0.00 mg/m ³	
Sum of positive CS at reference point	0.50 mg/m ³	
Sum of negative CS at reference point	-0.65 mg/m ³	
Maximum sum of cross sensitivities	-0.65 mg/m ³	
Uncertainty of cross sensitivity	-0.377 mg/m ³	
Calculation of the combined standard uncertainty		
Tested parameter		
Standard deviation from paired measurements under field conditions *	u_D mg/m ³	0.356 (mg/m ³) ²
Lack of fit	u_{lof} mg/m ³	0.070 (mg/m ³) ²
Zero drift from field test	u_{zdr} mg/m ³	0.706 (mg/m ³) ²
Span drift from field test	u_{sdr} mg/m ³	0.456 (mg/m ³) ²
Influence of ambient temperature at span	u_t 0.866 mg/m ³	0.750 (mg/m ³) ²
Influence of supply voltage	u_v 0.286 mg/m ³	0.082 (mg/m ³) ²
Cross sensitivity (interference)	u_i mg/m ³	0.142 (mg/m ³) ²
Influence of sample gas flow	u_p mg/m ³	0.001 (mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u_{rm} mg/m ³	0.368 (mg/m ³) ²
* The larger value is used: "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"		
Combined standard uncertainty (u_c)	$u_c = \sqrt{\sum (u_{max})^2}$	1.71 mg/m ³
Total expanded uncertainty	$U = u_c \cdot k = u_c \cdot 1.96$	3.35 mg/m ³
Relative total expanded uncertainty	U in % of the ELV 50 mg/m³	6.7
Requirement of 2000/76/EC and 2001/80/EC	U in % of the ELV 50 mg/m³	10.0
Requirement of EN 15267-3	U in % of the ELV 50 mg/m³	7.5

qa11.de info@qa11.de page 6 of 10



	Certificate: 0000032301 / 22 March 2013	
Calculation of overall uncertainty according to EN 14181 and EN 15267-3		
Measuring system		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB9 / XL7LTUL1	
Measuring principle	NDIR	
Test report		
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
Measured component		
Certification range	CO ₂ 0 - 20 Vol.-%	
Evaluation of the cross sensitivity (CS) (system with largest CS)		
Sum of positive CS at zero point	0.00	Vol.-%
Sum of negative CS at zero point	0.00	Vol.-%
Sum of positive CS at reference point	0.00	Vol.-%
Sum of negative CS at reference point	-0.11	Vol.-%
Maximum sum of cross sensitivities	-0.11	Vol.-%
Uncertainty of cross sensitivity	-0.064	Vol.-%
Calculation of the combined standard uncertainty		
Tested parameter		
Standard deviation from paired measurements under field conditions *	U _D	Vol.-% 0.000 (Vol.-%) ²
Lack of fit	U _{LOF}	Vol.-% 0.013 (Vol.-%) ²
Zero drift from field test	U _{ZD}	Vol.-% 0.071 (Vol.-%) ²
Span drift from field test	U _{SD}	0.238 Vol.-% 0.057 (Vol.-%) ²
Influence of ambient temperature at span	U _t	0.115 Vol.-% 0.013 (Vol.-%) ²
Influence of supply voltage	U _v	0.051 Vol.-% 0.003 (Vol.-%) ²
Cross sensitivity (interference)	U _i	Vol.-% 0.004 (Vol.-%) ²
Influence of sample gas flow	U _g	Vol.-% 0.000 (Vol.-%) ²
Uncertainty of reference material at 70% of certification range	U _{rm}	Vol.-% 0.026 (Vol.-%) ²
* The larger value is used : "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"		
Combined standard uncertainty (u _c)	$u_c = \sqrt{\sum (u_{max,i})^2}$	0.43 Vol.-%
Total expanded uncertainty	$U = u_c \cdot k = u_c \cdot 1.96$	0.85 Vol.-%
Relative total expanded uncertainty		
Requirement of 2000/76/EC and 2001/80/EC	U in % of the range 20 Vol.-%	4.2
Requirement of EN 15267-3	U in % of the range 20 Vol.-%	10.0**
	U in % of the range 20 Vol.-%	7.5
** For this component no requirements in the EC-directives 2001/80/EG und 2000/76/EG are given. The chosen value is recommended by the certification body.		
qal1.de	info@qal1.de	page 9 of 10



Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system

Manufacturer
Name of measuring system
Serial number of the candidates
Measuring principle

Horiba Europe GmbH
PG-350E
VC4DFKB9 / XL7LTUL1
Paramagnetism

Test report

Test laboratory
Date of report

21217617/A
TÜV Rheinland
2012-10-08

Measured component

Certification range

O₂
0 - 25 Vol.-%

Evaluation of the cross sensitivity (CS)
(system with largest CS)

Sum of positive CS at zero point	0.00	Vol.-%
Sum of negative CS at zero point	0.00	Vol.-%
Sum of positive CS at reference point	0.00	Vol.-%
Sum of negative CS at reference point	0.00	Vol.-%
Maximum sum of cross sensitivities	0.00	Vol.-%
Uncertainty of cross sensitivity	0.000	Vol.-%

Calculation of the combined standard uncertainty

Tested parameter

			u ²
Standard deviation from paired measurements under field conditions *	u _D	Vol.-%	0.004 (Vol.-%) ²
Lack of fit	u _{lof}	Vol.-%	0.000 (Vol.-%) ²
Zero drift from field test	u _z	Vol.-%	0.006 (Vol.-%) ²
Span drift from field test	u _s	Vol.-%	0.008 (Vol.-%) ²
Influence of ambient temperature at span	u _t	Vol.-%	0.007 (Vol.-%) ²
Influence of supply voltage	u _v	Vol.-%	0.000 (Vol.-%) ²
Cross sensitivity (Interference)	u _i	Vol.-%	0.000 (Vol.-%) ²
Influence of sample gas flow	u _g	Vol.-%	0.000 (Vol.-%) ²
Uncertainty of reference material at 70% of certification range	u _{rm}	Vol.-%	0.041 (Vol.-%) ²

* The larger value is used:

"Repeatability standard deviation at span" or

"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u _c)	$u_c = \sqrt{\sum (u_{max,i})^2}$	0.26	Vol.-%
Total expanded uncertainty	$U = u_c \cdot k = u_c \cdot 1.96$	0.51	Vol.-%

Relative total expanded uncertainty

Requirement of 2000/76/EC and 2001/80/EC	U in % of the range 25 Vol.-%	2.0
Requirement of EN 15267-3	U in % of the range 25 Vol.-%	10.0**
	U in % of the range 25 Vol.-%	7.5

** For this component no requirements in the EC-directives 2001/80/EG und 2000/76/EG are given.
The chosen value is recommended by the certification body.



15 ANNEX 6 – DILUTION SYSTEM CALIBRATION CERTIFICATE

Kalibrierlaboratorium der TetraTec Instruments GmbH
Calibration Laboratory of TetraTec Instruments GmbH

TetraTec
Instruments

akkreditiert durch die / accredited by the

Deutsche Akkreditierungsstelle GmbH



Deutsche
Akkreditierungsstelle
D-K-17569-01-00

als Kalibrierlaboratorium im / as calibration laboratory in the

Deutschen Kalibrierdienst

DKD

Kalibrierschein
Calibration certificate

Kalibrierzeichen
Calibration mark

06013
D-K- 17569-01-00
2014-10

Gegenstand
Object

Gas Blender

Hersteller
Manufacturer

Be.T.A Strumentazione S.r.l

Typ
Type

BetaCAP30 RK

Fabrikat/Serien-Nr.
Serial number

300229

Auftraggeber
Customer

**Chimica Applicata Depurazione Acque
S.n.c
92013 Menfi, Italy**

Auftragsnummer
Order No.

PF790

Anzahl der Seiten des Kalibrierscheines
Number of pages of the certificate

3

Datum der Kalibrierung
Date of calibration

22.10.2014

Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung sowohl der Deutschen Akkreditierungsstelle als auch des ausstellenden Kalibrierlaboratoriums. Kalibrierscheine ohne Unterschrift haben keine Gültigkeit.

This calibration certificate may not be reproduced other than in full except with the permission of both the German Accreditation Body GmbH and the Issuing laboratory. Calibration certificates without signature are not valid.

Datum
Date

22.10.2014

Leiter des Kalibrierlaboratoriums
Head of the calibration laboratory
Dr.rer.nat. Johannes Schubert

Bearbeiter
Person in charge

PTA Dominik Wörn

TetraTec Instruments GmbH · Gewerbestrasse 8 · 71144 Steinenbronn · Germany
Tel +497157/53870 · Fax +497157/538710 · www.tetratec.de · info@tetratec.de

File: CAL032528
DA0999 VQ300 R00



Calibration Laboratory of TetraTec Instruments GmbH

Seite 2 of 3
Page english version

06013
D-K 17589-01-00
2014-10

1.) Calibration object: Gas Blender
Type: BetaCAP30 RK
Manufacturer: Be.T.A. strumentazione
Serial-No.: 300229
Meas.range: ca. 3.091 sml/min air
at a relative pressure of ca. 1000 hPa
Standard conditions: standard volume flows are related to standard conditions
1013,25 hPa ; 293,15°K (20 °C) ; 0 % r.F.

2.) Calibration standards: Laminar Flow Element
Type: LDS-ES-05-10 50MJ10-14 50MJ10-12
Serial-No.: LDS-ES-05-10 2.3 776810-N7 752050-J13
Meas.range: 50...1350 ml/min 160...3500 ml/min 1000...12000 ml/min

3.) Calibration procedure:

Before the calibration the unit under test (uut) rested at least 6 hours in the laboratory for thermal accommodation.

calibration-medium: compressed air
calibration set-up: compressed air, 1000 hPa rel. - cal.standard 1 - unit under test -
calibration standard 2 - atmosphere

The calibration set-up was leak-proofed before the calibration.
To avoid running-in effects the uut was run at least 10 min. at max. flow before taking measurements. Measurements were taken not before 3 min after tuning the flow.

4.) Ambient conditions during calibration

atmospheric pressure: $964,5 \pm 1,0$ hPa
room temperature: $23,0 \pm 1,0$ °C
atmospheric humidity: $32,2 \pm 5,0$ %r.F.

5.) Uncertainties of measurement

volume flow: 0,65% o.r. for $Q \geq 10$ l/h
0,85% o.r. for $Q < 10$ l/h
absolute pressure: 0,10% o.r.

Given is the extended uncertainty, which is calculated from the standard uncertainty by multiplication with the extension factor $k = 2$. It was determined according to DKD-3 / EAL-R2. The value of the measured variable is in the corresponding interval of values with a probability of 95%.

The given uncertainties of values are composed of the uncertainties of the calibration procedure and that of the uut during calibration. A part for the long-term-instability of the uut is not included.

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File: CAL032528



Calibration Laboratory of TetraTec Instruments GmbH

Seite 3 of 3
Page english version

06013
D-K 17589-01-00
2014-10

6.) results

Given values have the following meaning:

Step : selected divider-step
 $Q_{N,TG1}$: measured standard volume flow inlet gas to be diluted ("TG1")
 $Q_{N,OUT}$: measured standard volume flow diluted gas output ("OUT")
 $Q_{N,TG0}$: calculated standard volume flow diluting gas inlet ("TG0"), $Q_{N,TG0} = Q_{N,OUT} - Q_{N,TG1}$
 c_S : Concentration according to divider step (as displayed)
 c_I : Concentration calculated from flow values
 $c_I = 100\% \cdot Q_{N,TG1} / (Q_{N,TG0} + Q_{N,TG1})$
dev.: deviation calculated concentration against displayed value
dev. = $c_I - c_S$
unc.: uncertainty of c_I due to uncertainties of the measured flows

$$unc. = \sqrt{\left(\frac{\partial c}{\partial Q_1} \cdot uQ_1\right)^2 + \left(\frac{\partial c}{\partial Q_2} \cdot uQ_2\right)^2} \quad \text{resp.} \quad unc.(c=100\%)=0$$

All measurements were performed at an entrance pressure of the gas-blender of ca. 1000 hPa rel.

Step	$Q_{N,TG1}$	$Q_{N,TG0}$	$Q_{N,OUT}$	c_S	c_I	dev.	unc.
-	ml/min	ml/min	ml/min	%	%	%	%
0	0,00	3116,1	3116,1	0,00	0,00	0,00	0,00
1	106,82	3014,4	3121,2	3,33	3,42	0,09	0,04
2	210,99	2891,7	3102,7	6,67	6,80	0,13	0,06
4	421,33	2685,3	3106,6	13,33	13,56	0,23	0,12
8	837,74	2279,1	3116,8	26,67	26,88	0,21	0,25
15	1524,3	1534,0	3058,3	50,00	49,84	-0,16	0,46
30	3016,3	0,0	3016,3	100,00	100,00	0,00	0,00

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File: CAL032528



16 ANNEX 7 - CERTIFICATE OF ACCREDITATION TO UNI CEI EN ISO / IEC 17025: 2005



CERTIFICATO DI ACCREDITAMENTO Accreditation Certificate

Accreditamento n°
Accreditation n°

0439

Rev. 4

Si dichiara che
We declare that

**CHIMICA APPLICATA DEPURAZIONE ACQUE di
GIGLIO FILIPPO & C. Snc**

Sede:
Via Pio La Torre, 13 - AREA P.I.P. - 92013 Menfi AG

è conforme ai requisiti
della norma

UNI CEI EN ISO/IEC 17025:2005 "Requisiti generali per la competenza dei
Laboratori di prova e taratura"

meets the requirements
of the standard

EN ISO/IEC 17025:2005 "General Requirements for the Competence of Testing
and Calibration Laboratories" standard

quale

Laboratorio di Prova

as

Testing Laboratory

L'accreditamento attesta la competenza tecnica del Laboratorio relativamente allo scopo riportato nelle schede allegate al presente certificato. Le schede possono variare nel tempo. I requisiti gestionali della ISO/IEC 17025:2005 (sezione 4) sono scritti in un linguaggio idoneo all'attività dei Laboratori di Prova, sono conformi ai principi della ISO 9001:2008 ed allineati con i suoi requisiti applicabili.

Il presente certificato non è da ritenersi valido se non accompagnato dalle schede allegate e può essere sospeso o revocato in qualsiasi momento nel caso di inadempienza accertata da parte di ACCREDIA.

La validità dell'accreditamento può essere verificata sul sito WEB (www.accredia.it) o richiesta direttamente ai singoli Dipartimenti.

The accreditation certifies the technical competence of the laboratory limited to the scope detailed in the attached Enclosure. The scope may vary in the time. The management system requirements in ISO/IEC 17025:2005 (Section 4) are written in a language relevant to Testing Laboratories operations and meet the principles of ISO 9001:2008 and are aligned with its pertinent requirements.

The present certificate is valid only if associated to the annexed schedule, and can be suspended or withdrawn at any time in the event of non fulfilment as ascertained by ACCREDIA.

The in force status of the accreditation may be checked in the WEB site (www.accredia.it) or on direct request to appointed Department.

Data di 1ª emissione
1st issue date
2002-11-14

Data di modifica
Modification date
2015-02-17

Data di scadenza
Expiring date
2018-02-07

Il Direttore Generale
The General Director
(Dr. Filippo Trifiletti)

Il Direttore di Dipartimento
Department Director
(Dr.ssa Silvia Tramontin)

Il Presidente
The President
(Cav. del Lav. Federico Grazioli)



17 ANNEX 8 - CERTIFICATES REFERENCE MATERIAL



SAPIO PRODUZIONE IDROGENO OSSIGENO S.r.l.

SFIDE LEGALE: VIA SAN MAURIZIO 13, 20123, MILANO
UNICI OPERATIVI: VIA SENATORE SMOLETTA 27, 20057, CAPONAGO (MB)
TELEFONO: 02.857081 / TELEFAX: 02.85740842

CERTIFICATO DI ANALISI Certificate of analysis

638-04

CLIENTE: CHIMICA APPLICATA DEPURAZIONE ACQUE
Customer:

INDIRIZZO: VIA PIO LA TORRE 13 - AREA PIP MENFI 92013 AG
Address:

NUMERO ORDINE: 3632091
Order number

CODICE RIORDINO: P66313YDEN
Code reordering:

PER RIORDINO: ordini@sapio.it
Numero verde: 800416110

MATRICOLA: P35756
Serial number:

CAPACITA' (litri): 10
Capacity (liters):

SCADENZA
PROVA IDRAULICA: 01/2025
Expiration hydraulic test:

CONTENUTO: MISCELA DI GAS
Content:

RECIPIENTE: BOMBOLA GRUPPO 5-UNI1144
INOX
Vessel:

METODO DI PREPARAZIONE: GRAVIMETRICO SECONDO NORME ISO 6142 - ISO 6143
Method of preparation:

COMPONENTE Componente	RICHIESTA Request	CONCENTRAZIONE (C) Concentration (C)	incertezza Relativa (ΔC%) Relative Uncertainty (ΔC%)
BIOSSIDO DI CARBONIO	25,00 %	25,17 %	2,0%
OSSIDO DI CARBONIO	230 ppm	231 ppm	2,0%
OSSIDO DI AZOTO	300 ppm	298 ppm	2,0%
ANIDRIDE SOLFOROSA	50,0 ppm	49,3 ppm	2,0%
OSSIDI DI AZOTO TOTALI	-	297 ppm	2,0%

Complemento: AZOTO
Balance:

Concentrazione (C) espressa in termini di: mol/m³
Concentration (C) expressed in terms of:

L'incertezza relativa (ΔC%) riportata è espressa come incertezza estesa relativa con fattore di copertura k=2, corrispondente ad un livello di fiducia del 95% circa.

Riferibilità: La taratura del misuratore di massa utilizzato per la preparazione della miscela è effettuata utilizzando masse certificate dal centro di taratura LAT n°055;
Tracciabilità: la taratura delle masse è eseguita in conformità alla procedura PTS3;
I certificati di riferimento delle masse utilizzate sono:
LAT055 451/2015; 572/2015; 029/2015; 027/2015

Note:
Note:

PRESSIONE DI RIEMPIMENTO (bar): Filling pressure (bar):	120,0	RISCHI PER LA SALUTE: Health hazard:	NOCIVO
PRESSIONE MINIMA DI UTILIZZO (bar): Minimum pressure (bar):	12	PROPRIETÀ CHIMICO-FISICHE: Chemical and physical properties:	INERTE
TEMPERATURA DI STOCCAGGIO (°C): Storage temperature (°C):	0-40	DATA DI SCADENZA: Expiry date:	03/2019

Data certificato: 31/03/2017
Certification date:

Numero certificato: 201702238A
Certificate number:

Operatore: F. Padovani
Operator:



SAPIO PRODUZIONE IDROGENO OSSIGENO S.r.l.

S.r.l. LEGALE: VIA SAN MAURELIO 13, 20123, MILANO
UFFICIO OPERATIVO: VIA SENATORI SIMONE TTA 27, 20067, CAPONAGO (MB)
TELEFONO: 02.957051 / TELEFAX: 02.95740841

CERTIFICATO DI ANALISI
Certificate of analysis

C-39-01

CLIENTE: CHIMICA APPLICATA DEPURAZIONE ACQUE

Customer:

INDIRIZZO: VIA PIO LA TORRE 13 - AREA PIP - MENFI 92013 AG

Address:

NUMERO ORDINE: 3632354

Order number:

CODICE RIORDINO: P61YZ3YDFN

Code reordering:

PER RIORDINO: ordini@sapio.it

Numero verde: 800416110

MATRICOLA: MP31905

Serial number:

CAPACITA' (litri): 10

Capacity (liters):

SCADENZA

PROVA IDRAULICA: 07/2018

Expiration hydraulic test:

CONTENUTO: MISCELA DI GAS

Content:

RECIPIENTE: BOMBOLA GRUPPO 5-UNI11144

INOX

Vessel:

METODO DI PREPARAZIONE: GRAVIMETRICO SECONDO NORME ISO 6142 - ISO 6143

Method of preparation:

COMPONENTE Component	RICHIESTA Request	CONCENTRAZIONE (C) Concentration (C)	Incertezza Relativa (ΔC%) Relative Uncertainty (ΔC%)
OSSIDO DI AZOTO	80,0 ppm	81,31 ppm	2,0%

Complemento: AZOTO

Balance:

Concentrazione (C) espressa in termini di: mol/mol

Concentration (C) expressed in terms of:

L'incertezza relativa (ΔC%) riportata è espressa come incertezza estesa relativa con fattore di copertura $k=2$, corrispondente ad un livello di fiducia del 95% circa.

Riferibilità: La taratura del misuratore di massa utilizzato per la preparazione della miscela è effettuata utilizzando masse certificate dal centro di taratura LAT n°065;
Traceability: la taratura delle miscele è eseguita in conformità alla procedura PTSS3;
I certificati di riferimento delle masse utilizzate sono:
LAT055 451/2015; 572/2015; 028/2015; 027/2015

Note:

Note:

PRESSIONE DI RIEMPIMENTO (bar): Filling pressure (bar):	150	RISCHI PER LA SALUTE: Health hazards:	ASFISSIANTE SEMPLICE
PRESSIONE MINIMA DI UTILIZZO (bar): Minimum pressure (bar):	15	PROPRIETÀ CHIMICO-FISICHE: (Chemical and physical properties):	INERTE
TEMPERATURA DI STOCCAGGIO (°C): Storage temperature (°C):	0-40	DATA DI SCADENZA: Expiry date:	03/2018

Data certificato: 23/03/2017

Certification date:

Numero certificato: 201702018

Certificate number:

Operatore: M. Bignardi

Operator:



SAPIO PRODUZIONE IDROGENO OSSIGENO S.r.l.

SEDE LEGALE: VIA SAN MAURILIO 13, 20153, MILANO
UFFICIO OPERATIVO: VIA SENATORE SMONETTA 27, 20867, CAPONAGO (MB)
TELEFONO: 02.867051 / TELEFAX: 02.86740842

CERTIFICATO DI ANALISI
Certificate of analysis

G18-02

CLIENTE: CHIMICA APPLICATA DEPURAZIONE ACQUE
Customer:
INDIRIZZO: VIA PIO LA TORRE 13 - AREA PIP - MENFI 92013 AG
Address:

NUMERO ORDINE: 3632354 CODICE RIORDINO: P61LB2BDFN
Order number Code reordering:

PER RIORDINO: ordini@sapio.it
Numero verde: 800416110

MATRICOLA: P33021 CAPACITA' (litri): 10
Serial number Capacity (liters):

SCADENZA
PROVA IDRAULICA: 02/2024
Expiration hydraulic test:

CONTENUTO: MISCELA DI GAS RECIPIENTE: BOMBOLA GRUPPO 2-UNIT1144
Content: Vessel:

METODO DI PREPARAZIONE: GRAVIMETRICO SECONDO NORME ISO 6142 - ISO 6143
Method of preparation:

COMPONENTE Component	RICHIESTA Request	CONCENTRAZIONE (C) Concentration (C)	incertezza Relativa ($\Delta C\%$) Relative Uncertainty ($\Delta C\%$)
OSSIGENO	25,00 %	25,06 %	2,0%

Complemento: AZOTO
Balance:

Concentrazione (C) espressa in termini di: mol/mol
Concentration (C) expressed in terms of:

L'incertezza relativa ($\Delta C\%$) riportata è espressa come incertezza estesa relativa con fattore di copertura $k=2$, corrispondente ad un livello di fiducia del 95% circa.

Riferibilità: La taratura del m suratore di massa utilizzato per la preparazione della miscela è effettuata utilizzando masse certificate dal centro di taratura LAT n°055.
Traceability: la taratura delle masse è eseguita in conformità alla procedura PTS3;
I certificati di riferimento delle masse utilizzate sono:
LAT055 451/2015; 572/2015; 028/2015, 027/2015

Note:
Note:

PRESSIONE DI RIEMPIMENTO (bar): Filling pressure (bar):	150,00	RISCHI PER LA SALUTE: Health hazards:	-
PRESSIONE MINIMA DI UTILIZZO (bar): Minimum pressure (bar):	15	PROPRIETA' CHIMICO-FISICHE: Chemical and physical properties:	COMBURENTE
TEMPERATURA DI STOCCAGGIO (°C): Storage temperature (°C):	0-40	DATA DI SCADENZA: Expiry date:	03/2020

Data certificato: 22/03/2017
Certification date:

Numero certificato: 201701957
Certificate number:

Operator: S. Manzoni
Operator:



SAPIO PRODUZIONE IDROGENO OSSIGENO S.r.l.

SEDE LEGALE: VIA SAN MAURILIO 13, 20123, MILANO
UFFICI OPERATIVI: VIA SENATORE SIMONE TTA 27, 20067, CAPONAGO (MB)
TELEFONO: 02.817051 / TELEFAX: 02.85740842

CERTIFICATO DI ANALISI
Certificate of analysis

630-02

CLIENTE: CHIMICA APPLICATA DEPURAZIONE ACQUE
Customer:
INDIRIZZO: VIA PIO LA TORRE 13 - AREA PIP MENFI 92013 AG
Address:

NUMERO ORDINE: 3633364
Order number

CODICE RIORDINO: P61AR3YDFN
Code reordering:

PER RIORDINO: ordini@sapiogroup.it
Numero verde: 800416110

MATRICOLA: MP17107
Serial number:

CAPACITA' (litri): 10
Capacity (liters):

SCADENZA
PROVA IDRAULICA: 03/2024
Expiration hydraulic test:

CONTENUTO: MISCELA DI GAS
Content:

RECIPIENTE: BOMBOLA GRUPPO 5-UNI1144
INOX
Vessel:

METODO DI PREPARAZIONE: GRAVIMETRICO SECONDO NORME ISO 6142 - ISO 6143
Method of preparation:

COMPONENTE Component	RICHIESTA Request	CONCENTRAZIONE (C) Concentration (C)	Incertezza Relativa (ΔC%) Relative Uncertainty (ΔC%)
AMMONIACA	50.0 ppm	47.3 ppm	2.0%

Complemento: AZOTO Balance:	Concentrazione (C) espressa in termini di: mol/mo Concentration (C) expressed in terms of:
--------------------------------	---

L'incertezza relativa (ΔC%) riportata è espressa come incertezza estesa relativa con fattore di copertura k=2, corrispondente ad un livello di fiducia del 95% circa.

Riferibilità:
Traceability: La taratura del misuratore di massa utilizzato per la preparazione della miscela è effettuata utilizzando masse certificate dal centro di taratura LAT n° 055; la taratura delle masse è eseguita in conformità alle procedure PTSS; i certificati di riferimento delle masse utilizzate sono: LAT055 451/2015; 572/2015; 028/2015; 027/2015

Note:
Note:

PRESSIONE DI RIEMPIMENTO (bar): Filling pressure (bar):	150	RISCHI PER LA SALUTE: Health hazards:	ASPISSIANTE SEMPLICE
PRESSIONE MINIMA DI UTILIZZO (bar): Minimum pressure (bar):	15	PROPRIETA' CHIMICO-FISICHE: Chemical and physical properties:	INERTE
TEMPERATURA DI STOCCAGGIO (°C): Storage temperature (°C):	0-40	DATA DI SCADENZA: Expiry date:	09/2017

Data certificato: 24/03/2017
Certification date:

Numero certificato: 201702042
Certificate number:

Operatore: M. Gioschi
Operator: