

26<sup>th</sup> February 2021

Permitting Unit  
 Environment and Resources Authority  
 Hexagon House  
 Spencer Hill  
 Marsa  
 MRS 1441

### **Renewal of existing subsidiary IPPC for the D3 (Phase 3) block within the Delimara Power Station**

Dear Sir/Madam

The D3 (Phase 3) block within the Delimara Power Station is currently operating in line with the subsidiary IPPC permit IP 0002/07/Gii, which was issued in September 2017. The subsidiary permit forms part of the full IPPC permit IP 0002/07/G which includes operations undertaken by third parties in the Delimara Power Station complex.

The application for a renewal to the existing IPPC permit (IP 0002/07/Gii) for the D3 Power Generation Ltd. facility at Delimara has been emailed to your department on 26<sup>th</sup> February, 2021. Information relevant to this renewal application is provided hereunder.

#### **Relevant structural/technological changes at the facility**

No structural/technological changes which are relevant to the IPPC permit are applicable as part of this application.

#### **IPPC permit amendments**

No changes to the permit conditions are being requested as part of this application.

#### **Status report for improvement programme items**

A status report on the items listed in the Improvement Programme of IPPC permit IP 0002/07/Gii is provided in Table 1.

*Table 1: Status of improvement programme items for IPPC permit IP 0002/07/Gii*

Table 1.5.1: Improvement programme			Status
Reference	Requirement	Date	
Improvement programme related to the commissioning phase			
3	Calibration of CEMS	Prior to conclusion of commissioning of CCGT	Completed (Appendix 1)

Table 1.5.1: Improvement programme			Status
Reference	Requirement	Date	
5	Notification of conclusion of full commissioning	Two weeks prior to conclusion	Completed (Appendix 2)
<b>Improvements during operations</b>			
2	Submission of data to Enemalta plc. to allow updates to the air dispersion modelling study carried out by the Authority as per condition 2.2.1.22.	Proposed methodology to be submitted by end November 2017. First update to the study shall be submitted by end June 2018.	Completed (Appendix 3)
3	Submission of data to Enemalta plc. to allow the submission of a coordinated baseline report and a monitoring strategy.	Ongoing	Completed (Appendix 4)
4	Submission of an outline decommissioning plan	By end June 2018	Open*
5	ISO 14001 accreditation	By end December 2017	Completed (Appendix 5)

\* Decommissioning plan cannot be established at this stage since it is not yet clear if the current plant owner will eventually decommission D3 power plant.

Should you require any clarifications related to the application, kindly do not hesitate to contact the undersigned.

Yours faithfully



Sacha Dunlop  
 Departmental Head  
 AIS Environment Ltd.

## Appendix 1: Evidence of CEMS Calibration



**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

### **QAL 2 REPORT ON AUTOMATED MEASURING SYSTEM INSTALLED FOR CONTINUOUS MONITORING OF EMISSIONS OF STACK 6A**

performed on behalf of

**SUN LAB GROUP Ltd**

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

**December, 2017**





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# 1 INTRODUCTION

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SUNLAB Ltd commissioned to CADA snc di F.Giglio & C. the calibration activities (QAL2) in accordance to the EN 14181:2015 on Automated Measuring System (AMS) installed for continuous monitoring of Stack 6A emissions at the Delimara Power Station, Marsaxlokk, Malta .

In this technical report, we describe the linearity test performed on AMS Stack 6A after change over to the methane conversion of the plant.

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),
- ⇒ Calibration function created on 15 parallel measurements.

The technical activity has been performed on 6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> November 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	
Address	Triq Belt il-Hazna Marsa, MRS II	
City	Marsa - Malta	
Location of Sampling	Delimara (MALTA)	
Emission Point	6A	
Responsible	Eng. David Griscti (D3 Power)	
Description of the plant	Power plant	
Process characteristics	Electricity production	
Source of emission	DE41 - DE42	
Majority fuel	Natural Gas	
GPS Coordinates (N - E)	35°49'57.93" N	14°33'29.19" E
Pollution abatement system	SCR/Denox	
Authorization decree	IPPC IP 0002/07/Gii	
Reference Oxygen for Correction of Results	15 % Vol.	

The emission limits with Natural Gas Fuel are as follows.

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

Emission Limit Value		
Parameter	Unit of Measurement	Value
Dust	mg/Nm <sup>3</sup>	5
Nitrogen Oxides	mg/Nm <sup>3</sup>	55
Sulfur Dioxide	mg/Nm <sup>3</sup>	10
Carbon Monoxide	mg/Nm <sup>3</sup>	110
Ammonia	mg/Nm <sup>3</sup>	2,6
<b>Note:</b> 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 “6A” 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 [cm]	200
Stack Area [m <sup>2</sup> ]	3,14
Number of Sampling Lines (Access Ports)	2
Conformance of the Sampling Platform	
Sampling platform area > 5 m <sup>2</sup> 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 have been changed, this operation represents the normal plant conditions and increase the variability of data to implement the calibration.

**Table 4 - Plant Load during the measurements**

Plant Load during the measurements				
Fuel	Natural Gas	Other Fuel	/	
Day	Time	Source of emission	Load	
06/11/2017	08:00 - 24:00	DE 42	18,33 MW	50 %
07/11/2017	08:00 - 24:00	DE 42	14,66 MW	40 %
08/11/2017	08:00 - 24:00	DE 42	11,9 MW	33 %



## 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 <sub>3</sub>	EPA CTM 027:1997	Procedure for collection and analysis of ammonia in stationary sources.
NO <sub>x</sub>	UNI EN 14792:2006	Stationary source emissions. Determination of mass concentration of nitrogen oxides (NO <sub>x</sub> ). Reference method: Chemiluminescence.
SO <sub>2</sub>	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 <sub>2</sub>	ISO 11042-1:1996	Gas turbines - Exhaust gas emission - Part 1: Measurement and evaluation. Principle of Measurement: Non-dispersive infrared (NDIR).
O <sub>2</sub>	UNI EN 14789:2006	Determination of volume concentration of oxygen (O <sub>2</sub> ). Reference method - Paramagnetism.
H <sub>2</sub> 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 <sub>3</sub>	Dado Lab - ST5	Sampling	
NOx	Horiba / PG - 350 E	CLD chemiluminescence	0-25/50/100/250/ 500/1000/2500 ppm
SO <sub>2</sub>	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 <sub>2</sub>	Horiba / PG - 350 E	ND-IR	0-10/20/30 %
O <sub>2</sub>	Horiba / PG - 350 E	Paramagnetic	0-/10/25 %
H <sub>2</sub> O	Tecora - Ayrton	Sampling	Only Sampling

In Annex 6 and 7, 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 6A.

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 (SO<sub>2</sub>), nitrogen monoxide (NO), nitrogen dioxide (NO<sub>2</sub>), carbon dioxide (CO<sub>2</sub>), ammonia (NH<sub>3</sub>) and water vapor (H<sub>2</sub>O).

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 <sup>3</sup>
		MCS 100 E	ZrO <sub>2</sub>	O <sub>2</sub>	0 - 21 %
			IR Non-Dispersive (NDIR)	CO	0 - 300 mg/Nm <sup>3</sup>
				CO <sub>2</sub>	0 - 25 %
				NO	0 - 300 mg/Nm <sup>3</sup>
				NO <sub>2</sub>	0 - 100 mg/Nm <sup>3</sup>
				SO <sub>2</sub>	0 - 2000 mg/Nm <sup>3</sup>
				NH <sub>3</sub>	0 - 30 mg/Nm <sup>3</sup>



## 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 6<sup>th</sup> November 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.

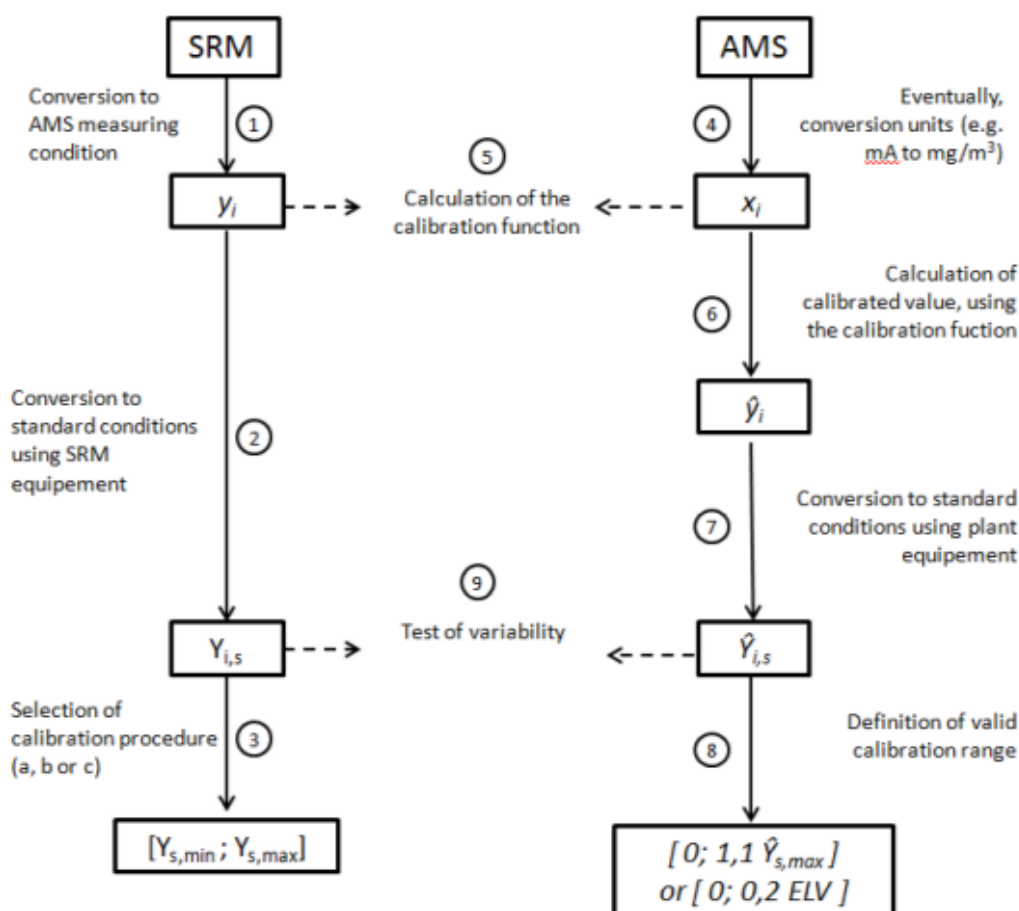
## 7 CALIBRATION and VALIDATION OF THE AMS (QAL2)

### 7.1 DETERMINATION OF THE CALIBRATION FUNCTION

The calibration of the AMS measurement should be performed on at least fifteen parallel measurements with an SRM distributed in a period of 6-8 hours for three days. The object of the parallel measurements was to calibrate and validate the AMS through an independent method (SRM). The tests were carried out over a period of three days in order to take measurements during different states of the system (for example changes of load).

Below it is shown flowchart that describes the steps of the calibration process.

Figure 1 - Flowchart of calibration process



The standard assumes that the calibration function is linear with a constant residual standard deviation. The calibration function is described by the following model.(See ISO 11095):



$$y_i = a + bx_i + \varepsilon_i \quad (9)$$

Where

- $x_i$  is the result  $i^{\text{th}}$  of the AMS;  $i$ =from 1 to N;  $N \geq 15$ ;  
 $y_i$  is the result  $i^{\text{th}}$  of the SRM;  $i$ =from 1 to N;  $N \geq 15$ ;  
 $\varepsilon_i$  is the deviation between  $y_i$  and the expected value;  
 $a$  is the intercept of calibration function;  
 $b$  is the slope of the calibration function.

The following quantities shall be calculated, average value of the AMS ( $\bar{x}$ ) and SRM ( $\bar{y}$ ):

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

$$\bar{y} = \frac{1}{N} \sum_{i=1}^N y_i \quad (11)$$

Following, the difference between the highest and lowest measured SRM concentration at standard condition shall be calculated ( $y_{s,max} - y_{s,min}$ ). Depending on the range of concentrations ( $y_{s,max} - y_{s,min}$ ) reported during the measurement one has to choose the method of calculation of the calibration function.

**Method a:** if ( $y_{s,max} - y_{s,min}$ )  $\geq$  maximum permissible uncertainty.

The parameters of the calibration function shall be calculated according to Formula (12) and Formula (13):

$$\hat{b} = \frac{\sum_{i=1}^N (x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^N (x_i - \bar{x})^2} \quad (12)$$

$$\hat{a} = \bar{y} - \hat{b}\bar{x} \quad (13)$$

**Method b:** if ( $y_{s,max} - y_{s,min}$ )  $<$  maximum permissible uncertainty and  $y_{s,min} \geq 15\%$  of Limit Emission Value (ELV). The parameters of the calibration function shall be calculated according to Formula (14) and Formula (15):



$$\hat{b} = \frac{\bar{y}}{\bar{x} - Z} \quad (14)$$

$$\hat{a} = -\hat{b}Z \quad (15)$$

Where

$Z$  is the difference between the zero reading of the AMS and the zero.

**Method c:** if  $(y_{s,max} - y_{s,min}) < \text{maximum permissible uncertainty}$  and  $y_{s,min} < 15\%$  of Limit Emission Value (ELV). The function is constructed with the same formulas of *Method a* (12 - 13). In addition, two points "surrogate" of Zero and Span (*near the ELV*) are used using gaseous standards.

The calibration function is valid when the plant is operated within the valid calibration range. This valid calibration range is either the calibration range from zero to the maximum value  $y_{s,max}$  of calibrated AMS measured value at standard conditions, determined the QAL2 procedure, plus an extension of 10% of  $y_{s,max}$ , or to 20% of ELV, whichever is greater.

## 7.2 TEST OF VARIABILITY

In order to validate the calibration function obtained in this way, will be executed the test of variability.

The data pairs (SRM and AMS calibrated) thus obtained are normalized and reported to the standard conditions of the plant using auxiliary measures supplied with measurement systems.

For the series of data are calculated:

$$D_i = y_{i,s} - \hat{y}_{i,s} \quad (16)$$

Where

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

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

Mean differences, Formula 17:





$$\bar{D} = \frac{1}{N} \sum_{i=1}^N D_i \quad (17)$$

Standard deviation of differences, Formula 18:

$$S_D = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (D_i - \bar{D})^2} \quad (18)$$

The AMS passes the variability test when:

$$S_D \leq \sigma_0 k_v \quad (16)$$

where

$\sigma_0$  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 factors is:

$$\sigma_0 = \frac{P \times ELV}{1,96} \quad (17)$$

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

$k_v$  is a value from  $\chi^2$ -test with a  $\beta$ -value of 50%. The  $k_v$  value depending on the number of tests conducted.

Table 9-  $k_v$  values

Number of parallel measurement	$k_v(N)$
15	0,9761
16	0,9777
17	0,9791
18	0,9803



## 8 ACCURACY INDEX ACCORDING TO LEGISLATIVE DECREE. 152/06 (IAR)

To verify that the analyzer correctly measures the auxiliary parameters, it has been used Accuracy Index (IAR). This index is reported on Italian Legislative Decree N. 152/2006 - Part V, Annex VI "Criteria for conformity assessment of the measured values to the emission limit values".

In this law the calculation of the IAR (accuracy relative index) was calculated according to the following formula:

$$IAR = 100 \times \left(1 - \frac{M + I_c}{M_r}\right) \quad (18)$$

where

- $M$  It is the arithmetic average of  $N$  values  $X_i$ .
- $X_i$  It represents the absolute value of the difference of the concentrations measured by the two measuring systems (stationary analyzer "AMS" and reference analyzer "SRM").
- $M_r$  It represents the average of the values of the concentrations measured by the reference system (SRM).
- $I_c$  It represents the absolute value of the confidence range calculated for the average of  $N$  values  $X_i$  namely.

$$I_c = t_n \frac{S}{\sqrt{N}} \quad (19)$$

where

- $N$  number of measurements performed.
- $S$  It represents the standard deviation of values  $X_i$ .
- $t_n$  Represents the t Student calculated for the level of confidence of 95% and for (n) degrees of freedom equal to (N-1);



Table 10 - t Student values

N	t <sub>n</sub>
3	4,303
4	3,182
5	2,776
6	2,571
7	2,447
8	2,365
9	2,306
10	2,262
11	2,229
12	2,201
13	2,179
14	2,16
15	2,145
16	2,131

The AMS system is considered verified if the value of the **IAR** is above **80%**. The result of IAR test are in Annex 5.

## 8.1 DETERMINATION OF HOMOGENEITY OF THE SAMPLING POINT

During the Accuracy test (IAR), the homogeneity testing of the sampling point is performed in according to Technical standard UNI EN 15259:2006, *paragraph 8.3 - Determination of homogeneity*. The procedure involves measuring one parameter, such as Oxygen (O<sub>2</sub>) and its spatial and temporal variations shall be applied to determine the homogeneity. Below, the procedure:

- ⇒ determine the sampling points for the grid measurement;
- ⇒ install the probe of the measuring system for the grid measurement;
- ⇒ install the probe of an independent measuring system (reference measurement) at a fixed point in the measurement section;
- ⇒ adjust the sample flow in both systems in order to obtain equal response times;
- ⇒ perform a grid measurement and in parallel measurements at a fixed point in the measurement section, with a sampling time of at least four times the response time of the measuring system but not less than three minutes for each sampling point;



- ⇒ Record for each sampling point  $i$  the actual value  $y_{i,grid}$  of the measurand in the grid and the value  $y_{i,ref}$  of the reference measurement;
- ⇒ For each sample point  $i$ , determines the ratio  $r_i$  defined as follows:

$$r_i = \frac{y_{i,grid}}{y_{i,ref}} \quad (20)$$

- ⇒ average  $\bar{r}$  of the ratios  $r_i$  according to Equation (21):

$$\bar{r} = \frac{1}{N} \sum_{i=1}^N r_i \quad (21)$$

- ⇒ standard deviation  $s_{grid}$  of the grid measurements according to Equation (22):

$$s_{grid} = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (y_{i,grid} - \bar{y}_{grid})^2} \quad (22)$$

- ⇒ standard deviation  $s_{ref}$  of the reference measurements according to Equation (23):

$$s_{ref} = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (y_{i,ref} - \bar{y}_{ref})^2} \quad (23)$$

If  $s_{grid} < s_{ref}$ , the distribution of the gas in the measuring section can be considered homogeneous and sampling can therefore be performed in any point of the section occurred.

The result of Homogeneity of sampling point are in Annex 1.



## 9 RESULTS

Below a summary of the results obtained from the QAL2 test performed on the analyzer (AMS) installed on the stack 6A. Note that for ammonia and sulfur dioxide the QAL2 procedure is not applicable because the parameters concentration are below the detection limit (LOD) of the AMS. In Annex 4, there are reports for single parameter.

Table 11 - Results of QAL2

Summary Report of QAL2							
Parameter	Slope	Intercept	Range of Validity	Procedure for the determination of the calibration function	Maximum permissible uncertainty (95% confidence interval)	Experimental Confidence interval [%]	Emission Limit Value (ELV)
Dust	0,441	0,000	0 - 4,21 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	Metodo B	30	27,79	5
Nitrogen Oxide (NO)	1,169	2,870	0 - 24,81 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	Metodo A	20	3,13	55
Carbon Monoxide (CO)	1,007	-1,663	0 - 22 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	Metodo C	10	0,62	110
Oxygen (O <sub>2</sub> )	1,124	0,000	0 - 14,54 [% Vol.]	Metodo B	10	3,74	/
Carbon Dioxide (CO <sub>2</sub> )	0,955	0,010	0 - 5,02 [% Vol.]	Metodo B	10	1,49	/

As regards carbon monoxide and nitrogen monoxide, the range of validity is lower than the emission limit value, carbon monoxide ELV is 110 mg/Nm<sup>3</sup> and nitrogen monoxide ELV is 55 mg/Nm<sup>3</sup>, then the consideration of Chapter 6.5 "Calibration Function of the AMS and its validity" of the technical standard EN 14181 : 2015 are applied.

Table 12 - Zero Verify

Zero verify for single parameter (Rif. 6.5 - Calibration Function of the AMS and its validity EN 14181 : 2015)						
Parameter	Emission Limit Value (ELV)	Range of Validity	Reference Concentration (ZERO)	AMS Response	Deviation of the AMS calibrated value compared to the reference concentration	Result (Deviation < 10 % ELV)
Nitrogen Oxide (NO)	55	0 - 24,81 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	0	0,1	2,99	Positive
Carbon Monoxide (CO)	110	0 - 22 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	0	0	1,66	Positive



Table 13 - Span/ELV Verify

Span/ELV Verify (Rif. 6.5 - Calibration Function of the AMS and its validity EN 14181 : 2015)								
Parameter	Emission Limit Value (ELV)	Range of Validity	Reference Concentration (ELV - SPAN)	AMS Response	Deviation of the AMS calibrated value compared to the reference concentration	Maximum permissible uncertainty (95% confidence interval)	Maximum permissible uncertainty (95% confidence interval) at ELV	Result (Deviation < I.C. 95% - ELV)
Nitrogen Oxide (NO)	55	0 - 24,81 [mg/Nm3 rif O2]	61,56	59,58	10,96	20	11	Positive
Carbon Monoxide (CO)	110	0 - 22 [mg/Nm3 rif O2]	116,44	117	0,32	10	11	Positive

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

Table 14 - IAR Values

I <sub>AR</sub> Water Vapour	I <sub>AR</sub> Temperature	I <sub>AR</sub> Pressure	I <sub>AR</sub> Flow Rate
88,5	97,8	97,7	81,8



## 10 CONCLUSIONS AND COMMENTS

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Taken note of analytical determinations performed on the gaseous effluents of the plant and the processing on the data carried out, it demonstrates the positive result of the procedure QAL2. 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.

The Ammonia and Sulfur Dioxide parameters are in concentrations below instrumental detection limits of AMS, so it has not been possible to construct the QAL2 calibration. However, the analyzer can still correctly record the two parameters, this is noted by the linearity test.

Auxiliary parameter analyzers respond positively to the accuracy test, this shows that they work properly.



## 11 ANNEX 1 – FUNCTIONAL TEST

1	ALIGNMENT AND CLEANLINESS (ONLY NON-EXTRACTIVE SYSTEM)	
	Type of Verification (visual)	Notes / Comments
a	Obstruction Optical path	The operator performs the necessary maintenance and checks. The operator on 14/06/2017 instructed its supplier (DG Tech) to carry out the checks provided for in the user manuals of the instrument. The visual checks required by EN 14181 were positive.
b	Cleaning of Optical Components	
c	Alignment	
d	Presence of Air Purge	

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 14/06/2017 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 14/06/2017 by Danks Gasanalyse Teknik (DG TEK)				

5	LEAK TEST (ONLY EXTRACTIVE SYSTEM)	
a	Description of the test	Result
	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 <sup>(1)</sup>					
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	0,1	291,1	290,2
				0,1		290,6
				0,1		290,4
NO	mg/Nm3	0	0,0	0,2	256,5	244,7
				0,1		246,8
				0,2		247,1
SO <sub>2</sub>	mg/Nm3	0	0,0	0,1	185,9	190,0
				0,0		192,0
				0,0		195,0
O <sub>2</sub>	% Vol	0	0,0	0,0	16,7	16,6
				0,1		16,7
				0,0		16,7
CO <sub>2</sub>	% Vol	0	0,0	0,1	20,0	20,0
				0,2		19,9
				0,1		20,0
NH <sub>3</sub>	mg/Nm3	0	0,0	0,0	23,9	21,0
				0,0		21,0
				0,0		21,5
NO <sub>2</sub>	mg/Nm3	0,1	0,1	0,1	83,7	83,3
				0,3		82,8
				0,2		82,8

Notes / Comments:  
(\*) Values recorded by linearity tests.



7	<i>Linearity (*)</i>				
Parameter	Full Scale set	Slope (B)	Intercept (A)	d <sub>c,rel</sub> [%]	Results
CO	0 - 300 mg/Nm3	1,000	0,554	0,7	Positive
NO	0 - 300 mg/Nm3	0,970	1,054	1,0	Positive
SO <sub>2</sub>	0 - 2000 mg/Nm3	1,051	2,697	0,3	Positive
O <sub>2</sub>	0 - 21 %vol	0,990	-0,049	0,9	Positive
CO <sub>2</sub>	0 - 25 %vol	0,990	0,073	0,3	Positive
NH <sub>3</sub>	0 - 30 mg/Nm3	0,878	0,180	3,1	Positive
NO <sub>2</sub>	0 - 100 mg/Nm3	0,988	-0,001	2,0	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

Determination of homogeneity of the Sampling Point (Rif. 8.3 Determination of homogeneity - UNI EN 15259:2006)							
Point	Grid Sampling	Diameter	O <sub>2</sub> [% vol] SRM	S <sub>grid</sub> O <sub>2</sub> SRM	O <sub>2</sub> [% vol] AMS	S <sub>grid</sub> O <sub>2</sub> AMS	Result
1	9	1	12,43	0,08	11,54	0,19	Positive
2	29	1	12,45		11,74		
3	59	1	12,65		11,95		
4	141	1	12,44		11,65		
5	171	1	12,55		11,52		
6	191	1	12,50		11,65		
7							
8							
9							
10							
11	9	2	12,48		11,12		
12	29	2	12,44		11,65		
13	59	2	12,55		11,62		
14	141	2	12,62		11,52		
15	171	2	12,63		11,66		
16	191	2	12,55		11,58		
17							
18							
19							
20							

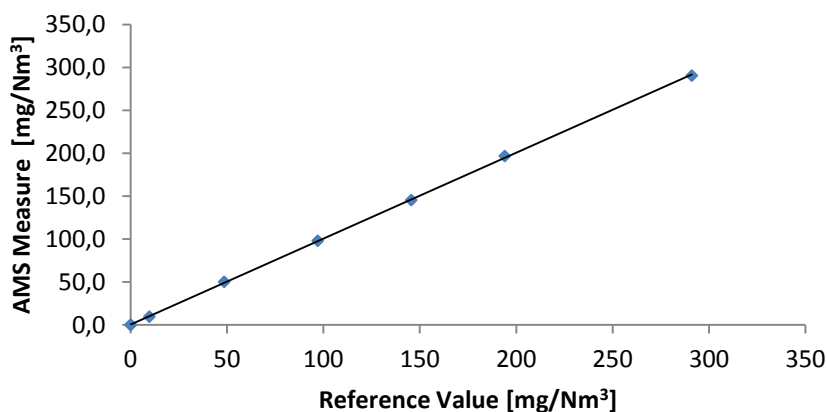


## 12 ANNEX 2 – TEST LINEARITY RESULTS

### 12.1 TEST LINEARITY OF CARBON MONOXIDE

Stack		6A		Data materials used					
Customer		D3 POWER GENERATION LIMITED		Cylinder Producer		SAPIO			
Parameter		CO		Serial/Certificate		MP9/1309			
Analyzer		SICK MCS 100 E		Concentration		233 ppm			
Full Scale set		0- 300	mg/Nm3	Expiration		01/08/2019			
Date measurements		06/11/2017		Diluter		Beta CAP30RK			
Measurements and calculations									
CO mg/Nm3	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0,1	0	0,1	0,1	-0,49	-0,2	Positive
	1	9,7	9,5	9,6	9,7	9,6	-0,66	-0,2	Positive
	2	48,5	50,2	50,3	50,2	50,2	1,15	0,4	Positive
	3	97,0	98,0	98,0	98,0	98,0	0,39	0,1	Positive
	4	145,5	145,5	145,4	145,3	145,4	-0,73	-0,2	Positive
	5	194,0	197,0	195,9	197,3	196,7	2,07	0,7	Positive
	6	291,1	290,2	290,6	290,4	290,4	-1,31	-0,4	Positive
	0	0	0,2	0	0,2	0,1	-0,42	-0,1	Positive
		Y <sub>z</sub>	98,2	A'	98,8	B	1,000	A	0,5540
	Legend								
Y <sub>i</sub> : concentration of reference material; Xi: AMS measure corresponding to the Reference Material Concentration Level; Y <sub>z</sub> : 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 monoxide



◆ Linearity Carbon Monoxide

$$y = 1,0003x + 0,554$$

$$R^2 = 0,9999$$



## 12.2 TEST LINEARITY OF NITROGEN OXIDE

Stack	6A		Data materials used	
Customer	D3 POWER GENERATION LIMITED		Cylinder Producer	SAPIO
Parameter	NO		Serial/Certificate	MP9/1309
Analyzer	SICK MCS 100 E		Concentration	230 ppm
Full Scale set	0- 300	mg/Nm <sup>3</sup>	Expiration	01/08/2019
Date measurements	06/11/2017		Diluter	Beta CAP30RK

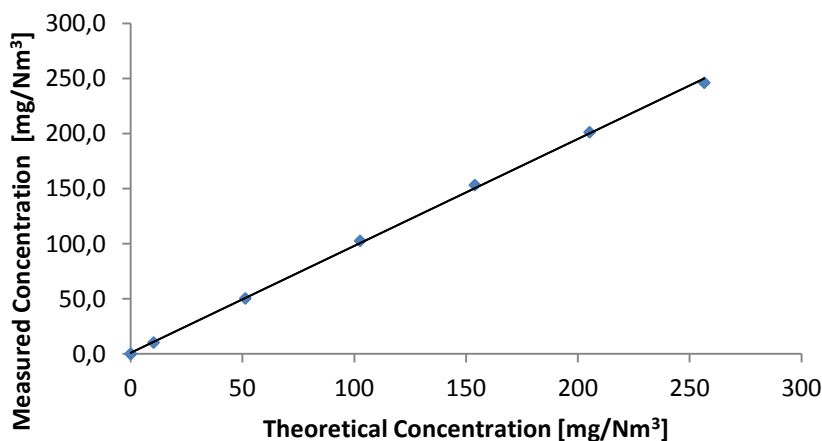
### Measurements and calculations

NO mg/Nm <sup>3</sup>	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0,2	0,1	0,2	0,2	-0,89	-0,3	Positive
	1	10,26	10,5	10,4	10,3	10,4	-0,60	-0,2	Positive
	2	51,3	50,1	50,8	50,4	50,4	-0,36	-0,1	Positive
	3	102,61	102,9	102,7	102,4	102,7	2,12	0,7	Positive
	4	153,92	153	152	155	153,3	3,04	1,0	Positive
	5	205,23	201,3	201,2	201,4	201,3	1,26	0,4	Positive
	6	256,53	244,7	246,8	247,1	246,2	-3,58	-1,2	Positive
	0	0	0,1	0,1	0	0,1	-0,99	-0,3	Positive
Y <sub>z</sub>			97,5	A'	95,6	B	0,970	A	1,0541

### Legend

Y<sub>i</sub>: concentration of reference material;  
X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  
Y<sub>z</sub>: 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



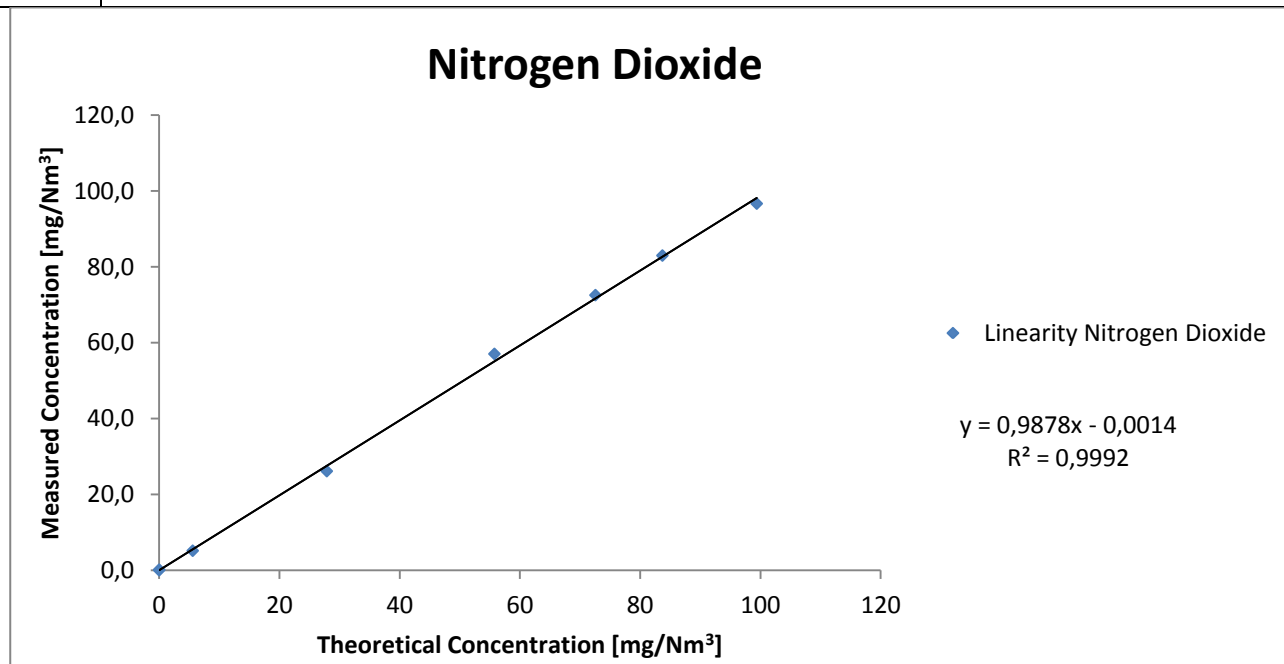
◆ Linearity Nitrogen monoxide

$$y = 0,9696x + 1,0541$$
$$R^2 = 0,9995$$



## 12.3 TEST LINEARITY OF NITROGEN DIOXIDE

Stack		6A		Data materials used					
Customer		D3 POWER GENERATION LIMITED		Cylinder Producer		SAPIO			
Parameter		NO <sub>2</sub>		Serial/Certificate		MP311905			
Analyzer		SICK MCS 100 E		Concentration		81,6	ppm		
Full Scale set		0- 100	mg/Nm3	Expiration		30/03/2018			
Date measurements		06/11/2017		Diluter		Beta CAP30RK			
Measurements and calculations									
NO2 mg/Nm3	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0,1	0,1	0,3	0,2	0,17	0,2	Positive
	1	5,58	5,4	5,1	5	5,2	-0,34	-0,3	Positive
	2	27,88	26,1	26,2	26,1	26,1	-1,40	-1,4	Positive
	3	55,76	56,6	57	57,5	57,0	1,96	2,0	Positive
	4	72,56	72,43	72,51	72,63	72,5	0,85	0,9	Positive
	5	83,7	83,29	82,76	82,82	83,0	0,28	0,3	Positive
	6	99,39	96,2	96,3	97,4	96,6	-1,54	-1,5	Positive
	0	0	0,1	0	0	0,0	0,03	0,0	Positive
	Y <sub>z</sub>	43,1	A'	42,6	B	0,988	A	-0,0014	
Legend									
Y <sub>i</sub> : concentration of reference material; X <sub>i</sub> : AMS measure corresponding to the Reference Material Concentration Level; Y <sub>z</sub> : 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									





## 12.4 TEST LINEARITY OF SULFUR DIOXIDE

Stack	6A		Data materials used	
Customer	D3 POWER GENERATION LIMITED		Cylinder Producer	SAPIO
Parameter	SO <sub>2</sub>		Serial/Certificate	MP9/1309
Analyzer	SICK MCS 100 E		Concentration	65,1 ppm
Full Scale set	0- 2000	mg/Nm <sup>3</sup>	Expiration	01/08/2019
Date measurements	06/11/2017		Diluter	Beta CAP30RK

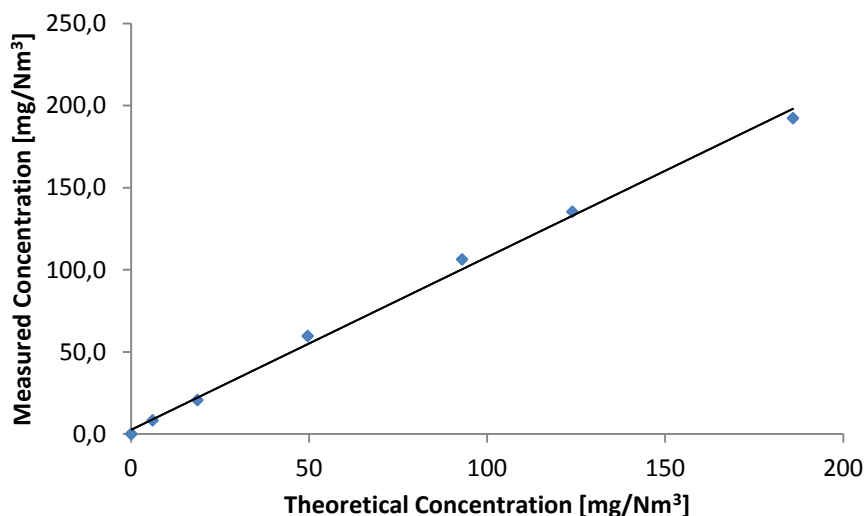
### Measurements and calculations

SO <sub>2</sub> mg/Nm <sup>3</sup>	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0,1	0	0	0,0	-2,66	-0,1	Positive
	1	6,01	8	9	8	8,3	-0,68	0,0	Positive
	2	18,59	21	20	21	20,7	-1,57	-0,1	Positive
	3	49,57	60	59	60	59,7	4,88	0,2	Positive
	4	92,94	110	105	104	106,3	5,96	0,3	Positive
	5	123,92	134	137	135	135,3	2,41	0,1	Positive
	6	185,88	190	192	195	192,3	-5,71	-0,3	Positive
	0	0	0,1	0	0,1	0,1	-2,63	-0,1	Positive
		Y <sub>z</sub>	59,6	A'	65,3	B	1,051	A	2,6965

### Legend

Y<sub>i</sub>: concentration of reference material;  
X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  
Y<sub>z</sub>: 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

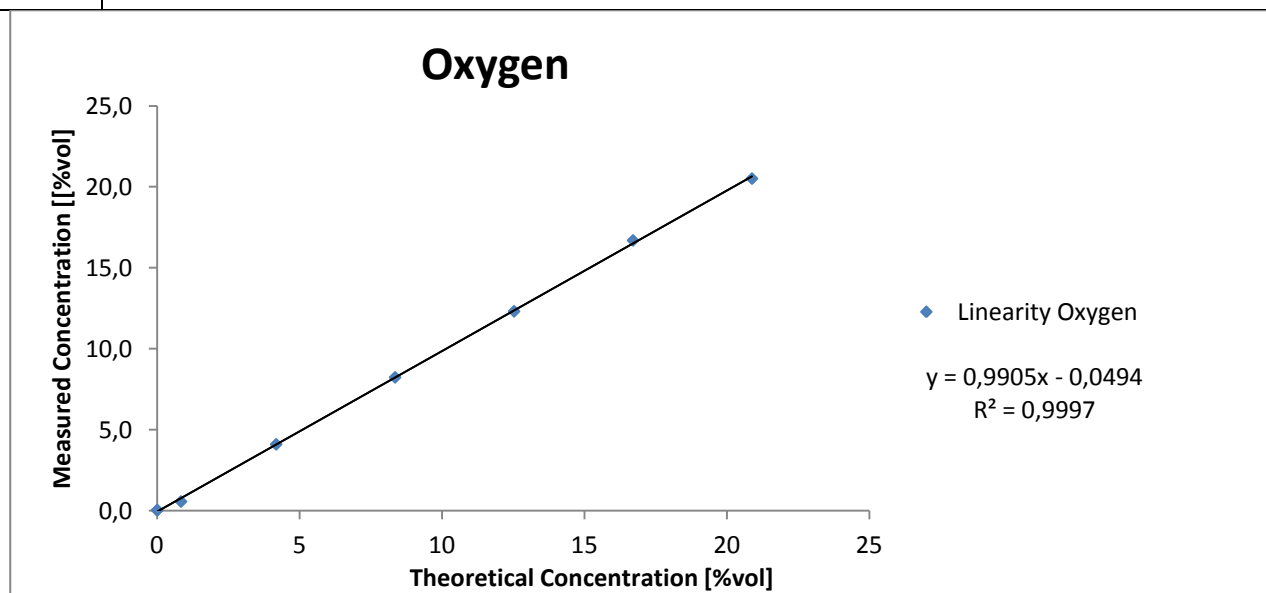
### Sulfur dioxide





## 12.5 TEST LINEARITY OF OXYGEN

Stack		6A			Data materials used				
Customer		D3 POWER GENERATION LIMITED			Cylinder Producer		SAPIO		
Parameter		O <sub>2</sub>			Serial/Certificate		P33021		
Analyzer		SICK MCS 100 E			Concentration		25,06	%vol	
Full Scale set		0- 21		%vol	Expiration		30/03/2020		
Date measurements		06/11/2017			Diluter		Beta CAP30RK		
Measurements and calculations									
O2 %vol	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0	0,1	0	0,0	0,08	0,4	Positive
	1	0,835	0,6	0,5	0,6	0,6	-0,21	-1,0	Positive
	2	4,177	4,2	4	4,1	4,1	0,01	0,1	Positive
	3	8,353	8,21	8,3	8,2	8,2	0,01	0,1	Positive
	4	12,53	12,33	12,31	12,3	12,3	-0,05	-0,2	Positive
	5	16,707	16,59	16,74	16,74	16,7	0,19	0,9	Positive
	6	20,883	20,53	20,48	20,52	20,5	-0,12	-0,6	Positive
	0	0	0	0	0,1	0,0	0,08	0,4	Positive
	Y <sub>z</sub>	7,9	A'	7,8	B	0,990	A	-0,0494	
Legend									
Y <sub>i</sub> : concentration of reference material; Xi: AMS measure corresponding to the Reference Material Concentration Level; Y <sub>z</sub> : 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									





## 12.6 TEST LINEARITY OF CARBON DIOXIDE

Stack	6A		Data materials used	
Customer	D3 POWER GENERATION LIMITED		Cylinder Producer	SAPIO
Parameter	CO <sub>2</sub>		Serial/Certificate	MP9/1309
Analyzer	SICK MCS 100 E		Concentration	20,02 %vol
Full Scale set	0- 25	%vol	Expiration	01/08/2019
Date measurements	06/11/2017		Diluter	Beta CAP30RK

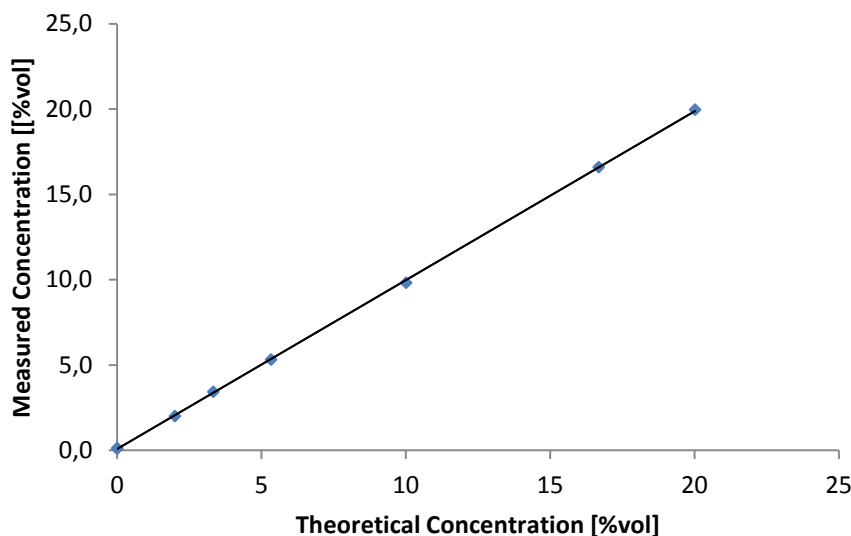
### Measurements and calculations

CO <sub>2</sub> %vol	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0,1	0,2	0,1	0,1	0,06	0,2	Positive
	1	2	2,01	2,02	2	2,0	-0,04	-0,2	Positive
	2	3,33	3,46	3,4	3,44	3,4	0,06	0,3	Positive
	3	5,33	5,3	5,31	5,35	5,3	-0,03	-0,1	Positive
	4	10,01	9,81	9,86	9,8	9,8	-0,16	-0,6	Positive
	5	16,68	16,55	16,65	16,59	16,6	0,01	0,0	Positive
	6	20,02	20	19,89	20,01	20,0	0,07	0,3	Positive
	0	0	0,3	0	0	0,1	0,03	0,1	Positive
		Y <sub>z</sub>	7,2	A'	7,2	B	0,990	A	0,0733

### Legend

Y<sub>i</sub>: concentration of reference material;  
X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  
Y<sub>z</sub>: 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







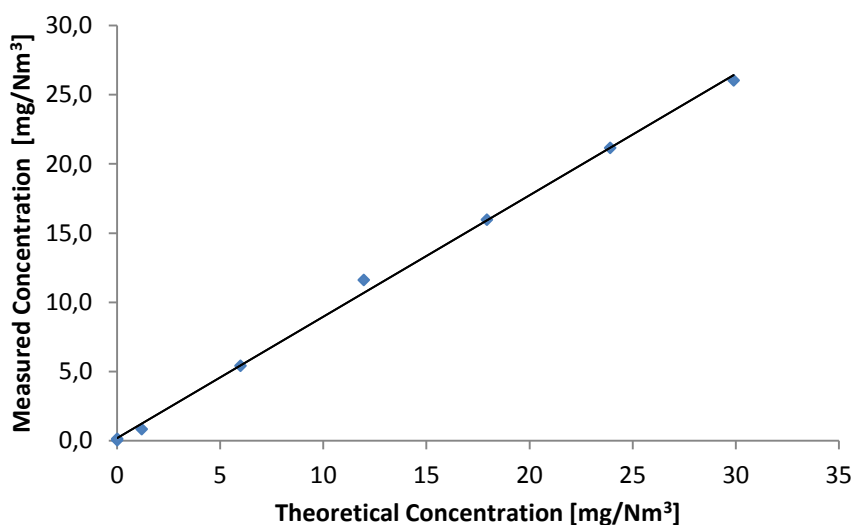
## 12.7 TEST LINEARITY OF AMMONIA

Stack	6A		Data materials used	
Customer	D3 POWER GENERATION LIMITED		Cylinder Producer	SAPIO
Parameter	NH <sub>3</sub>		Serial/Certificate	MP17107
Analyzer	SICK MCS 100 E		Concentration	47,3 ppm
Full Scale set	0- 30	mg/Nm <sup>3</sup>	Expiration	31/12/2017
Date measurements	06/11/2017		Diluter	Beta CAP30RK

### Measurements and calculations

NH <sub>3</sub> mg/Nm <sup>3</sup>	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0	0,1	0	0,0	-0,15	-0,5	Positive
	1	1,19	1,1	0,8	0,6	0,8	-0,39	-1,3	Positive
	2	5,98	5,39	5,41	5,43	5,4	-0,02	-0,1	Positive
	3	11,96	11,59	11,61	11,63	11,6	0,94	3,1	Positive
	4	17,93	15,8	15,9	16,2	16,0	0,05	0,2	Positive
	5	23,91	20,95	21,02	21,5	21,2	0,00	0,0	Positive
	6	29,9	25,8	26,2	26,1	26,0	-0,38	-1,3	Positive
	0	0	0,2	0,2	0	0,1	-0,05	-0,2	Positive
		Y <sub>z</sub>	11,4	A'	10,1	B	0,878	A	0,1797
Legend									
<p>Y<sub>i</sub>: concentration of reference material;  X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  Y<sub>z</sub>: 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>									

### Ammonia



$y = 0,8775x + 0,1797$   
 $R^2 = 0,9983$



## 13 ANNEX 3 - TEST REPORT

### 13.1 DETERMINATION OF THE VELOCITY PROFILE

Report Campionamento / Determinazione del Profilo di Velocità							
Determinazione della Velocità e Portata				UNI EN ISO 16911-1:2013 Annex A			
Parametri Ausiliari							
Ossigeno (O <sub>2</sub> )				UNI EN 14789:2006			
Temperatura				UNI EN ISO 16911-1:2013 Annex A			
Pressione				UNI EN ISO 16911-1:2013 Annex A			
Vapor d'acqua				UNI EN 14790:2006			
Informazioni in merito alla strumentazione e supporti utilizzati per il campionamento ed analisi							
Strumentazione							
Misuratore di Velocità e Portata		DADO LAB	ST55AA20160199	DADO LAB - ST5 V8.5			
Analizzatore Gas		Horiba	MY25EG2X	Analizzatore Horiba PG-350E			
Tubo di Pitot		Zambelli	30435	k =0,8296; Type Pitot (S)			
Informazioni relative al Punto Emissivo							
Diametro del camino [m]		2,00	Altezza da terra [m]			40	
Superficie del camino [m <sup>2</sup> ]		3,14	Altezza da terra del punto di campionamento [m]			Verticale	
Diametri a monte del punto di campionamento		12,5	Diametri a valle del punto di campionamento			1	
Personale tecnico che ha eseguito il campionamento							
Dott. Giorgio Rocchia							
Determinazione del profilo di velocità						06/11/2017	
Punto	Diametro	Affondamento [cm]	Temperatura [°C]	Δpi [Pa]	Velocità [m/s]	Parametri Ausiliari	
1	1	9	365	335	29,3	Ossigeno [% vol]	12,5
2	1	29	364	344	29,6		
3	1	59	365	326	28,9		
4	1	141	365	325	28,8	Biossido di Carbonio [%vol]	4,8
5	1	171	365	334	29,2		
6	1	191	364	341	29,5		
7						Vapore Acqueo [% vol]	10,48
8							
9							
10						Densità - ρ (Kg/m <sup>3</sup> )	1,305
11	2	9	363	321	28,6		
12	2	29	365	336	29,3		
13	2	59	362	336	29,3	Pressione Emissione [kPa]	102
14	2	141	363	333	29,1		
15	2	171	365	334	29,2		
16	2	191	365	330	29,1	Temperatura Ambiente [°C]	18
17							
18							
19						Pressione Ambiente [hPa]	1008
20							



Determinazione del profilo di velocità						07/11/2017	
Punto	Diametro	Affondamento [cm]	Temperatura [°C]	$\Delta p_i$ [Pa]	Velocità [m/s]	Parametri Ausiliari	
1	1	9	153	67,5	10,73	Ossigeno [% vol]	11,9
2	1	29	152	68,4	10,79		
3	1	59	153	69,6	10,89		
4	1	141	154	72,4	11,12	Biossido di Carbonio [%vol]	4,6
5	1	171	152	70,1	10,92		
6	1	191	155	69,6	10,92		
7						Vapore Acqueo [% vol]	10,46
8							
9							
10						Densità - $\rho$ (Kg/m <sup>3</sup> )	1,303
11	2	9	152	71,5	11,03		
12	2	29	151	72	11,05		
13	2	59	155	72,6	11,15	Pressione Emissione [kPa]	102
14	2	141	153	72	11,08		
15	2	171	155	70,1	10,96		
16	2	191	153	69,2	10,86	Temperatura Ambiente [°C]	19
17							
18							
19						Pressione Ambiente [hPa]	1010
20							

Determinazione del profilo di velocità						08/11/2017	
Punto	Diametro	Affondamento [cm]	Temperatura [°C]	$\Delta p_i$ [Pa]	Velocità [m/s]	Parametri Ausiliari	
1	1	9	141	43,44	8,50	Ossigeno [% vol]	12,8
2	1	29	142	42,1	8,38		
3	1	59	140	40,8	8,23		
4	1	141	140	40,6	8,21	Biossido di Carbonio [%vol]	4,3
5	1	171	139	41	8,24		
6	1	191	138	41,2	8,25		
7						Vapore Acqueo [% vol]	11,62
8							
9							
10						Densità - $\rho$ (Kg/m <sup>3</sup> )	1,302
11	2	9	140	42,1	8,36		
12	2	29	141	42,2	8,38		
13	2	59	139	39,4	8,08	Pressione Emissione [kPa]	102
14	2	141	138	40,1	8,14		
15	2	171	141	38,9	8,05		
16	2	191	140	40,1	8,16	Temperatura Ambiente [°C]	20
17							
18							
19						Pressione Ambiente [hPa]	102
20							



## 13.2 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 <sub>2</sub> )				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			
Tubo di Pitot		Zambelli	30435	k = 0,8296; 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							
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 <sup>3</sup> ] <sup>(1)</sup>
Method Blank		06/11/2017	/	FN01	0,00	0,06	0,881
2125827-001	Reply 1	06/11/2017 13:15	60	FN02	0,92	0,16	0,506
2125827-002	Reply 2	06/11/2017 14:38	60	FN03	3,43	0,16	1,633
2125827-003	Reply 3	06/11/2017 15:52	60	FN04	1,05	0,15	0,641
2125827-004	Reply 4	06/11/2017 17:06	60	FN05	1,06	0,11	0,607
2125827-005	Reply 5	06/11/2017 18:16	60	FN06	2,02	0,11	1,016
Method Blank		07/11/2017	/	FM91	0,00	0,05	0,883
2125827-006	Reply 6	07/11/2017 09:04	60	FM92	1,90	0,16	0,884
2125827-007	Reply 7	07/11/2017 10:21	60	FM93	2,26	0,14	0,894
2125827-008	Reply 8	07/11/2017 11:40	60	FM94	2,13	0,15	0,880
2125827-009	Reply 9	07/11/2017 12:47	60	FM95	2,05	0,14	0,874
2125827-010	Reply 10	07/11/2017 14:14	60	FM97	1,64	0,13	0,881
Method Blank		08/11/2017	/	FN07	0,00	0,05	0,662
2125827-011	Reply 11	08/11/2017 08:35	60	FN08	2,01	0,13	0,710
2125827-012	Reply 12	08/11/2017 09:35	60	FN09	1,40	0,11	0,700
2125827-013	Reply 13	08/11/2017 10:39	60	FN10	1,11	0,11	0,458
2125827-014	Reply 14	08/11/2017 11:48	60	FN11	2,48	0,11	0,716
2125827-015	Reply 15	08/11/2017 12:57	60	FN12	1,89	0,11	0,728

<sup>(1)</sup> The pressure, temperature and volume data related to the Method Blank are obtained from the average of the values of the 5 replies of the day.



Dust - Sampling and analysis Data							2
I.D. Sample	Stack Speed [m/s]	Temperature [°C] <sup>(1)</sup>	Pressure [kPa] <sup>(1)</sup>	H <sub>2</sub> O [%v/v] <sup>(1)</sup>	O <sub>2</sub> [%v/v] <sup>(1)</sup>	Dust Concentration [mg/Nm <sup>3</sup> ] <sup>(1) (2)</sup>	Dust Concentration correct with O <sub>2</sub> [mg/Nm <sup>3</sup> ] <sup>(1)(3)</sup>
Method Blank	/	363,95	100,7	10,60	12,53	0,06	0,04
2125827-001	9,52	364,62	100,7	11,00	12,56	2,13	1,51
2125827-002	30,88	365,10	100,6	10,80	12,57	2,20	1,56
2125827-003	11,95	363,43	100,7	10,30	12,49	1,87	1,32
2125827-004	11,37	362,52	100,8	10,90	12,51	1,94	1,37
2125827-005	19,04	364,08	100,7	10,00	12,53	2,10	1,49
Method Blank	/	152,26	101,2	10,44	13,50	0,06	0,05
2125827-006	10,94	152,88	101,1	10,10	13,88	2,33	1,96
2125827-007	11,14	155,65	101,1	10,50	13,90	2,69	2,27
2125827-008	10,95	153,28	101,2	11,00	13,19	2,59	1,99
2125827-009	10,76	150,17	101,1	10,02	13,27	2,51	1,95
2125827-010	10,95	149,34	101,7	10,60	13,29	2,01	1,57
Method Blank	/	144,14	101,5	11,38	13,27	0,07	0,05
2125827-011	8,67	140,48	101,6	11,00	13,22	3,02	2,33
2125827-012	8,73	140,05	101,7	12,00	13,30	2,15	1,68
2125827-013	5,64	148,15	101,8	11,00	13,27	2,66	2,06
2125827-014	8,88	146,57	100,7	12,00	13,29	3,62	2,81
2125827-015	8,88	145,44	101,7	10,90	13,27	2,75	2,14
<sup>(2)</sup> Dust Concentration (Wet). <sup>(3)</sup> 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 [%] <sup>(4)</sup>	Result	Dust Concentration correct with O <sub>2</sub> [mg/Nm <sup>3</sup> ] - Blank	Result <sup>(5)</sup>
Method Blank		06/11/2017	/			0,04	Positive
2125827-001	Reply 1	06/11/2017 13:15	60	0,2	Positive		
2125827-002	Reply 2	06/11/2017 14:38	60	-0,1	Positive		
2125827-003	Reply 3	06/11/2017 15:52	60	0,2	Positive		
2125827-004	Reply 4	06/11/2017 17:06	60	0	Positive		
2125827-005	Reply 5	06/11/2017 18:16	60	0	Positive		
Method Blank		07/11/2017	/			0,05	Positive
2125827-006	Reply 6	07/11/2017 09:04	60	0	Positive		
2125827-007	Reply 7	07/11/2017 10:21	60	0,1	Positive		
2125827-008	Reply 8	07/11/2017 11:40	60	0,1	Positive		
2125827-009	Reply 9	07/11/2017 12:47	60	0	Positive		
2125827-010	Reply 10	07/11/2017 14:14	60	0	Positive		
Method Blank		08/11/2017	/			0,05	Positive
2125827-011	Reply 11	08/11/2017 08:35	60	0	Positive		
2125827-012	Reply 12	08/11/2017 09:35	60	0	Positive		
2125827-013	Reply 13	08/11/2017 10:39	60	2,3	Positive		
2125827-014	Reply 14	08/11/2017 11:48	60	0	Positive		
2125827-015	Reply 15	08/11/2017 12:57	60	0	Positive		
<sup>(4)</sup> Dust sampling must be done in isocinetics. The isocinetetic value must be within the Range -5% <G <+ 15%. <sup>(5)</sup> 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).							



### 13.3 COMBUSTION GAS REPORT

Nitrogen Oxides, Carbon Monoxide, Sulfur Dioxide, Oxygen and Carbon Dioxide - Sampling and Analysis Report					
Oxygen (O <sub>2</sub> )					UNI EN 14789:2017
Nitrogen Oxide (NO)					UNI EN 14792:2017
Carbon Monoxide (CO)					UNI EN 15058:2017
Sulfur Dioxide (SO <sub>2</sub> )					ISO 11042-1:1996
Carbon Dioxide (CO <sub>2</sub> )					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					
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 (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2125827-001	Reply 1	06/11/2017 16:51	60	37,60	12,56
2125827-002	Reply 2	06/11/2017 18:05	60	33,97	12,57
2125827-003	Reply 3	06/11/2017 19:15	60	33,54	12,49
2125827-004	Reply 4	06/11/2017 20:29	60	32,62	12,51
2125827-005	Reply 5	06/11/2017 21:29	60	31,10	12,53
2125827-006	Reply 6	07/11/2017 10:03	60	18,88	13,88
2125827-007	Reply 7	07/11/2017 11:20	60	18,42	13,90
2125827-008	Reply 8	07/11/2017 12:39	60	20,41	13,19
2125827-009	Reply 9	07/11/2017 13:46	60	21,64	13,27
2125827-010	Reply 10	07/11/2017 15:13	60	22,82	13,29
2125827-011	Reply 11	08/11/2017 09:34	60	25,93	13,22
2125827-012	Reply 12	08/11/2017 10:34	60	24,78	13,30
2125827-013	Reply 13	08/11/2017 11:38	60	24,16	13,27
2125827-014	Reply 14	08/11/2017 12:47	60	24,03	13,29
2125827-015	Reply 15	08/11/2017 13:56	60	24,25	13,27
Notes:					
(1) The oxygen value reported refers to the same measurement period of the parameter on which QAL2 (NO) is performed.					
(2) The Nitric Oxide (NO) value is not 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
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Carbon Monoxide (CO) - [mg/Nm <sup>3</sup> ]	Oxygen (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2125827-001	Reply 1	06/11/2017 14:14	60	3,28	12,44
2125827-002	Reply 2	06/11/2017 15:37	60	2,98	12,49
2125827-003	Reply 3	06/11/2017 16:51	60	2,98	12,56
2125827-004	Reply 4	06/11/2017 18:05	60	2,91	12,57
2125827-005	Reply 5	06/11/2017 19:15	60	2,74	12,49
2125827-006	Reply 6	07/11/2017 10:03	60	0,11	13,88
2125827-007	Reply 7	07/11/2017 11:20	60	0,12	13,90
2125827-008	Reply 8	07/11/2017 12:39	60	0,11	13,19
2125827-009	Reply 9	07/11/2017 13:46	60	0,11	13,27
2125827-010	Reply 10	07/11/2017 15:13	60	0,11	13,29
2125827-011	Reply 11	08/11/2017 09:34	60	0,11	13,22
2125827-012	Reply 12	08/11/2017 10:34	60	0,11	13,30
2125827-013	Reply 13	08/11/2017 11:38	60	0,11	13,27
2125827-014	Reply 14	08/11/2017 12:47	60	0,11	13,29
2125827-015	Reply 15	08/11/2017 13:56	60	0,11	13,27
Notes: (1) The oxygen value reported refers to the same measurement period of the parameter on which QAL2 (CO) is performed. (2) The carbon monoxide (CO) value is not corrected for the reference oxygen, is normalized by temperature and pressure and is expressed on a dry basis.					

Determination of Sulfur Dioxide (SO <sub>2</sub> ) - Sampling and analysis Data					3
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Sulfur Dioxide (SO <sub>2</sub> ) - [mg/Nm <sup>3</sup> ]	Oxygen (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2125827-001	Reply 1	06/11/2017 14:14	60	< 1	/
2125827-002	Reply 2	06/11/2017 15:37	60	< 1	/
2125827-003	Reply 3	06/11/2017 16:51	60	< 1	/
2125827-004	Reply 4	06/11/2017 18:05	60	< 1	/
2125827-005	Reply 5	06/11/2017 19:15	60	< 1	/
2125827-006	Reply 6	07/11/2017 10:03	60	< 1	/
2125827-007	Reply 7	07/11/2017 11:20	60	< 1	/
2125827-008	Reply 8	07/11/2017 12:39	60	< 1	/
2125827-009	Reply 9	07/11/2017 13:46	60	< 1	/
2125827-010	Reply 10	07/11/2017 15:13	60	< 1	/
2125827-011	Reply 11	08/11/2017 09:34	60	< 1	/
2125827-012	Reply 12	08/11/2017 10:34	60	< 1	/
2125827-013	Reply 13	08/11/2017 11:38	60	< 1	/
2125827-014	Reply 14	08/11/2017 12:47	60	< 1	/
2125827-015	Reply 15	08/11/2017 13:56	60	< 1	/
Notes: (1) The oxygen value reported refers to the same measurement period of the parameter on which QAL2 (SO <sub>2</sub> ) is performed. (2) The sulfur dioxide (SO <sub>2</sub> ) value is not corrected for the reference oxygen, is normalized by temperature and pressure and is expressed on a dry basis.					





Determination of Oxygen (O <sub>2</sub> ) - Sampling and analysis Data				4
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Oxygen (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2125827-001	Reply 1	06/11/2017 14:14	60	12,44
2125827-002	Reply 2	06/11/2017 15:37	60	12,49
2125827-003	Reply 3	06/11/2017 16:51	60	12,56
2125827-004	Reply 4	06/11/2017 18:05	60	12,57
2125827-005	Reply 5	06/11/2017 19:15	60	12,49
2125827-006	Reply 6	07/11/2017 10:03	60	13,88
2125827-007	Reply 7	07/11/2017 11:20	60	13,90
2125827-008	Reply 8	07/11/2017 12:39	60	13,19
2125827-009	Reply 9	07/11/2017 13:46	60	13,27
2125827-010	Reply 10	07/11/2017 15:13	60	13,29
2125827-011	Reply 11	08/11/2017 09:34	60	13,22
2125827-012	Reply 12	08/11/2017 10:34	60	13,30
2125827-013	Reply 13	08/11/2017 11:38	60	13,27
2125827-014	Reply 14	08/11/2017 12:47	60	13,29
2125827-015	Reply 15	08/11/2017 13:56	60	13,27
Notes: (1) The Oxygen value reported refers to the values used to construct the QAL2 calibration function.				

Determination of Carbon Dioxide (CO <sub>2</sub> ) - Sampling and analysis Data				5
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Carbon Dioxide (CO <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2125827-001	Reply 1	06/11/2017 14:14	60	4,78
2125827-002	Reply 2	06/11/2017 15:37	60	4,73
2125827-003	Reply 3	06/11/2017 16:51	60	4,70
2125827-004	Reply 4	06/11/2017 18:05	60	4,70
2125827-005	Reply 5	06/11/2017 19:15	60	4,74
2125827-006	Reply 6	07/11/2017 10:03	60	3,92
2125827-007	Reply 7	07/11/2017 11:20	60	3,93
2125827-008	Reply 8	07/11/2017 12:39	60	4,26
2125827-009	Reply 9	07/11/2017 13:46	60	4,22
2125827-010	Reply 10	07/11/2017 15:13	60	4,23
2125827-011	Reply 11	08/11/2017 09:34	60	4,45
2125827-012	Reply 12	08/11/2017 10:34	60	4,41
2125827-013	Reply 13	08/11/2017 11:38	60	4,43
2125827-014	Reply 14	08/11/2017 12:47	60	4,42
2125827-015	Reply 15	08/11/2017 13:56	60	4,42
Notes: (1) The value of Carbon Dioxide reported refers to the values used to construct the QAL2 calibration function.				





## 13.4 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 <sub>2</sub> )				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 <sub>2</sub> SO <sub>4</sub> - 0,1 N	
Filtration Temperature		Stack Temperature		Conditioning Temperature [° C]		180	
Technical personnel who performed the sampling							
Dott. Giorgio Rocchia							
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Sampling Volume [Nm <sup>3</sup> ] <sup>(1)</sup>	Impinger G1 [mg]	Impinger G2 [mg]	Concentration [mg/Nm <sup>3</sup> ]
Method Blank		06/11/2017	/	0,881	0,000	0,000	/
2125827-001	Reply 1	06/11/2017 13:15	60	0,506	0,000	0,000	< 0,1
2125827-002	Reply 2	06/11/2017 14:38	60	1,633	0,000	0,000	< 0,1
2125827-003	Reply 3	06/11/2017 15:52	60	0,641	0,000	0,000	< 0,1
2125827-004	Reply 4	06/11/2017 17:06	60	0,607	0,000	0,000	< 0,1
2125827-005	Reply 5	06/11/2017 18:16	60	1,016	0,000	0,000	< 0,1
Method Blank		07/11/2017	/	0,883	0,000	0,000	/
2125827-006	Reply 6	07/11/2017 09:04	60	0,884	0,000	0,000	< 0,1
2125827-007	Reply 7	07/11/2017 10:21	60	0,894	0,000	0,000	< 0,1
2125827-008	Reply 8	07/11/2017 11:40	60	0,880	0,000	0,000	< 0,1
2125827-009	Reply 9	07/11/2017 12:47	60	0,874	0,000	0,000	< 0,1
2125827-010	Reply 10	07/11/2017 14:14	60	0,881	0,000	0,000	< 0,1
Method Blank		08/11/2017	/	0,662	0,000	0,000	/
2125827-011	Reply 11	08/11/2017 08:35	60	0,710	0,000	0,000	< 0,1
2125827-012	Reply 12	08/11/2017 09:35	60	0,700	0,000	0,000	< 0,1
2125827-013	Reply 13	08/11/2017 10:39	60	0,458	0,000	0,000	< 0,1
2125827-014	Reply 14	08/11/2017 11:48	60	0,716	0,000	0,000	< 0,1
2125827-015	Reply 15	08/11/2017 12:57	60	0,728	0,000	0,000	< 0,1

<sup>(1)</sup> The pressure, temperature and volume data related to the Method Blank are obtained from the average of the values of the 5 replies of the day.



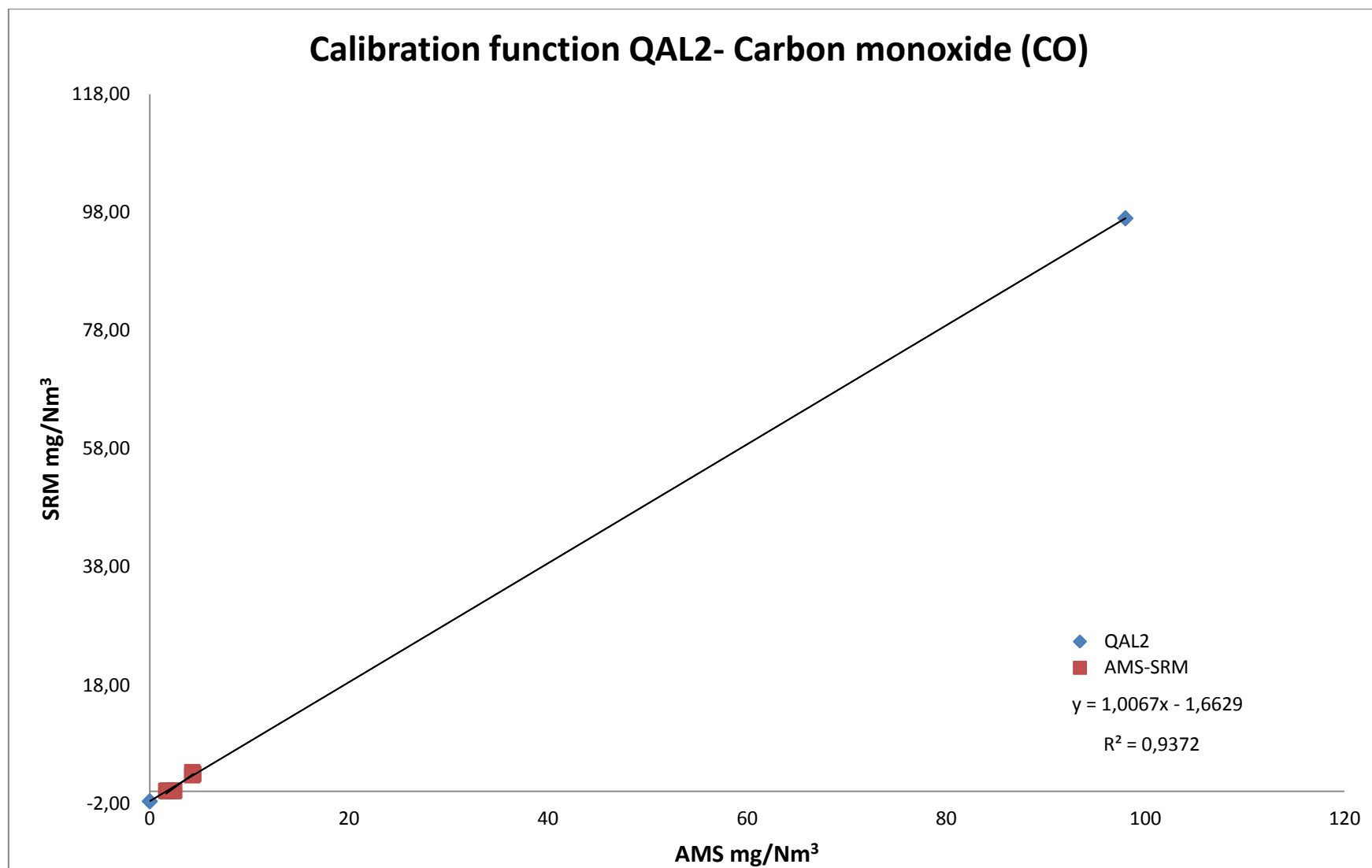


## 14 ANNEX 4 - QAL2 REPORT

### 14.1 CARBON MONOXIDE - QAL2

Parameter				CO			Emission Point			6A							
O <sub>2</sub> rif %	15	SRM				AMS							Calculations				
N. Test	DATE/TIME	Y <sub>i</sub>	Yi-Ym	O <sub>2</sub>	Y <sub>i,s</sub>	x <sub>i</sub>	O <sub>2</sub>	xi-xm	(xi-xm) <sup>2</sup>	(xi-xm)*(Yi-Ym)	ŷ <sub>i</sub>	ŷ <sub>i,s</sub>	D <sub>i</sub> = y <sub>i,s</sub> -ŷ <sub>i,s</sub>	D <sub>i</sub> -d̄	(D <sub>i</sub> -d̄) <sup>2</sup>		
1	6/11/17 14:14	3,28	-3,37	12,44	2,30	4,26	11,52	-3,99	15,91	13,43	2,63	1,67	0,63	0,62	0,39		
2	6/11/17 15:37	2,98	-3,67	12,49	2,10	4,28	11,53	-3,97	15,75	14,57	2,65	1,68	0,42	0,41	0,16		
3	6/11/17 16:51	2,98	-3,67	12,56	2,12	4,37	11,58	-3,88	15,05	14,22	2,74	1,75	0,37	0,36	0,13		
4	6/11/17 18:05	2,91	-3,73	12,57	2,07	4,34	11,58	-3,92	15,34	14,62	2,70	1,72	0,35	0,34	0,11		
5	6/11/17 19:15	2,74	-3,91	12,49	1,93	4,26	11,53	-3,99	15,94	15,59	2,63	1,66	0,27	0,26	0,07		
6	7/11/17 10:03	0,11	-6,54	13,88	0,09	2,38	11,74	-5,88	34,52	38,39	0,73	0,47	-0,38	-0,39	0,15		
7	7/11/17 11:20	0,12	-6,53	13,90	0,10	2,45	11,74	-5,81	33,72	37,90	0,80	0,52	-0,42	-0,43	0,19		
8	7/11/17 12:39	0,11	-6,53	13,19	0,09	2,43	11,75	-5,82	33,89	38,03	0,79	0,51	-0,42	-0,44	0,19		
9	7/11/17 13:46	0,11	-6,54	13,27	0,08	2,40	11,75	-5,85	34,24	38,27	0,76	0,49	-0,41	-0,42	0,18		
10	7/11/17 15:13	0,11	-6,53	13,29	0,09	2,24	11,76	-6,01	36,13	39,28	0,60	0,39	-0,30	-0,31	0,10		
11	8/11/17 9:34	0,11	-6,54	13,22	0,08	1,65	11,56	-6,61	43,67	43,21	-0,01	0,00	0,09	0,07	0,01		
12	8/11/17 10:34	0,11	-6,54	13,30	0,08	1,75	11,63	-6,51	42,35	42,56	0,09	0,06	0,02	0,01	0,00		
13	8/11/17 11:38	0,11	-6,54	13,27	0,08	1,80	11,67	-6,45	41,65	42,20	0,15	0,10	-0,01	-0,03	0,00		
14	8/11/17 12:47	0,11	-6,54	13,29	0,08	1,78	11,68	-6,48	41,96	42,36	0,12	0,08	0,00	-0,01	0,00		
15	8/11/17 13:56	0,11	-6,54	13,27	0,08	1,82	11,66	-6,43	41,40	42,08	0,17	0,11	-0,03	-0,04	0,00		
16	zero	0,00	-6,65	15,00	0,00	0,10	15,00	-8,15	66,48	54,19	-1,56	-1,56					
17	span	97,00	90,35	15,00	97,00	98,00	15,00	89,75	8054,44	8108,98	96,99	96,99					
Average												0,01					
Sum									8582,44	8639,88					1,67		
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		110	Yaverage	6,65	x average	8,25	Z	/	Procedure for the determination of the calibration fuction								
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		16,5	m	1,007	i	-1,663	r	0,99971	Method C				Calibration Function				
Ys Max-Ys min		2,22	ŷs, max	1,75	Calibration Range				0 - 22 [mg/Nm3 rif O2]				Y= 1,007X - 1,663				
Test of Variability																	
Maximum permissible uncertainty (95% confidence interval)		10	Test value for variability (k <sub>v</sub> )		0,9761	σ0kv		5,478	Result of Variability Test (s <sub>0</sub> σ <sub>0</sub> k <sub>v</sub> )								
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,345643	Standard Deviation (σ <sub>0</sub> )		5,61	Experimental Confidence interval [%]		0,62	Positive								

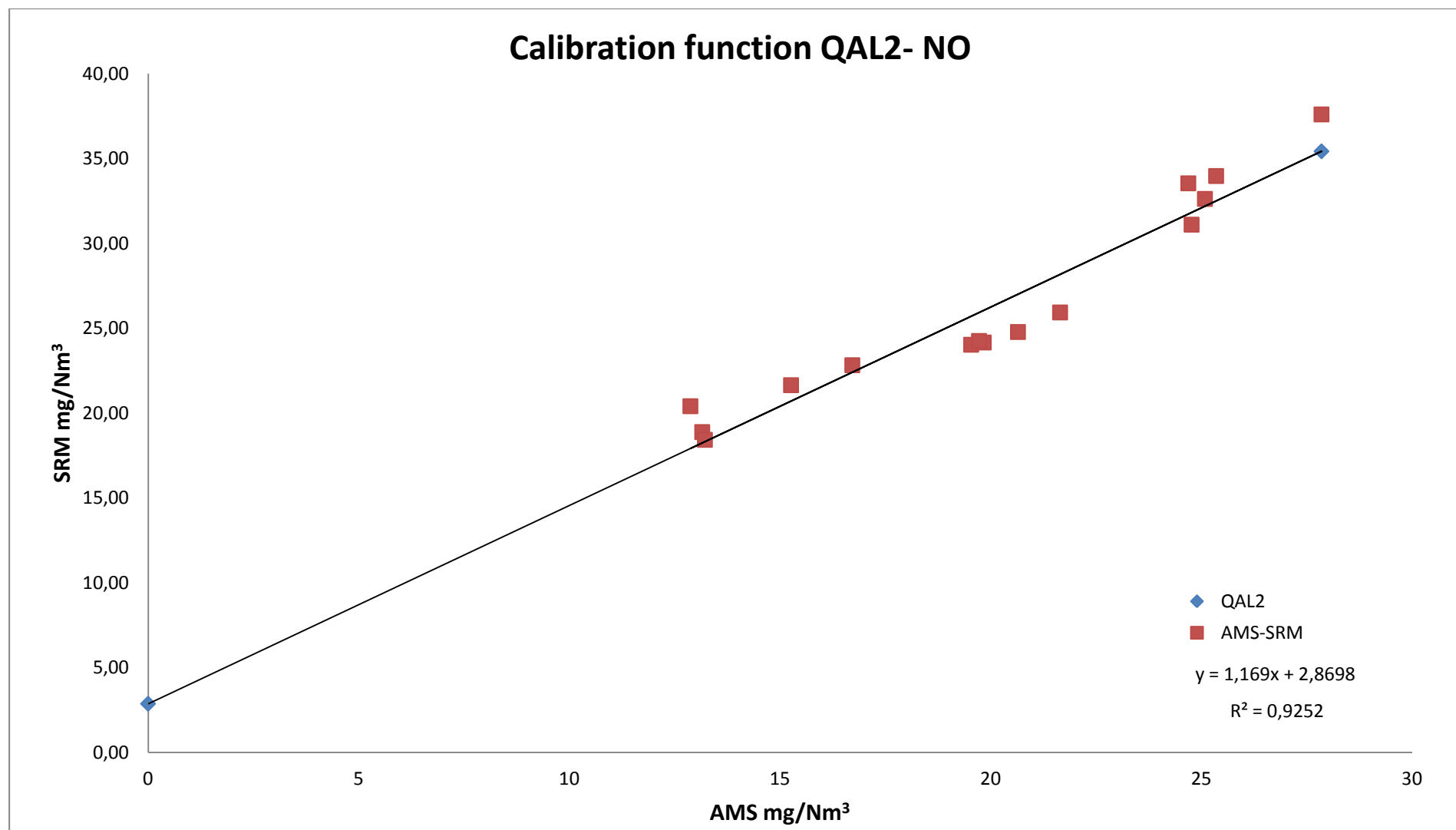
DR.21.25 Rev.0





## 14.2 NITROGEN OXIDE - QAL2

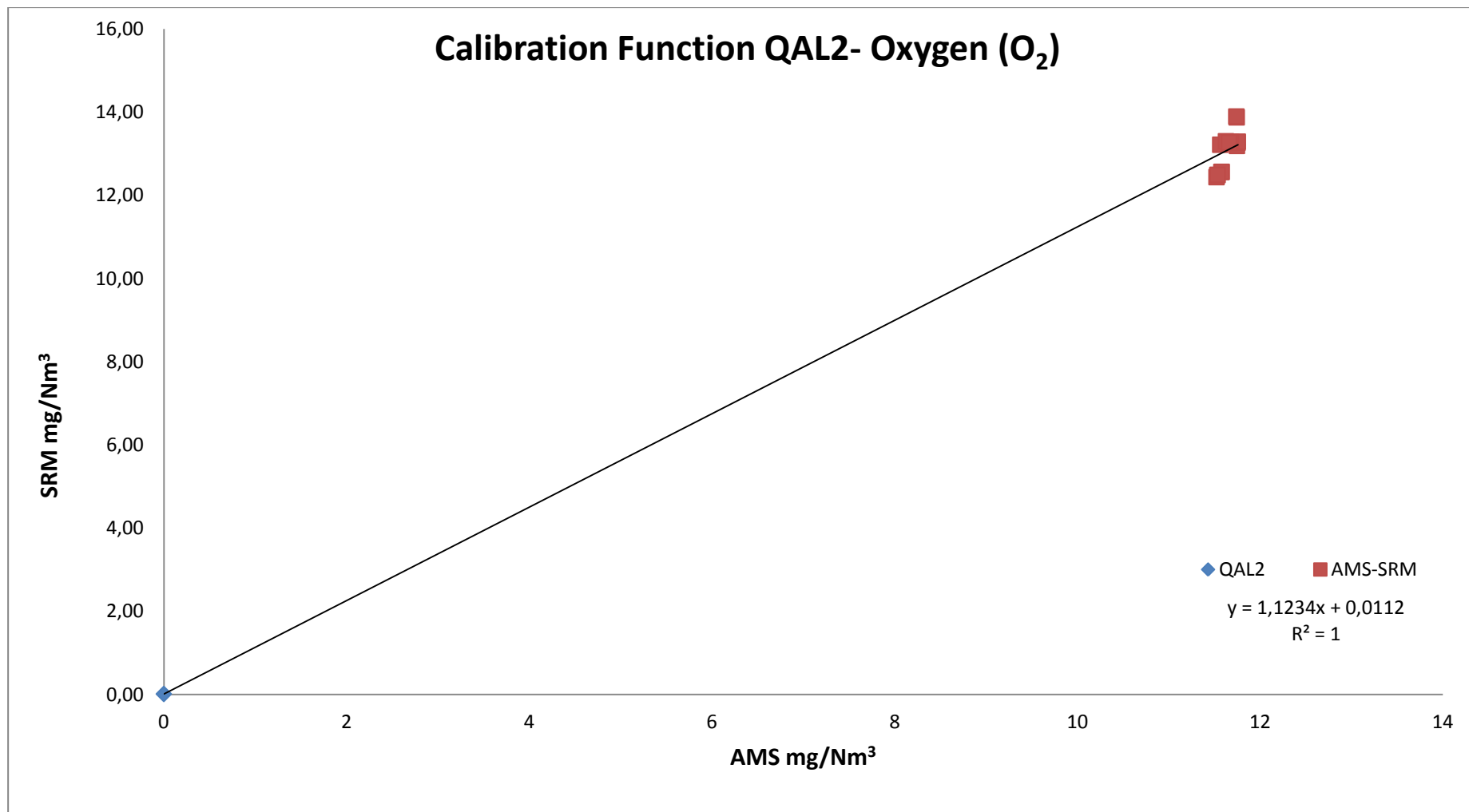
Parameter				NO		Emission Point				6A							
O2 rif %	15	SRM				AMS							Calculations				
N. Test	DATE/TIME	Y <sub>i</sub>	Yi-Ym	O <sub>2</sub>	Y <sub>i,s</sub>	X <sub>i</sub>	O <sub>2</sub>	xi-xm	(xi-xm) <sup>2</sup>	(xi-xm)*(Yi-Ym)	ŷ <sub>i</sub>	ŷ <sub>i,s</sub>	D <sub>i</sub> = y <sub>i,s</sub> -ŷ <sub>i,s</sub>	D <sub>i</sub> -đ	(D <sub>i</sub> -đ) <sup>2</sup>		
1	6/11/17 16:51	37,60	11,32	12,56	26,74	27,85	11,58	7,83	61,28	88,65	35,43	22,56	4,18	1,23	1,51		
2	6/11/17 18:05	33,97	7,69	12,57	24,17	25,35	11,58	5,33	28,38	40,99	32,51	20,70	3,47	0,51	0,26		
3	6/11/17 19:15	33,54	7,26	12,49	23,66	24,69	11,53	4,67	21,77	33,89	31,73	20,11	3,55	0,59	0,35		
4	6/11/17 20:29	32,62	6,35	12,51	23,05	25,09	11,57	5,06	25,62	32,12	32,19	20,49	2,56	-0,40	0,16		
5	6/11/17 21:29	31,10	4,83	12,53	22,02	24,77	11,58	4,74	22,51	22,90	31,82	20,26	1,76	-1,19	1,43		
6	7/11/17 10:03	18,88	-7,40	13,88	15,90	13,15	11,74	-6,87	47,20	50,82	18,25	11,83	4,08	1,12	1,26		
7	7/11/17 11:20	18,42	-7,85	13,90	15,56	13,22	11,74	-6,81	46,33	53,45	18,32	11,87	3,69	0,74	0,54		
8	7/11/17 12:39	20,41	-5,87	13,19	15,68	12,87	11,75	-7,15	51,14	42,00	17,92	11,62	4,06	1,10	1,22		
9	7/11/17 13:46	21,64	-4,63	13,27	16,79	15,26	11,75	-4,76	22,68	22,07	20,71	13,44	3,35	0,40	0,16		
10	7/11/17 15:13	22,82	-3,46	13,29	17,77	16,72	11,76	-3,31	10,94	11,43	22,41	14,55	3,22	0,27	0,07		
11	8/11/17 9:34	25,93	-0,35	13,22	20,00	21,65	11,56	1,62	2,64	-0,56	28,18	17,92	2,08	-0,88	0,77		
12	8/11/17 10:34	24,78	-1,50	13,30	19,31	20,65	11,63	0,62	0,39	-0,94	27,01	17,29	2,02	-0,93	0,87		
13	8/11/17 11:38	24,16	-2,12	13,27	18,75	19,83	11,67	-0,19	0,04	0,40	26,06	16,76	1,98	-0,97	0,94		
14	8/11/17 12:47	24,03	-2,25	13,29	18,70	19,54	11,68	-0,49	0,24	1,10	25,71	16,55	2,15	-0,80	0,64		
15	8/11/17 13:56	24,25	-2,03	13,27	18,83	19,72	11,66	-0,30	0,09	0,61	25,93	16,66	2,17	-0,78	0,61		
Average													2,96				
Sum									341,3	398,9					10,78		
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		55	Yaverage	26,28	x average	20,02	Z	//	Procedure for the determination of the calibration fuction								
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		8,25	m	1,169	i	2,870	r	0,962	Method A				Calibration Function				
Ys Max-Ys min		11,18	ŷs, max	22,56	Calibration Range				0 - 24,81 [mg/Nm3 rif O2]				Y= 1,168X + 2,869				
Test of Variability																	
Maximum permissible uncertainty (95% confidence interval)		20	Test value for variability (k <sub>v</sub> )		0,9761	σ0kv		5,478	Result of Variability Test (s <sub>p</sub> ≤σ <sub>0</sub> k <sub>v</sub> )								
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,877595	Standard Deviation (σ <sub>0</sub> )		5,61	Experimental Confidence interval [%]		3,13	Positive								





## 14.3 OXYGEN - QAL2

Parameter				O <sub>2</sub>		Emission Point			6A								
O2 rif %	15	SRM				AMS						Calculations					
N. Test	DATE/TIME	Y <sub>i</sub>	Yi-Ym	O <sub>2</sub>	Y <sub>i,s</sub>	x <sub>i</sub>	O <sub>2</sub>	xi-xm	(xi-xm) <sup>2</sup>	(xi-xm)*(Yi-Ym)	ŷ <sub>i</sub>		D <sub>i</sub> = y <sub>i,s</sub> -ŷ <sub>i,s</sub>	D <sub>i</sub> -đ	(D <sub>i</sub> -đ) <sup>2</sup>		
1	6/11/17 14:14	12,44	-0,66			11,52		-0,12	0,02	0,08	12,96		-0,52	-0,52	0,27		
2	6/11/17 15:37	12,49	-0,61			11,53		-0,11	0,01	0,07	12,97		-0,48	-0,48	0,23		
3	6/11/17 16:51	12,56	-0,53			11,58		-0,07	0,00	0,04	13,02		-0,45	-0,45	0,21		
4	6/11/17 18:05	12,57	-0,53			11,58		-0,07	0,00	0,04	13,02		-0,45	-0,45	0,21		
5	6/11/17 19:15	12,49	-0,60			11,53		-0,11	0,01	0,07	12,97		-0,47	-0,47	0,23		
6	7/11/17 10:03	13,88	0,78			11,74		0,10	0,01	0,08	13,21		0,67	0,67	0,45		
7	7/11/17 11:20	13,90	0,80			11,74		0,09	0,01	0,08	13,20		0,70	0,70	0,48		
8	7/11/17 12:39	13,19	0,09			11,75		0,10	0,01	0,01	13,21		-0,02	-0,02	0,00		
9	7/11/17 13:46	13,27	0,17			11,75		0,11	0,01	0,02	13,22		0,05	0,05	0,00		
10	7/11/17 15:13	13,29	0,20			11,76		0,11	0,01	0,02	13,22		0,07	0,07	0,01		
11	8/11/17 9:34	13,22	0,12			11,56		-0,08	0,01	-0,01	13,00		0,22	0,22	0,05		
12	8/11/17 10:34	13,30	0,21			11,63		-0,02	0,00	0,00	13,07		0,23	0,23	0,05		
13	8/11/17 11:38	13,27	0,17			11,67		0,03	0,00	0,00	13,13		0,14	0,14	0,02		
14	8/11/17 12:47	13,29	0,20			11,68		0,03	0,00	0,01	13,13		0,16	0,16	0,03		
15	8/11/17 13:56	13,27	0,18			11,66		0,01	0,00	0,00	13,11		0,16	0,16	0,03		
Average													0,00				
Sum									0,11		0,49		2,25				
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		21	Yaverage	13,10	x average	11,65	Z	-0,01	Procedure for the determination of the calibration fuction								
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		3,15	m	1,123	i	0,011	r	0,82103616	Method B				Calibration Function				
Ys Max-Ys min		1,46	ŷs, max	13,22	Calibration Range				0 - 14,54 [% Vol.]				Y= 1,123X + 0,011				
Test of Variability																	
Maximum permissible uncertainty (95% confidence interval)		10	Test value for variability (k <sub>v</sub> )		0,9761	σ0kv		1,046	Result of Variability Test (s <sub>0</sub> ≤σ <sub>0</sub> k <sub>v</sub> )								
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,400674	Standard Deviation (σ <sub>0</sub> )		1,07	Experimental Confidence interval [%]		3,74	Positive								

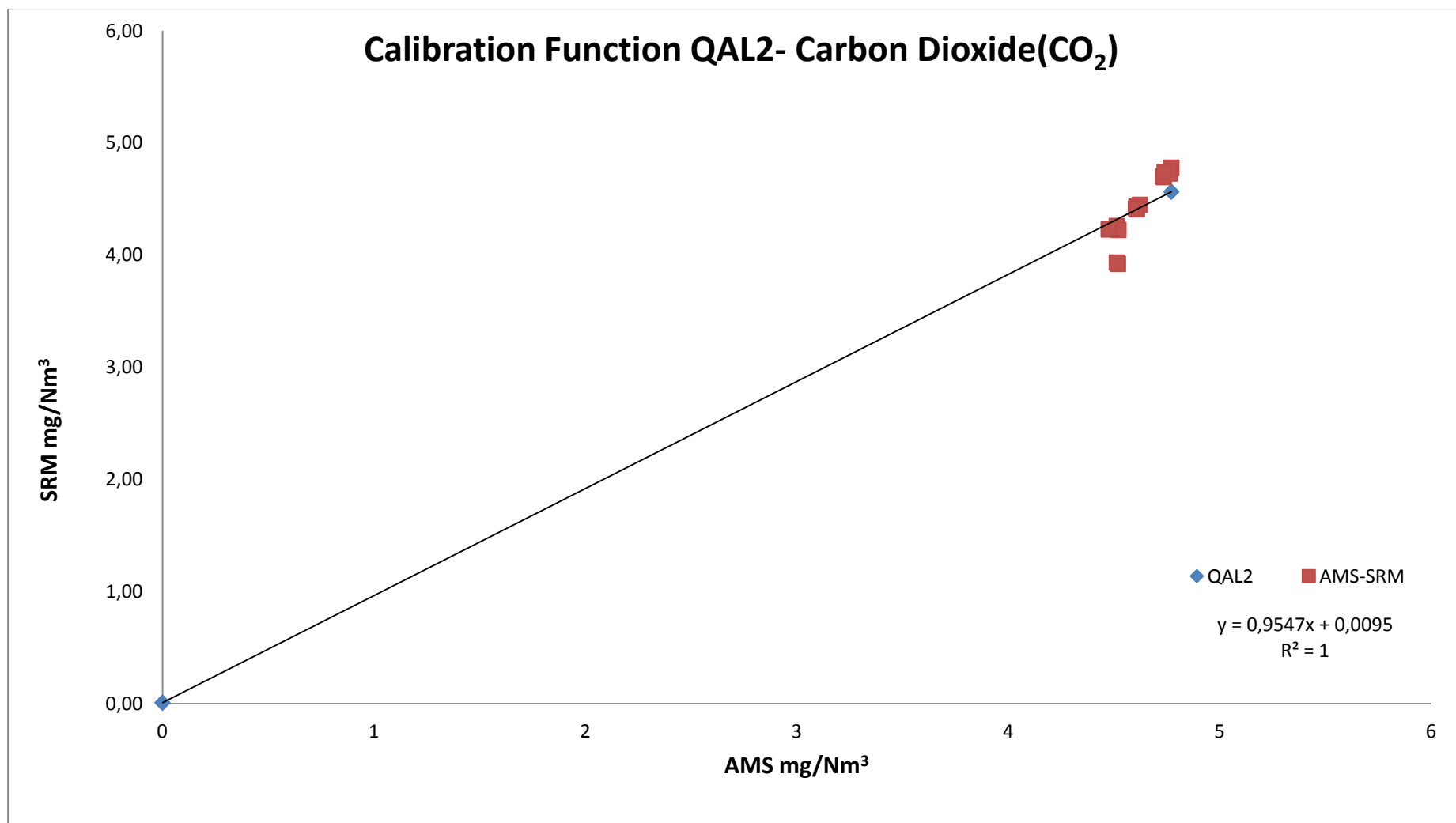




## 14.4 CARBON DIOXIDE – QAL2

Parameter				CO <sub>2</sub>		Emission Point			6A								
O <sub>2</sub> rif %	15	SRM				AMS						Calculations					
N. Test	DATE/TIME	Y <sub>i</sub>	Yi-Ym	O <sub>2</sub>	Y <sub>i,s</sub>	x <sub>i</sub>	O <sub>2</sub>	xi-xm	(xi-xm) <sup>2</sup>	(xi-xm)*(Yi-Ym)	ŷ <sub>i</sub>		D <sub>i</sub> = y <sub>i,s</sub> -ŷ <sub>i,s</sub>	D <sub>i</sub> -đ	(D <sub>i</sub> -đ) <sup>2</sup>		
1	6/11/17 14:14	4,78	0,36			4,77		0,15	0,02	0,05	4,57		0,21	0,21	0,05		
2	6/11/17 15:37	4,73	0,30			4,77		0,14	0,02	0,04	4,56		0,17	0,17	0,03		
3	6/11/17 16:51	4,70	0,27			4,74		0,11	0,01	0,03	4,53		0,16	0,16	0,03		
4	6/11/17 18:05	4,70	0,28			4,73		0,11	0,01	0,03	4,53		0,18	0,18	0,03		
5	6/11/17 19:15	4,74	0,32			4,74		0,12	0,01	0,04	4,54		0,21	0,21	0,04		
6	7/11/17 10:03	3,92	-0,50			4,52		-0,10	0,01	0,05	4,32		-0,40	-0,40	0,16		
7	7/11/17 11:20	3,93	-0,49			4,51		-0,11	0,01	0,05	4,32		-0,39	-0,39	0,15		
8	7/11/17 12:39	4,26	-0,16			4,51		-0,11	0,01	0,02	4,32		-0,06	-0,06	0,00		
9	7/11/17 13:46	4,22	-0,20			4,52		-0,10	0,01	0,02	4,33		-0,10	-0,10	0,01		
10	7/11/17 15:13	4,23	-0,19			4,48		-0,15	0,02	0,03	4,28		-0,05	-0,05	0,00		
11	8/11/17 9:34	4,45	0,03			4,62		0,00	0,00	0,00	4,42		0,03	0,03	0,00		
12	8/11/17 10:34	4,41	-0,01			4,61		-0,01	0,00	0,00	4,41		0,00	0,00	0,00		
13	8/11/17 11:38	4,43	0,01			4,61		-0,02	0,00	0,00	4,41		0,03	0,03	0,00		
14	8/11/17 12:47	4,42	-0,01			4,60		-0,02	0,00	0,00	4,41		0,01	0,01	0,00		
15	8/11/17 13:56	4,42	-0,01			4,61		-0,02	0,00	0,00	4,41		0,01	0,01	0,00		
Average													0,00				
Sum									0,15	0,37		0,50					
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		25	Yaverage	4,42	x average	4,62	Z	-0,01	Procedure for the determination of the calibration fuction								
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		3,75	m	0,955	i	0,010	r	0,92149966	Method B				Calibration Function				
Ys Max-Ys min		0,86	ŷs, max	4,57	Calibration Range				0 - 5,02 [% Vol.]				Y= 0,954X + 0,009				
Test of Variability																	
Maximum permissible uncertainty (95% confidence interval)		10	Test value for variability (k <sub>v</sub> )		0,9761	σ0kv		1,245	Result of Variability Test (s <sub>0</sub> ≤σ0k <sub>v</sub> )								
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,189675	Standard Deviation (σ <sub>0</sub> )		1,28	Experimental Confidence interval [%]		1,49	Positive								





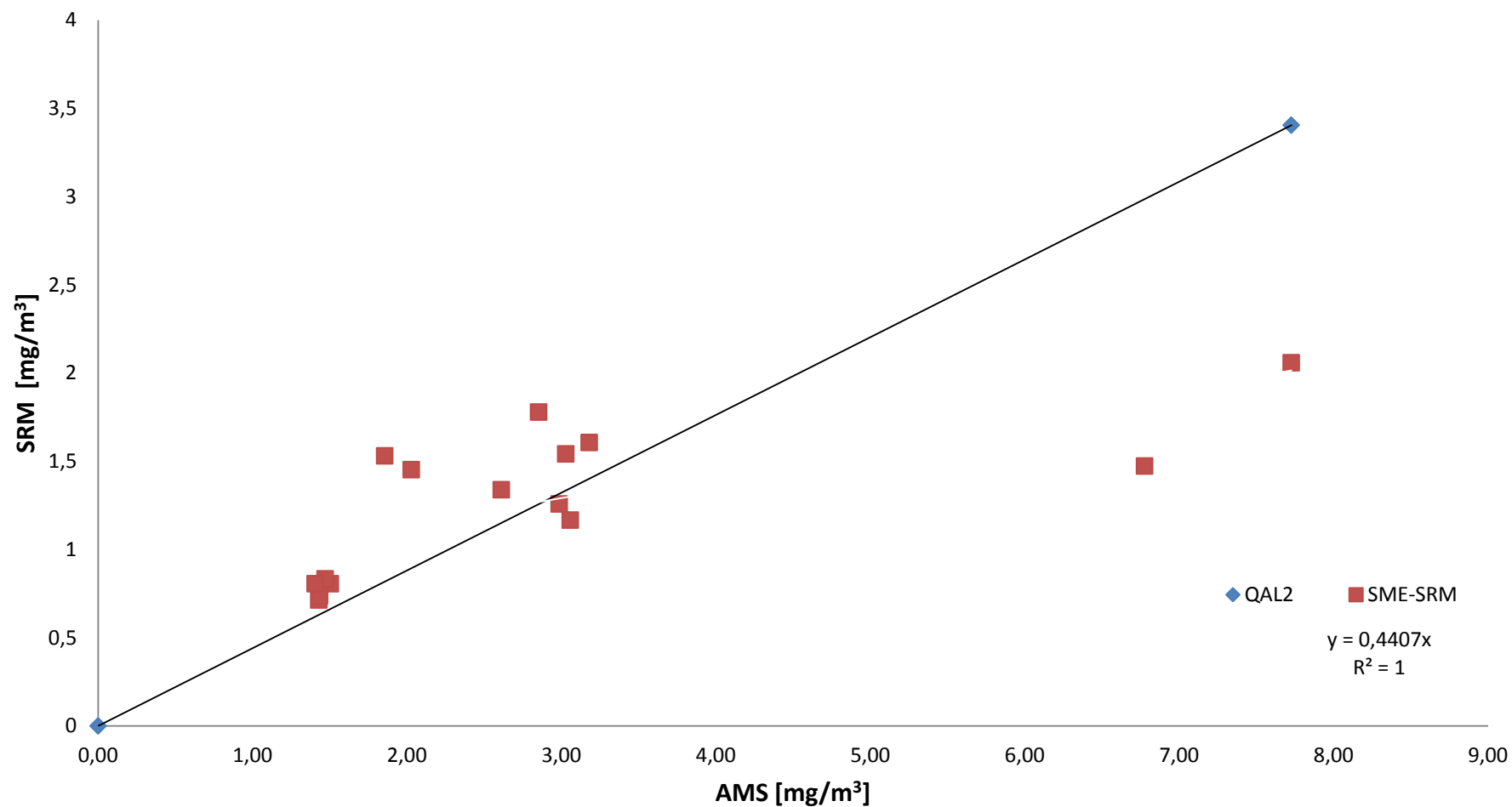


## 14.5 DUST – QAL2

Parameter									Dust		Emission Point					6A							
O <sub>2</sub> rif. %	15	SRM							AMS										Calculations				
N. Test	DATE/TIME	Y <sub>i</sub> [mg/m <sup>3</sup> ]	O <sub>2</sub> [%vol]	T [°C]	P [kPa]	U [%]	Y <sub>i</sub> -Y <sub>m</sub>	Y <sub>i,s</sub> [mg/Nm <sup>3</sup> ]	x <sub>i</sub> [mg/m3]	O <sub>2</sub> [%vol]	T [°C]	P [hPa]	U [%]	x <sub>i</sub> -x <sub>m</sub>	(x <sub>i</sub> -x <sub>m</sub> ) <sup>2</sup>	(x <sub>i</sub> -x <sub>m</sub> )* (Y <sub>i</sub> -Y <sub>m</sub> )	Ŷ <sub>i</sub> [mg/m <sup>3</sup> ]	Ŷ <sub>i,s</sub> [mg/Nm <sup>3</sup> ]	D <sub>i</sub> = Y <sub>i,s</sub> -Ŷ <sub>i,s</sub>	D <sub>i</sub> -d̄	(D <sub>i</sub> -d̄)		
1	06/11/2017 14:14	0,81	12,56	364,62	100,65	11,00	-0,47	1,51	1,50	11,52	363,58	991,18	11,03	-1,39	1,92	0,65	0,66	1,12	0,39	0,09	0,01		
2	06/11/2017 15:37	0,83	12,57	365,10	100,62	10,80	-0,44	1,56	1,47	11,53	364,08	991,16	11,00	-1,42	2,01	0,62	0,65	1,10	0,46	0,16	0,03		
3	06/11/2017 16:51	0,71	12,49	363,43	100,65	10,30	-0,56	1,32	1,43	11,58	363,28	991,22	10,92	-1,46	2,13	0,82	0,63	1,07	0,24	-0,06	0,00		
4	06/11/2017 18:05	0,74	12,51	362,52	100,78	10,90	-0,54	1,37	1,43	11,58	362,44	991,28	10,90	-1,46	2,12	0,78	0,63	1,07	0,29	-0,01	0,00		
5	06/11/2017 19:15	0,81	12,53	364,08	100,73	10,00	-0,47	1,49	1,41	11,53	363,12	991,39	10,93	-1,48	2,20	0,69	0,62	1,05	0,44	0,14	0,02		
6	07/11/2017 10:03	1,34	13,88	152,88	101,09	10,10	0,07	1,96	2,61	11,74	152,33	992,07	10,09	-0,28	0,08	-0,02	1,15	1,32	0,64	0,34	0,11		
7	07/11/2017 11:20	1,53	13,90	155,65	101,14	10,50	0,26	2,27	1,86	11,74	155,31	992,12	10,06	-1,03	1,07	-0,27	0,82	0,94	1,33	1,03	1,05		
8	07/11/2017 12:39	1,47	13,19	153,28	101,23	11,00	0,20	1,99	6,78	11,75	152,87	992,08	10,10	3,89	15,11	0,78	2,99	3,43	-1,44	-1,75	3,05		
9	07/11/2017 13:46	1,45	13,27	150,17	101,08	10,02	0,18	1,95	2,03	11,75	149,81	992,03	10,16	-0,86	0,74	-0,15	0,89	1,02	0,93	0,62	0,39		
10	07/11/2017 15:13	1,17	13,29	149,30	101,70	10,60	-0,11	1,56	3,06	11,76	148,75	992,06	11,37	0,17	0,03	-0,02	1,35	1,56	0,01	-0,30	0,09		
11	08/11/2017 09:34	1,78	13,22	140,50	101,61	11,00	0,51	2,33	2,85	11,56	141,99	993,12	10,54	-0,04	0,00	-0,02	1,26	1,39	0,94	0,64	0,41		
12	08/11/2017 10:34	1,26	13,30	140,10	101,68	12,00	-0,02	1,68	2,99	11,63	146,77	993,16	10,43	0,10	0,01	0,00	1,32	1,47	0,20	-0,10	0,01		
13	08/11/2017 11:38	1,54	13,27	148,20	101,76	11,00	0,27	2,06	3,03	11,67	147,93	993,16	10,39	0,14	0,02	0,04	1,33	1,51	0,56	0,25	0,06		
14	08/11/2017 12:47	2,06	13,29	146,60	100,72	12,00	0,78	2,81	7,73	11,68	145,97	993,12	10,34	4,84	23,40	3,80	3,41	3,83	-1,01	-1,32	1,73		
15	08/11/2017 13:56	1,61	13,27	145,40	101,65	10,90	0,33	2,14	3,18	11,66	144,86	993,10	10,35	0,29	0,08	0,10	1,40	1,57	0,57	0,27	0,07		
Average																			0,30				
Sum															50,93	7,79					7,04		
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		5	Yaverag e	1,27	x average	2,89	Z		Procedure for the determination of the calibration fuction						Calibration Function								
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		0,75	m	0,44	i	0,000 0	r	0,70	Method B						Y= 0,44X + 0								
Ys Max-Ys min		1,50	ŷs, max	3,83	Calibration Range				0 - 4,21 [mg/Nm3 rif O2]														
Test of Variability																							
Maximum permissible uncertainty (95% confidence interval)		30	Test value for variability (k <sub>v</sub> )				0,9761	σ0kv		0,747	Result of Variability Test (s <sub>0</sub> ≤σ <sub>0</sub> k <sub>v</sub> )												
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,709	Standard Deviation (σ <sub>0</sub> )			0,77	Experimental Confidence interval [%]			27,79	Positive												
Note: Method B was used to process the results in order to obtain a proper calibration function.																							



## Calibration function QAL2- Dust





## 15 ANNEX 5 – IAR REPORT

### 15.1 WATER VAPOUR – IAR

Parameter		Water Vapour		
N. Test	DATE/TIME	SRM [%]	AMS [%]	Absolute Differences (X <sub>i</sub> )
1	6/11/17 14:14	11,0	11,0	0,0
2	6/11/17 15:37	10,8	11,0	0,2
3	7/11/17 10:03	10,1	10,1	0,0
4	7/11/17 11:20	10,5	10,1	0,4
5	8/11/17 10:34	12	10,4	2
Average		10,9	10,5	0,5
t student 0,95 (N-1)		2,78		
Standard Deviation (S <sub>D</sub> )		0,65		
Confidence Interval (I <sub>c</sub> )		0,80		
<b>I.A.R</b>		<b>88,5</b>		

### 15.2 TEMPERATURE – IAR

Parameter		Temperature		
N. Test	DATE/TIME	SRM [°C]	AMS [°C]	Absolute Differences (X <sub>i</sub> )
1	6/11/17 14:14	365	364	1
2	6/11/17 15:37	365	364	1
3	7/11/17 10:03	153	152	1
4	7/11/17 11:20	156	155	0
5	8/11/17 10:34	140	147	7
Average		236	236	1,9
t student 0,95 (N-1)		2,78		
Dev. Standard (S <sub>D</sub> )		2,70		
Intervallo di Confidenza (I <sub>c</sub> )		3,35		
<b>I.A.R</b>		<b>97,8</b>		



### 15.3 PRESSURE - IAR

Parameter		Pressure		
N. Test	DATE/TIME	SRM [hPa]	AMS [hPa]	Absolute Differences (X <sub>i</sub> )
1	6/11/17 14:14	1007	991	15
2	6/11/17 15:37	1006	991	15
3	7/11/17 10:03	1011	992	19
4	7/11/17 11:20	1011	992	19
5	8/11/17 10:34	1017	993	24
Average		1010	992	18
t student 0,95 (N-1)		2,78		
Standard Deviation (S <sub>D</sub> )		3,51		
Confidence Interval (I <sub>c</sub> )		4,36		
<b>I.A.R</b>		<b>97,7</b>		

### 15.4 FLOW - IAR

Parameter			Flow	
N. Test	DATE/TIME	SRM [Nm <sup>3</sup> /h]	AMS [Nm <sup>3</sup> /h]	Absolute Differences (X <sub>i</sub> )
1	7/11/17 10:03	79121	92040	12919
2	7/11/17 11:20	80086	92245	12159
3	7/11/17 12:39	79228	92204	12976
4	7/11/17 13:46	78309	92211	13902
5	8/11/17 10:34	64916	76085	11169
Average		76332,16	88957,03	12625
t student 0,95 (N-1)		2,78		
Standard Deviation (S <sub>D</sub> )		1021,92		
Confidence Interval (I <sub>c</sub> )		1268,88		
<b>I.A.R</b>		<b>81,8</b>		



## 16 ANNEX 6 – QAL1 CERTIFIED SRM ANALYZER

	
<h1>CERTIFICATE</h1> <p>on Product Conformity (QAL1)</p>	
Certificate No.: 0000032301	
<b>Certified AMS:</b>	PG-350E for NO <sub>x</sub> , SO <sub>2</sub> , CO, CO <sub>2</sub> and O <sub>2</sub>
<b>Manufacturer:</b>	HORIBA Europe GmbH Julius-Kronenberg-Str. 9 42799 Leichlingen Germany
<b>Test Institute:</b>	TÜV Rheinland Energie und Umwelt GmbH
<p><b>This is to certify that the AMS has been tested and found to comply with:</b></p> <p><b>EN 15267-1: 2009, EN 15267-2: 2009, EN 15267-3: 2007 and EN 14181: 2004</b></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"><li>• EN 15267-3 tested</li><li>• QAL1 certified</li><li>• TÜV approved</li><li>• Annual inspection</li></ul>	
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
<a href="http://www.umwelt-tuv.de">www.umwelt-tuv.de</a> / <a href="http://www.eco-tuv.com">www.eco-tuv.com</a> 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
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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<sub>x</sub>, SO<sub>2</sub>, CO, CO<sub>2</sub> and O<sub>2</sub>

**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 <sub>x</sub>	0 - 205 <sup>1)</sup>	0 - 2050 <sup>2)</sup>	mg/m <sup>3</sup>
SO <sub>2</sub>	0 - 143	0 - 1430	mg/m <sup>3</sup>
CO	0 - 75	0 - 1250	mg/m <sup>3</sup>
CO <sub>2</sub>	0 - 20	-	Vol.-%
O <sub>2</sub>	0 - 25	0 - 10	Vol.-%

<sup>1)</sup> as NO<sub>2</sub>, this corresponds to apx 0 - 134 mg/m<sup>3</sup> NO

<sup>2)</sup> as NO<sub>2</sub>, this corresponds to apx. 0 - 1340 mg/m<sup>3</sup> NO

**Software version:**

P2000788001D / 1.11

**Restrictions:**

None

**Notes:**

1. The maintenance interval is four weeks.
2. The certification range for the component SO<sub>2</sub> 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 SO<sub>2</sub> the PD-100 permeation dryer manufactured by Horiba should be used.

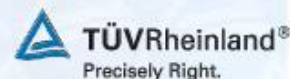
**Test report:**

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 <sub>x</sub>	Chemiluminescence
CO, SO <sub>2</sub> , CO <sub>2</sub>	Non-dispersive absorption (NDIR) Infrared
O <sub>2</sub>	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](http://qal1.de).

Certification of PG-350E for NO<sub>x</sub>, SO<sub>2</sub>, CO, CO<sub>2</sub> and O<sub>2</sub> 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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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	VC4DFKB0 / XL7LTUL1
Measuring principle	Chemiluminescence

Test report

Test laboratory	21217817/A
Date of report	TÜV Rheinland 2012-10-08

Measured component

Certification range	NO <sub>x</sub> as NO 0 - 134 mg/m <sup>3</sup>
---------------------	--

Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	0,84 mg/m <sup>3</sup>
Sum of negative CS at zero point	0,00 mg/m <sup>3</sup>
Sum of positive CS at reference point	0,00 mg/m <sup>3</sup>
Sum of negative CS at reference point	-0,70 mg/m <sup>3</sup>
Maximum sum of cross sensitivities	0,84 mg/m <sup>3</sup>
Uncertainty of cross sensitivity	0,487 mg/m <sup>3</sup>

Calculation of the combined standard uncertainty

Tested parameter

			$u^2$
Standard deviation from paired measurements under field conditions *	$u_D$	mg/m <sup>3</sup>	0,797 (mg/m <sup>3</sup> ) <sup>2</sup>
Lack of fit	$u_{LoF}$	mg/m <sup>3</sup>	0,336 (mg/m <sup>3</sup> ) <sup>2</sup>
Zero drift from field test	$u_{0,z}$	mg/m <sup>3</sup>	0,082 (mg/m <sup>3</sup> ) <sup>2</sup>
Span drift from field test	$u_{0,s}$	2,035 mg/m <sup>3</sup>	4,141 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of ambient temperature at span	$u_t$	1,332 mg/m <sup>3</sup>	1,774 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of supply voltage	$u_v$	0,306 mg/m <sup>3</sup>	0,094 (mg/m <sup>3</sup> ) <sup>2</sup>
Cross sensitivity (interference)	$u_i$	mg/m <sup>3</sup>	0,238 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of sample gas flow	$u_b$	mg/m <sup>3</sup>	0,013 (mg/m <sup>3</sup> ) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	$u_{rm}$	mg/m <sup>3</sup>	1,173 (mg/m <sup>3</sup> ) <sup>2</sup>
Converter efficiency for AMS measuring NO <sub>x</sub>	$u_{ce}$	mg/m <sup>3</sup>	10,583 (mg/m <sup>3</sup> ) <sup>2</sup>

\* The larger value is used:

"Repeatability standard deviation at span" or

"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty ( $u_c$ )

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 4,38 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c \cdot k = u_c \cdot 1,96 \quad 8,59 \text{ mg/m}^3$$

Relative total expanded uncertainty

$$U \text{ in \% of the ELV } 131 \text{ mg/m}^3 \quad 6,6$$

Requirement of 2000/76/EC and 2001/80/EC

$$U \text{ in \% of the ELV } 131 \text{ mg/m}^3 \quad 20,0$$

Requirement of EN 15267-3

$$U \text{ in \% of the ELV } 131 \text{ mg/m}^3 \quad 15,0$$



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

SO<sub>2</sub>  
Certification range 0 - 143 mg/m<sup>3</sup>

Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point 0.54 mg/m<sup>3</sup>  
Sum of negative CS at zero point -0.69 mg/m<sup>3</sup>  
Sum of positive CS at reference point 0.70 mg/m<sup>3</sup>  
Sum of negative CS at reference point -2.60 mg/m<sup>3</sup>  
Maximum sum of cross sensitivities -2.60 mg/m<sup>3</sup>  
Uncertainty of cross sensitivity -1.503 mg/m<sup>3</sup>

Calculation of the combined standard uncertainty

Tested parameter

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

\* The larger value is used:

"Repeatability standard deviation at span" or

"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u<sub>c</sub>)  $u_c = \sqrt{\sum (u_{max,i})^2}$  4.23 mg/m<sup>3</sup>  
Total expanded uncertainty  $U = u_c \cdot k = u_c \cdot 1.96$  8.30 mg/m<sup>3</sup>

Relative total expanded uncertainty



U in % of the ELV 60 mg/m<sup>3</sup> 13.8

Requirement of 2000/76/EC and 2001/80/EC U in % of the ELV 60 mg/m<sup>3</sup> 20.0

Requirement of EN 15267-3 U in % of the ELV 60 mg/m<sup>3</sup> 15.0







	<p align="center"><b>Certificate:</b> 0000032301 / 22 March 2013</p>	
<p align="center"><b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b></p>		
<b>Measuring system</b>		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB0 / XL7LTUL1	
Measuring principle	NDIR	
<b>Test report</b>	21217617/A	
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
<b>Measured component</b>	CO	
Certification range	0 - 75 mg/m <sup>3</sup>	
<b>Evaluation of the cross sensitivity (CS)</b> (system with largest CS)		
Sum of positive CS at zero point	0.00 mg/m <sup>3</sup>	
Sum of negative CS at zero point	0.00 mg/m <sup>3</sup>	
Sum of positive CS at reference point	0.50 mg/m <sup>3</sup>	
Sum of negative CS at reference point	-0.65 mg/m <sup>3</sup>	
Maximum sum of cross sensitivities	-0.65 mg/m <sup>3</sup>	
Uncertainty of cross sensitivity	-0.377 mg/m <sup>3</sup>	
<b>Calculation of the combined standard uncertainty</b>		
<b>Tested parameter</b>	<b>u<sub>i</sub></b>	<b>u<sup>2</sup></b>
Standard deviation from paired measurements under field conditions *	u <sub>D</sub> mg/m <sup>3</sup>	0.356 (mg/m <sup>3</sup> ) <sup>2</sup>
Lack of fit	u <sub>of</sub> mg/m <sup>3</sup>	0.070 (mg/m <sup>3</sup> ) <sup>2</sup>
Zero drift from field test	u <sub>z,d</sub> mg/m <sup>3</sup>	0.706 (mg/m <sup>3</sup> ) <sup>2</sup>
Span drift from field test	u <sub>s,d</sub> -0.675 mg/m <sup>3</sup>	0.456 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of ambient temperature at span	u <sub>t</sub> 0.868 mg/m <sup>3</sup>	0.750 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of supply voltage	u <sub>v</sub> 0.288 mg/m <sup>3</sup>	0.082 (mg/m <sup>3</sup> ) <sup>2</sup>
Cross sensitivity (interference)	u <sub>i</sub> mg/m <sup>3</sup>	0.142 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of sample gas flow	u <sub>p</sub> mg/m <sup>3</sup>	0.001 (mg/m <sup>3</sup> ) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	u <sub>rm</sub> mg/m <sup>3</sup>	0.368 (mg/m <sup>3</sup> ) <sup>2</sup>
* The larger value is used: "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"		
Combined standard uncertainty (u <sub>c</sub> )	$u_c = \sqrt{\sum (u_{max,i})^2}$	1.71 mg/m <sup>3</sup>
Total expanded uncertainty	$U = u_c \cdot k = u_c \cdot 1.96$	3.35 mg/m <sup>3</sup>
<b>Relative total expanded uncertainty</b>	<b>U in % of the ELV 50 mg/m<sup>3</sup></b>	<b>6.7</b>
Requirement of 2000/76/EC and 2001/80/EC	U in % of the ELV 50 mg/m <sup>3</sup>	10.0
Requirement of EN 15267-3	U in % of the ELV 50 mg/m <sup>3</sup>	7.5

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	<p align="center"><b>Certificate:</b> 0000032301 / 22 March 2013</p>	
<p align="center"><b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b></p>		
<b>Measuring system</b>		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB9 / XL7LTUL1	
Measuring principle	NDIR	
<b>Test report</b>	21217617/A	
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
<b>Measured component</b>	CO <sub>2</sub>	
Certification range	0 - 20 Vol.-%	
<b>Evaluation of the cross sensitivity (CS)</b> (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.-%
<b>Calculation of the combined standard uncertainty</b>		
<b>Tested parameter</b>		<b>U<sup>2</sup></b>
Standard deviation from paired measurements under field conditions *	U <sub>D</sub>	Vol.-% 0.000 (Vol.-%) <sup>2</sup>
Lack of fit	U <sub>LOF</sub>	Vol.-% 0.013 (Vol.-%) <sup>2</sup>
Zero drift from field test	U <sub>ZD</sub>	Vol.-% 0.071 (Vol.-%) <sup>2</sup>
Span drift from field test	U <sub>SD</sub>	0.238 Vol.-% 0.057 (Vol.-%) <sup>2</sup>
Influence of ambient temperature at span	U <sub>t</sub>	0.115 Vol.-% 0.013 (Vol.-%) <sup>2</sup>
Influence of supply voltage	U <sub>v</sub>	0.051 Vol.-% 0.003 (Vol.-%) <sup>2</sup>
Cross sensitivity (interference)	U <sub>i</sub>	Vol.-% 0.004 (Vol.-%) <sup>2</sup>
Influence of sample gas flow	U <sub>g</sub>	Vol.-% 0.000 (Vol.-%) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	U <sub>rm</sub>	Vol.-% 0.026 (Vol.-%) <sup>2</sup>
* The larger value is used : "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"		
Combined standard uncertainty (u <sub>c</sub> )	$u_c = \sqrt{\sum (u_{max,i})^2}$	0.43 Vol.-%
Total expanded uncertainty	$U = u_c \cdot k = u_c \cdot 1.96$	0.85 Vol.-%
<b>Relative total expanded uncertainty</b>	<b>U in % of the range 20 Vol.-%</b>	<b>4.2</b>
Requirement of 2000/76/EC and 2001/80/EC	<b>U in % of the range 20 Vol.-%</b>	<b>10.0**</b>
Requirement of EN 15267-3	<b>U in % of the range 20 Vol.-%</b>	<b>7.5</b>
** 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.		
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Umwelt Bundes Amt For our Environment		Certificate: 0000032301 / 22 March 2013		TÜVRheinland® Precisely Right.	
<b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b>					
<b>Measuring system</b>					
Manufacturer	Horiba Europe GmbH				
Name of measuring system	PG-350E				
Serial number of the candidates	VC4DFKB9 / XL7LTUL1				
Measuring principle	Paramagnetism				
<b>Test report</b>		21217617/A			
Test laboratory	TÜV Rheinland				
Date of report	2012-10-08				
<b>Measured component</b>		O <sub>2</sub>			
Certification range	0 - 25 Vol.-%				
<b>Evaluation of the cross sensitivity (CS)</b> (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.-%				
<b>Calculation of the combined standard uncertainty</b>					
<b>Tested parameter</b>		<b>u<sup>2</sup></b>			
Standard deviation from paired measurements under field conditions *	u <sub>D</sub>	Vol.-%	0.004	(Vol.-%) <sup>2</sup>	
Lack of fit	u <sub>lof</sub>	Vol.-%	0.000	(Vol.-%) <sup>2</sup>	
Zero drift from field test	u <sub>dz</sub>	Vol.-%	0.006	(Vol.-%) <sup>2</sup>	
Span drift from field test	u <sub>ds</sub>	0.092 Vol.-%	0.008	(Vol.-%) <sup>2</sup>	
Influence of ambient temperature at span	u <sub>t</sub>	0.064 Vol.-%	0.007	(Vol.-%) <sup>2</sup>	
Influence of supply voltage	u <sub>v</sub>	0.018 Vol.-%	0.000	(Vol.-%) <sup>2</sup>	
Cross sensitivity (Interference)	u <sub>i</sub>	Vol.-%	0.000	(Vol.-%) <sup>2</sup>	
Influence of sample gas flow	u <sub>g</sub>	Vol.-%	0.000	(Vol.-%) <sup>2</sup>	
Uncertainty of reference material at 70% of certification range	u <sub>rm</sub>	Vol.-%	0.041	(Vol.-%) <sup>2</sup>	
* The larger value is used : "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"					
Combined standard uncertainty (u <sub>c</sub> )		$u_c = \sqrt{\sum (u_{max,i})^2}$		0.26	Vol.-%
Total expanded uncertainty		$U = u_c \cdot k = u_c \cdot 1.96$		0.51	Vol.-%
<b>Relative total expanded uncertainty</b>					
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.					
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## 17 ANNEX 7 – 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  
DAK-17588-01-00

als Kalibrierlaboratorium im / as calibration laboratory in the

**Deutschen Kalibrierdienst**

**DKD**

Kalibrierschein  
Calibration certificate

Kalibrierzeichen  
Calibration mark

09830
D-K- 17588-01-00
2017-10

Gegenstand Object	Gasteller
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, Italien

Auftragsnummer Order No.	PK752
Anzahl der Seiten des Kalibrierscheines Number of pages of the certificate	3
Datum der Kalibrierung Date of calibration	04.10.2017

Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung sowohl der Deutschen Akkreditierungsstelle GmbH 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 Deutsche Akkreditierungsstelle GmbH and the issuing laboratory. Calibration certificates without signature are not valid.

Datum Date	Leiter des Kalibrierlaboratoriums Head of the calibration laboratory
04.10.2017	Dr.rer.nat. Johannes Schubert

Bearbeiter Person in charge
Dr. Marc Plüschau

TetraTec Instruments GmbH · Gewerbestraße 8 · 71144 Steinbronn  
Tel 07157/53870 · Fax 07157/538710 · [www.tetrattec.de](http://www.tetrattec.de) · [info@tetrattec.de](mailto:info@tetrattec.de)

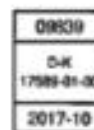
File: CAL055133  
DA9999 VQ350 R00





Calibration Laboratory of TetraTec Instruments GmbH

Seite 2 of 3  
Page english version



1.) Calibration object: Gas Blender  
Type: BetaCAP30 RK  
Manufacturer: Bu.T.A. strumentazione  
Serial-No.: 300229  
Meas.range: ca. 3.990 sm<sup>3</sup>/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: 50MK10-6 50MJ10-14 50MJ10-13  
Serial-No.: 752050-2 776810-N7 789090-S5  
Meas.range: 3,3...65 ml/min 133...4100 ml/min 300...7300 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, 1300 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:  $969,3 \pm 1,0$  hPa  
room temperature:  $23,0 \pm 1,0$  °C  
atmospheric humidity:  $39,9 \pm 5,0$  %r.F.

5.) Uncertainties of measurement

volume flow: 0,43% o.r. for  $Q \geq 10$  l/h  
0,38% 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.

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

File: CAL055133



Calibration Laboratory of TetraTec Instruments GmbH

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D-K 17589-01-00
2017-10

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

$$\text{dev.} = c_i - c_s$$

unc.: uncertainty of  $c_i$  due to uncertainties of the measured flows

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

All measurements were performed at an entrance pressure of the gas-blender of ca. 1300 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	3975,7	3975,7	0,00	0,00	0,00	0,00
1	137,64	3847,7	3985,4	3,33	3,45	0,12	0,02
2	272,18	3718,3	3990,5	6,67	6,82	0,15	0,04
4	543,07	3448,3	3991,4	13,33	13,61	0,27	0,07
8	1081,69	2910,2	3991,9	26,67	27,10	0,43	0,15
15	1989,6	2002,0	3991,6	50,00	49,85	-0,15	0,27
30	4005,4	0,0	4005,4	100,00	100,00	0,00	0,00

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Tel +497157/53870 · Fax +497157/538710 · www.tetratec.de · info@tetratec.de

File: CAL055133



## 18 ANNEX 8 - 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 del Laboratorio 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](http://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](http://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)



## 19 ANNEX 9 - CERTIFICATES REFERENCE MATERIAL



SAPIO PRODUZIONE IDROGENO OSSIGENO S.r.l.

SEDE LEGALE: VIA SAN MARCELLO 13, 20137 MILANO  
UFFICIO OPERATIVO VIA SEPIATORE SANVITTORIO 17, 20097, ORZINUOVI (MI)  
TELEFONO: 02.657891 / TELEFAX: 02.657892

### CERTIFICATO DI ANALISI Certificate of analysis

G-38-05

CLIENTE: CHIMICA APPLICATA DEPURAZIONE ACQUE

Customer:

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

Address:

NUMERO ORDINE: 2726323  
Order number:

CODICE RICORDO: PISA42177P  
Code reminder:

PER RICORDO: [verifica online](#)  
Numero verde: 800418110

MATRICOLO: MPN1386  
Serial number:

CAPACITA' (litri): 20  
Capacity (liters):

SCADENZA  
PROVA IDRAULICA: 08/2014  
Expiration hydraulic test:

CONTENUTO: MISCELA DI GAS  
Content:

RECIPIENTE: BOMBOLA GRUPPO 5-UN11146  
Vessel:

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

COMPONENTE Component	RICHIESTA Request	CONCENTRAZIONE (C) Concentration (C)	Incertezza Relativa (RC%) Relative Uncertainty (RC%)
ELUIRICO (O L'ALIBRINO)	10.00 %	10.00 %	0.0%
OSSIGENO (O CARBONIO)	27.0 ppm	27.0 ppm	0.0%
OSSIGENO (O AZOTO)	27.0 ppm	27.0 ppm	0.0%
ANIDRIDE SOLFORICA	10.0 ppm	10.0 ppm	0.0%
OSSIGENO AZOTO TOTALE	-	27.0 ppm	0.0%

Completamento: AZOTO  
Balance: Concentrazione (C) espressa in termini di: mol/m<sup>3</sup>  
Concentration (C) espressa in termini di:

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

Ripetibilità: La lettura del ricettore di massa utilizzato per la preparazione della miscela è effettuata utilizzando masse certificate del centro di taratura LAT s.p.a.

Taccetta: La lettura delle masse è eseguita in conformità alla procedura PT54 (EURAMET go-12 v. 4.0);  
I certificati di riferimento delle masse utilizzate sono: LAT06 0642017, 0652017, 4010215, 5722015.

Note:

Non:

PRESSIONE DI RIMPIANTO (bar) Filling pressure (bar):	150.0	RISCHI PER LA SALUTE: Health hazard:	NOGIVO
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:	08/2019

Data certificato: 01/06/2017  
Certification date:

Numero certificato: 201705601  
Certificate number:

Operatore: F. Pizzoli  
Operator:



SAPIO PRODUZIONE IDROGENO OSSIGENO S.r.l.

SEDE LEGALE: VIA SAN MAURELIO 13, 20123, MILANO  
UFFICIO OPERATIVO: VIA SENATORI SIMONE TTA 27, 20067, CAPONAGO (MB)  
TELEFONO: 02.957051 / TELEFAX: 02.9574084

**CERTIFICATO DI ANALISI**  
Certificate of analysis

G-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](mailto: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](mailto: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 RIPIEMIMENTO (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 E.V.)

SEDE LEGALE: VIA SAN MARINO 12, 20122, MILANO  
UFFICIO OPERATIVO VIA SIVARONE 5/A, 20122, CAPONNARO (MI)  
TELEFONO: 02 87061 / TELEFAX: 02 8706162

**CERTIFICATO DI ANALISI**  
Certificate of analysis

CLIENTE: CHIMICA APPLICATA DEPURAZIONE ACQUE  
Customer:

INDIRIZZO: VIA PIO LA TORRE 13 - AREA P.I.P. MENFI 92013 AG  
Address:

NUMERO ORDINE: 3832384  
Order number:

CODICE RICORDO: IP614R5YDFN  
Code reminder:

PER RICORDO: [ordini@sapiogroup.it](mailto:ordini@sapiogroup.it)  
Numero verde: 800416118

MATRICOLA: MP17187  
Serial number:

CAPACITA' (litri): 18  
Capacity (liters):

SCADENZA  
PROVA IDRAULICA: 03/2024  
Expiration hydraulic test:

CONTENUTO: MISCELA DI GAS  
Content:

RECIPIENTE: BOMBOLA GRUPPO S-UNIT1144  
BOMX  
Vessel:

METODO DI PREPARAZIONE: GRAMMETRICO SECONDO NORME ISO 8142 - ISO 8143  
Method of preparation:

COMPONENTE Component	RICHESTA Request	CONCENTRAZIONE (C) Concentration (C)	INCERTEZZA RELATIVA (IC%) Relative Uncertainty (IC%)
ARMONICA	98.0 ppm	97.3 ppm	0.8%
Completamento: AZOTO Addition:		Concentrazione (C) espressa in termini di: multipli Concentration (C) expressed in terms of:	

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

Ripetibilità: La taratura dei misuratori di massa utilizzati per la preparazione della miscela è effettuata utilizzando masse certificate del centro di taratura LAT n°066.  
Ripetibilità: La taratura delle masse è eseguita in conformità alla procedura PT04 (EURAMET go-18 v. 4.0).  
I certificati di riferimento delle masse utilizzate sono: LAT065 064/2017; 065/2017; 431/2015; 572/2015.

Note:  
Note:

PRESSIONE DI RIEMPIIMENTO (bar): Filling pressure (bar):	150	RISCHI PER LA SALUTE: Health hazard:	ASPIRANTE 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:	12/2017

Data certificato: 24/03/2017  
Certification date:

Numero certificato: 201702042  
Certificate number:

Operatore: M. BUCCHETTI  
Operator:



## **D3 POWER GENERATION LTD**

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

### **QAL 2 REPORT ON AUTOMATED MEASURING SYSTEM INSTALLED FOR CONTINUOUS MONITORING OF EMISSIONS OF STACK 6B**

performed on behalf of

**SUN LAB GROUP Ltd**

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

**December, 2017**





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# 1 INTRODUCTION

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SUNLAB Ltd commissioned to CADA snc di F.Giglio & C. the calibration activities (QAL2) in accordance to the EN 14181:2015 on Automated Measuring System (AMS) installed for continuous monitoring of Stack 6B emissions at the Delimara Power Station, Marsaxlokk, Malta .

In this technical report, we describe the linearity test performed on AMS Stack 6B after change over to the methane conversion of the plant.

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),
- ⇒ Calibration function created on 15 parallel measurements.

The technical activity has been performed on 9<sup>th</sup>, 10<sup>th</sup> and 11<sup>th</sup> November 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	
Address	Triq Belt il-Hazna Marsa, MRS II	
City	Marsa - Malta	
Location of Sampling	Delimara (MALTA)	
Emission Point	6B	
Responsible	Eng. David Griscti (D3 Power)	
Description of the plant	Power plant	
Process characteristics	Electricity production	
Source of emission	DE43 - DE44	
Majority fuel	Natural Gas	
GPS Coordinates (N - E)	35°49'57.93" N	14°33'29.19" E
Pollution abatement system	SCR/Denox	
Authorization decree	IP 0002/07/Gii	
Reference Oxygen for Correction of Results	15 % Vol.	

The emission limits with Natural Gas Fuel are as follows.

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

Emission Limit Value		
Parameter	Unit of Measurement	Value
Dust	mg/Nm <sup>3</sup>	5
Nitrogen Oxides	mg/Nm <sup>3</sup>	55
Sulfur Dioxide	mg/Nm <sup>3</sup>	10
Carbon Monoxide	mg/Nm <sup>3</sup>	110
Ammonia	mg/Nm <sup>3</sup>	2,6
<b>Note:</b> 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 “6B” 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 [cm]	200
Stack Area [m <sup>2</sup> ]	3,14
Number of Sampling Lines (Access Ports)	2
Conformance of the Sampling Platform	
Sampling platform area > 5 m <sup>2</sup> 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 have been changed, this operation represents the normal plant conditions and increase the variability of data to implement the calibration.

**Table 4 - Plant Load during the measurements**

Plant Load during the measurements				
Fuel	Natural Gas	Other Fuel	/	
Day	Time	Source of emission	Load	
09/11/2017	08:00 - 24:00	DE43 - DE44	36,60 MW	100 %
10/11/2017	08:00 - 24:00	DE43 - DE44	29,33 MW	80 %
11/11/2017	08:00 - 24:00	DE43 - DE44	18,33 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 <sub>3</sub>	EPA CTM 027:1997	Procedure for collection and analysis of ammonia in stationary sources.
NO <sub>x</sub>	UNI EN 14792:2006	Stationary source emissions. Determination of mass concentration of nitrogen oxides (NO <sub>x</sub> ). Reference method: Chemiluminescence.
SO <sub>2</sub>	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 <sub>2</sub>	ISO 11042-1:1996	Gas turbines - Exhaust gas emission - Part 1: Measurement and evaluation. Principle of Measurement: Non-dispersive infrared (NDIR).
O <sub>2</sub>	UNI EN 14789:2006	Determination of volume concentration of oxygen (O <sub>2</sub> ). Reference method - Paramagnetism.
H <sub>2</sub> 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 <sub>3</sub>	Dado Lab - ST5	Sampling	
NOx	Horiba / PG - 350 E	CLD chemiluminescence	0-25/50/100/250/ 500/1000/2500 ppm
SO <sub>2</sub>	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 <sub>2</sub>	Horiba / PG - 350 E	ND-IR	0-10/20/30 %
O <sub>2</sub>	Horiba / PG - 350 E	Paramagnetic	0-/10/25 %
H <sub>2</sub> O	Tecora - Ayrton	Sampling	Only Sampling

In Annex 6 and 7, 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 6B.

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 (SO<sub>2</sub>), nitrogen monoxide (NO), nitrogen dioxide (NO<sub>2</sub>), carbon dioxide (CO<sub>2</sub>), ammonia (NH<sub>3</sub>) and water vapor (H<sub>2</sub>O).

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 <sup>3</sup>
		MCS 100 E	ZrO <sub>2</sub>	O <sub>2</sub>	0 - 21 %
			IR Non-Dispersive (NDIR)	CO	0 - 300 mg/Nm <sup>3</sup>
				CO <sub>2</sub>	0 - 25 %
				NO	0 - 300 mg/Nm <sup>3</sup>
				NO <sub>2</sub>	0 - 100 mg/Nm <sup>3</sup>
				SO <sub>2</sub>	0 - 2000 mg/Nm <sup>3</sup>
				NH <sub>3</sub>	0 - 30 mg/Nm <sup>3</sup>



## 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 7<sup>th</sup> November 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.

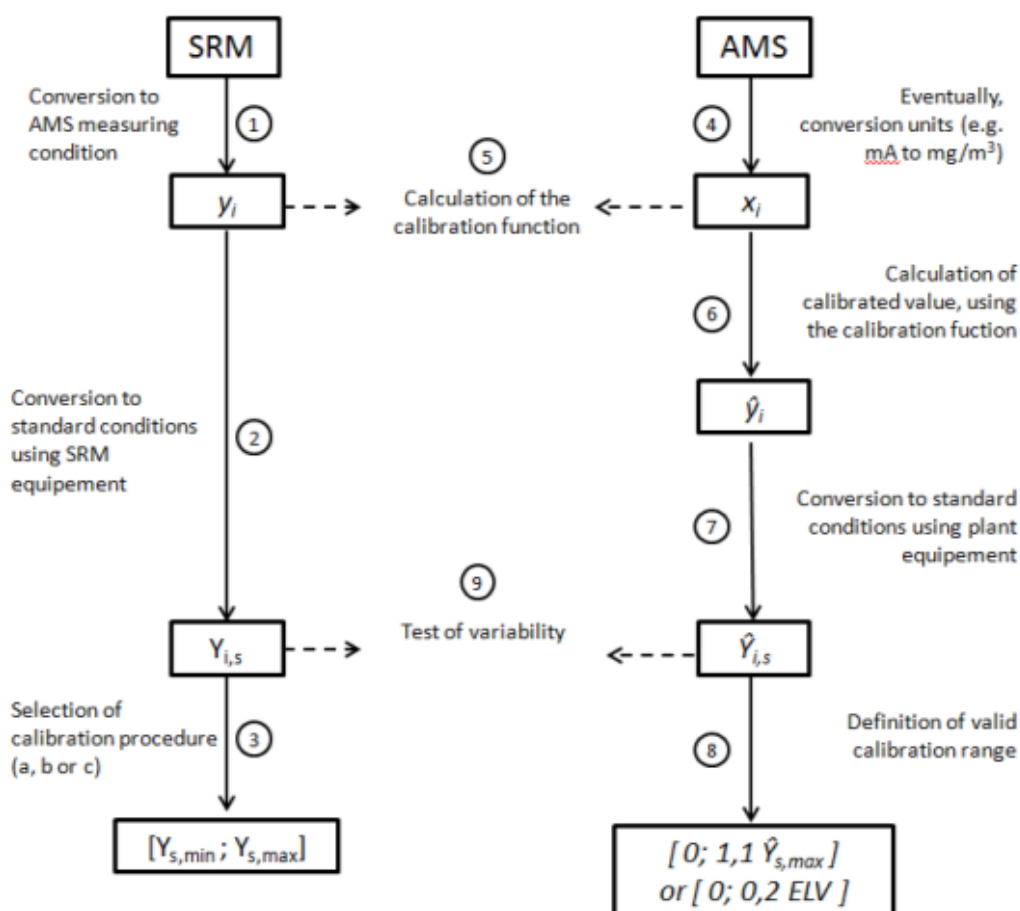
## 7 CALIBRATION and VALIDATION OF THE AMS (QAL2)

### 7.1 DETERMINATION OF THE CALIBRATION FUNCTION

The calibration of the AMS measurement should be performed on at least fifteen parallel measurements with an SRM distributed in a period of 6-8 hours for three days. The object of the parallel measurements was to calibrate and validate the AMS through an independent method (SRM). The tests were carried out over a period of three days in order to take measurements during different states of the system (for example changes of load).

Below it is shown flowchart that describes the steps of the calibration process.

Figure 1 - Flowchart of calibration process



The standard assumes that the calibration function is linear with a constant residual standard deviation. The calibration function is described by the following model.(See ISO 11095):



$$y_i = a + bx_i + \varepsilon_i \quad (9)$$

Where

- $x_i$  is the result  $i^{\text{th}}$  of the AMS;  $i$ =from 1 to N;  $N \geq 15$ ;  
 $y_i$  is the result  $i^{\text{th}}$  of the SRM;  $i$ =from 1 to N;  $N \geq 15$ ;  
 $\varepsilon_i$  is the deviation between  $y_i$  and the expected value;  
 $a$  is the intercept of calibration function;  
 $b$  is the slope of the calibration function.

The following quantities shall be calculated, average value of the AMS ( $\bar{x}$ ) and SRM ( $\bar{y}$ ):

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

$$\bar{y} = \frac{1}{N} \sum_{i=1}^N y_i \quad (11)$$

Following, the difference between the highest and lowest measured SRM concentration at standard condition shall be calculated ( $y_{s,max} - y_{s,min}$ ). Depending on the range of concentrations ( $y_{s,max} - y_{s,min}$ ) reported during the measurement one has to choose the method of calculation of the calibration function.

**Method a:** if ( $y_{s,max} - y_{s,min}$ )  $\geq$  maximum permissible uncertainty.

The parameters of the calibration function shall be calculated according to Formula (12) and Formula (13):

$$\hat{b} = \frac{\sum_{i=1}^N (x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^N (x_i - \bar{x})^2} \quad (12)$$

$$\hat{a} = \bar{y} - \hat{b}\bar{x} \quad (13)$$

**Method b:** if ( $y_{s,max} - y_{s,min}$ )  $<$  maximum permissible uncertainty and  $y_{s,min} \geq 15\%$  of Limit Emission Value (ELV). The parameters of the calibration function shall be calculated according to Formula (14) and Formula (15):



$$\hat{b} = \frac{\bar{y}}{\bar{x} - Z} \quad (14)$$

$$\hat{a} = -\hat{b}Z \quad (15)$$

Where

Z is the difference between the zero reading of the AMS and the zero.

**Method c:** if  $(y_{s,max} - y_{s,min}) < \text{maximum permissible uncertainty}$  and  $y_{s,min} < 15\%$  of Limit Emission Value (ELV). The function is constructed with the same formulas of *Method a* (12 - 13). In addition, two points "surrogate" of Zero and Span (*near the ELV*) are used using gaseous standards.

The calibration function is valid when the plant is operated within the valid calibration range. This valid calibration range is either the calibration range from zero to the maximum value  $y_{s,max}$  of calibrated AMS measured value at standard conditions, determined the QAL2 procedure, plus an extension of 10% of  $y_{s,max}$ , or to 20% of ELV, whichever is greater.

## 7.2 TEST OF VARIABILITY

In order to validate the calibration function obtained in this way, will be executed the test of variability.

The data pairs (SRM and AMS calibrated) thus obtained are normalized and reported to the standard conditions of the plant using auxiliary measures supplied with measurement systems.

For the series of data are calculated:

$$D_i = y_{i,s} - \hat{y}_{i,s} \quad (16)$$

Where

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

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

Mean differences, Formula 17:





$$\bar{D} = \frac{1}{N} \sum_{i=1}^N D_i \quad (17)$$

Standard deviation of differences, Formula 18:

$$S_D = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (D_i - \bar{D})^2} \quad (18)$$

The AMS passes the variability test when:

$$S_D \leq \sigma_0 k_v \quad (16)$$

where

$\sigma_0$  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 factors is:

$$\sigma_0 = \frac{P \times ELV}{1,96} \quad (17)$$

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

$k_v$  is a value from  $\chi^2$ -test with a  $\beta$ -value of 50%. The  $k_v$  value depending on the number of tests conducted.

Table 9-  $k_v$  values

Number of parallel measurement	$k_v(N)$
15	0,9761
16	0,9777
17	0,9791
18	0,9803



## 8 ACCURACY INDEX ACCORDING TO LEGISLATIVE DECREE. 152/06 (IAR)

To verify that the analyzer correctly measures the auxiliary parameters, it has been used Accuracy Index (IAR). This index is reported on Italian Legislative Decree N. 152/2006 - Part V, Annex VI "Criteria for conformity assessment of the measured values to the emission limit values".

In this law the calculation of the IAR (accuracy relative index) was calculated according to the following formula:

$$IAR = 100 \times \left(1 - \frac{M + I_c}{M_r}\right) \quad (18)$$

where

- $M$  It is the arithmetic average of  $N$  values  $X_i$ .
- $X_i$  It represents the absolute value of the difference of the concentrations measured by the two measuring systems (stationary analyzer "AMS" and reference analyzer "SRM").
- $M_r$  It represents the average of the values of the concentrations measured by the reference system (SRM).
- $I_c$  It represents the absolute value of the confidence range calculated for the average of  $N$  values  $X_i$  namely.

$$I_c = t_n \frac{S}{\sqrt{N}} \quad (19)$$

where

- $N$  number of measurements performed.
- $S$  It represents the standard deviation of values  $X_i$ .
- $t_n$  Represents the t Student calculated for the level of confidence of 95% and for (n) degrees of freedom equal to (N-1);



Table 10 - t Student values

N	t <sub>n</sub>
3	4,303
4	3,182
5	2,776
6	2,571
7	2,447
8	2,365
9	2,306
10	2,262
11	2,229
12	2,201
13	2,179
14	2,16
15	2,145
16	2,131

The AMS system is considered verified if the value of the **IAR** is above **80%**. The result of IAR test are in Annex 5.

## 8.1 DETERMINATION OF HOMOGENEITY OF THE SAMPLING POINT

During the Accuracy test (IAR), the homogeneity testing of the sampling point is performed in according to Technical standard UNI EN 15259:2006, *paragraph 8.3 - Determination of homogeneity*. The procedure involves measuring one parameter, such as Oxygen (O<sub>2</sub>) and its spatial and temporal variations shall be applied to determine the homogeneity. Below, the procedure:

- ⇒ determine the sampling points for the grid measurement;
- ⇒ install the probe of the measuring system for the grid measurement;
- ⇒ install the probe of an independent measuring system (reference measurement) at a fixed point in the measurement section;
- ⇒ adjust the sample flow in both systems in order to obtain equal response times;
- ⇒ perform a grid measurement and in parallel measurements at a fixed point in the measurement section, with a sampling time of at least four times the response time of the measuring system but not less than three minutes for each sampling point;



- ⇒ Record for each sampling point  $i$  the actual value  $y_{i,grid}$  of the measurand in the grid and the value  $y_{i,ref}$  of the reference measurement;
- ⇒ For each sample point  $i$ , determines the ratio  $r_i$  defined as follows:

$$r_i = \frac{y_{i,grid}}{y_{i,ref}} \quad (20)$$

- ⇒ average  $\bar{r}$  of the ratios  $r_i$  according to Equation (21):

$$\bar{r} = \frac{1}{N} \sum_{i=1}^N r_i \quad (21)$$

- ⇒ standard deviation  $s_{grid}$  of the grid measurements according to Equation (22):

$$s_{grid} = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (y_{i,grid} - \bar{y}_{grid})^2} \quad (22)$$

- ⇒ standard deviation  $s_{ref}$  of the reference measurements according to Equation (23):

$$s_{ref} = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (y_{i,ref} - \bar{y}_{ref})^2} \quad (23)$$

If  $s_{grid} < s_{ref}$ , the distribution of the gas in the measuring section can be considered homogeneous and sampling can therefore be performed in any point of the section occurred.

The result of Homogeneity of sampling point are in Annex 1.



## 9 RESULTS

Below a summary of the results obtained from the QAL2 test performed on the analyzer (AMS) installed on the stack 6B. Note that for ammonia and sulfur dioxide the QAL2 procedure is not applicable because the parameters concentration are below the detection limit (LOD) of the AMS. In Annex 4, there are reports for single parameter.

Table 11 - Results of QAL2

Summary Report of QAL2							
Parameter	Slope	Intercept	Range of Validity	Procedure for the determination of the calibration function	Maximum permissible uncertainty (95% confidence interval)	Experimental Confidence interval [%]	Emission Limit Value (ELV)
Dust	0,628	0,000	0 - 7,89 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	Metodo B	30	28,64	5
Nitrogen Oxide (NO)	0,898	-0,218	0 - 15,15 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	Metodo C	20	1,37	55
Carbon Monoxide (CO)	1,025	-2,059	0 - 22 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	Metodo C	10	0,17	110
Ossigeno (O <sub>2</sub> )	1,102	0,000	0 - 14,13 [% Vol.]	Metodo B	10	0,85	/
Biossido di Carbonio (CO <sub>2</sub> )	1,026	0,000	0 - 5,22 [% Vol.]	Metodo B	10	0,32	/

As regards carbon monoxide and nitrogen monoxide, the range of validity is lower than the emission limit value, carbon monoxide ELV is 110 mg/Nm<sup>3</sup> and nitrogen monoxide ELV is 55 mg/Nm<sup>3</sup>, then the consideration of Chapter 6.5 "Calibration Function of the AMS and its validity" of the technical standard EN 14181 : 2015 are applied.

Table 12 - Zero Verify

Zero verify for single parameter (Rif. 6.5 - Calibration Function of the AMS and its validity EN 14181 : 2015)						
Parameter	Emission Limit Value (ELV)	Range of Validity	Reference Concentration (ZERO)	AMS Response	Deviation of the AMS calibrated value compared to the reference concentration	Result (Deviation < 10 % ELV)
Nitrogen Oxide (NO)	55	0 - 15,15 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	0	0,1	0,13	Positive
Carbon Monoxide (CO)	110	0 - 22 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	0	0,2	1,85	Positive



Table 13 - Span/ELV Verify

Span/ELV Verify (Rif. 6.5 - Calibration Function of the AMS and its validity EN 14181 : 2015)								
Parameter	Emission Limit Value (ELV)	Range of Validity	Reference Concentration (ELV - SPAN)	AMS Response	Deviation of the AMS calibrated value compared to the reference concentration	Maximum permissible uncertainty (95% confidence interval)	Maximum permissible uncertainty (95% confidence interval) at ELV	Result (Deviation < I.C. 95% - ELV)
Nitrogen Oxide (NO)	55	0 - 15,15 [mg/Nm3 rif O2]	51,3	53,9	3,10	20	11	Positive
Carbon Monoxide (CO)	110	0 - 22 [mg/Nm3 rif O2]	97	96,5	0,13	10	11	Positive

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

Table 14 - IAR Values

I <sub>AR</sub> Water Vapour	I <sub>AR</sub> Temperature	I <sub>AR</sub> Pressure	I <sub>AR</sub> Flow Rate
89,1	99,8	97,4	80,9





## 10 CONCLUSIONS AND COMMENTS

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Taken note of analytical determinations performed on the gaseous effluents of the plant and the processing on the data carried out, it demonstrates the positive result of the procedure QAL2. 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.

The Ammonia and Sulfur Dioxide parameters are in concentrations below instrumental detection limits of AMS, so it has not been possible to construct the QAL2 calibration. However, the analyzer can still correctly record the two parameters, this is noted by the linearity test.

Auxiliary parameter analyzers respond positively to the accuracy test, this shows that they work properly.



## 11 ANNEX 1 – FUNCTIONAL TEST

1	ALIGNMENT AND CLEANLINESS (ONLY NON-EXTRACTIVE SYSTEM)	
	Type of Verification (visual)	Notes / Comments
a	Obstruction Optical path	The operator performs the necessary maintenance and checks. The operator on 14/06/2017 instructed its supplier (DG Tech) to carry out the checks provided for in the user manuals of the instrument. The visual checks required by EN 14181 were positive.
b	Cleaning of Optical Components	
c	Alignment	
d	Presence of Air Purge	

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 14/06/2017 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 14/06/2017 by Danks Gasanalyse Teknik (DG TEK)				

5	LEAK TEST (ONLY EXTRACTIVE SYSTEM)	
a	Description of the test	Result
	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 <sup>(1)</sup>					
Parameter	u.d.m.	Full Scale set	Reference Value ZERO	AMS Measure ZERO	Reference Value SPAN	AMS Measure SPAN
CO	mg/Nm <sup>3</sup>	0	0	0,0	291,06	201,8
				0,2		301,9
				0,1		301,9
NO	mg/Nm <sup>3</sup>	0	0	0,0	256,53	251,1
				0,1		250,6
				0,2		250,2
SO <sub>2</sub>	mg/Nm <sup>3</sup>	0	0	0,0	185,88	182
				0,0		182
				0,0		182
O <sub>2</sub>	% Vol	0	0	0,0	16,707	16,51
				0,1		16,58
				0,0		16,52
CO <sub>2</sub>	% Vol	0	0	0,0	20,02	20,05
				0,0		20,05
				0,0		20,05
NH <sub>3</sub>	mg/Nm <sup>3</sup>	0	0	0,3	23,91	23,63
				0,3		23,62
				0,0		23,58
NO <sub>2</sub>	mg/Nm <sup>3</sup>	0,1	0,1	0,0	83,7	83,15
				0,0		82,34
				0,0		82,34
Notes / Comments: (*) Values recorded by linearity tests.						



7	<i>Linearity (*)</i>				
Parameter	Full Scale set	Slope (B)	Intercept (A)	d <sub>c,rel</sub> [%]	Results
CO	0 - 300 mg/Nm3	0,946	2,595	3,3	Positive
NO	0 - 300 mg/Nm3	0,974	1,160	0,9	Positive
SO <sub>2</sub>	0 - 2000 mg/Nm3	0,978	-2,148	0,1	Positive
O <sub>2</sub>	0 - 21 %vol	0,980	0,021	0,7	Positive
CO <sub>2</sub>	0 - 25 %vol	0,996	-0,012	0,5	Positive
NH <sub>3</sub>	0 - 30 mg/Nm3	0,957	0,428	2,0	Positive
NO <sub>2</sub>	0 - 100 mg/Nm3	0,993	0,187	0,6	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

Determination of homogeneity of the Sampling Point (Rif. 8.3 Determination of homogeneity - UNI EN 15259:2006)							
Point	Grid Sampling	Diameter	O <sub>2</sub> [% vol] SRM	S <sub>grid</sub> O <sub>2</sub> SRM	O <sub>2</sub> [% vol] AMS	S <sub>grid</sub> O <sub>2</sub> AMS	Result
1	9	1	12,90	0,16	11,40	0,19	Positive
2	29	1	12,80		11,90		
3	59	1	13,20		11,50		
4	141	1	13,00		11,60		
5	171	1	13,00		11,40		
6	191	1	13,10		11,90		
7							
8							
9							
10							
11	9	2	12,80		11,40		
12	29	2	13,10		11,50		
13	59	2	12,90		11,38		
14	141	2	13,20		11,80		
15	171	2	13,20		11,50		
16	191	2	13,20		11,60		
17							
18							
19							
20							

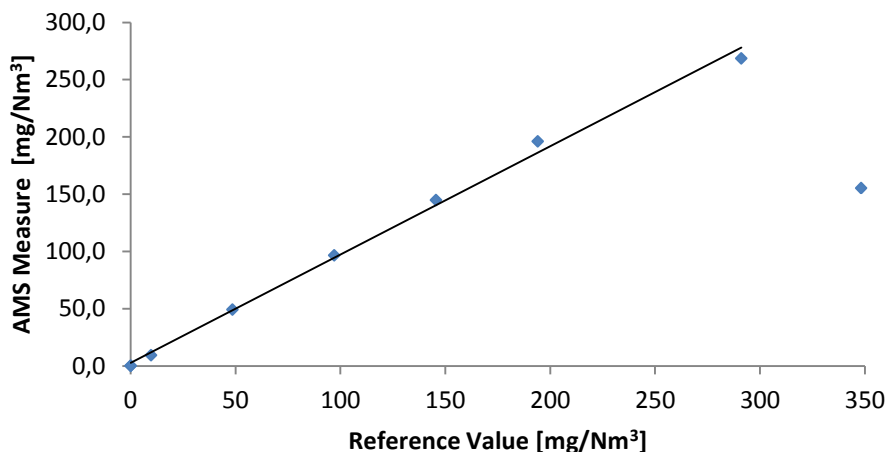


## 12 ANNEX 2 – TEST LINEARITY RESULTS

### 12.1 TEST LINEARITY OF CARBON MONOXIDE

Stack		6B		Data materials used					
Customer		D3 POWER GENERATION LIMITED		Cylinder Producer		SAPIO			
Parameter		CO		Serial/Certificate		MP9/1309			
Analyzer		SICK MCS 100 E		Concentration		233 ppm			
Full Scale set		0- 300	mg/Nm3	Expiration		01/08/2019			
Date measurements		07/11/2017		Diluter		Beta CAP30RK			
Measurements and calculations									
CO mg/Nm3	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0	0	0,2	0,1	-2,53	-0,8	Positive
	1	9,702	9,3	9,3	9,3	9,3	-2,48	-0,8	Positive
	2	48,51	49	49,2	49,2	49,1	0,63	0,2	Positive
	3	97,02	96,6	96,6	96,4	96,5	2,12	0,7	Positive
	4	145,53	144,8	144,8	144,8	144,8	4,48	1,5	Positive
	5	194,04	196,5	196,1	195,6	196,1	9,83	3,3	Positive
	6	291,06	201,8	301,9	301,9	268,5	-9,52	-3,2	Positive
	0	0	0	0	0,2	0,1	-2,53	-0,8	Positive
		Y <sub>z</sub>	98,2	A'	95,6	B	0,946	A	2,5950
	Legend								
Y <sub>i</sub> : concentration of reference material; X <sub>i</sub> : AMS measure corresponding to the Reference Material Concentration Level; Y <sub>z</sub> : 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 monoxide

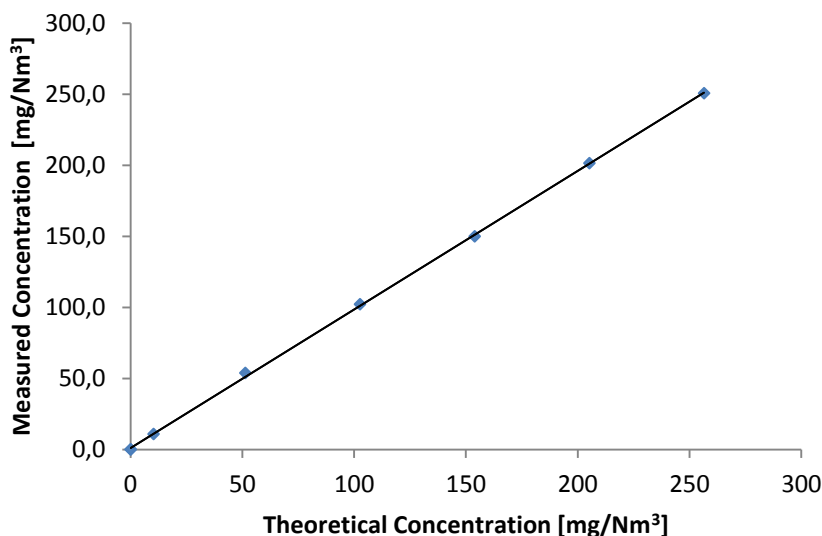




## 12.2 TEST LINEARITY OF NITROGEN OXIDE

Stack		6B		Data materials used					
Customer		D3 POWER GENERATION LIMITED		Cylinder Producer		SAPIO			
Parameter		NO		Serial/Certificate		MP9/1309			
Analyzer		SICK MCS 100 E		Concentration		230	ppm		
Full Scale set		0- 300	mg/Nm3	Expiration		01/08/2019			
Date measurements		07/11/2017		Diluter		Beta CAP30RK			
Measurements and calculations									
NO mg/Nm3	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0	0,1	0,2	0,1	-1,06	-0,4	Positive
	1	10,26	10,9	10,9	10,9	10,9	-0,26	-0,1	Positive
	2	51,3	53,9	53,9	53,8	53,9	2,72	0,9	Positive
	3	102,61	100,6	103	103	102,2	1,06	0,4	Positive
	4	153,92	149,9	150	150	150,0	-1,17	-0,4	Positive
	5	205,23	201,5	201,4	201,4	201,4	0,30	0,1	Positive
	6	256,53	251,1	250,6	250,2	250,6	-0,49	-0,2	Positive
	0	0	0,1	0,1	0	0,1	-1,09	-0,4	Positive
		Y <sub>z</sub>	97,5	A'	96,1	B	0,974	A	1,1599
Legend									
<p>Y<sub>i</sub>: concentration of reference material; X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level; Y<sub>z</sub>: 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>									

### Nitrogen monoxide



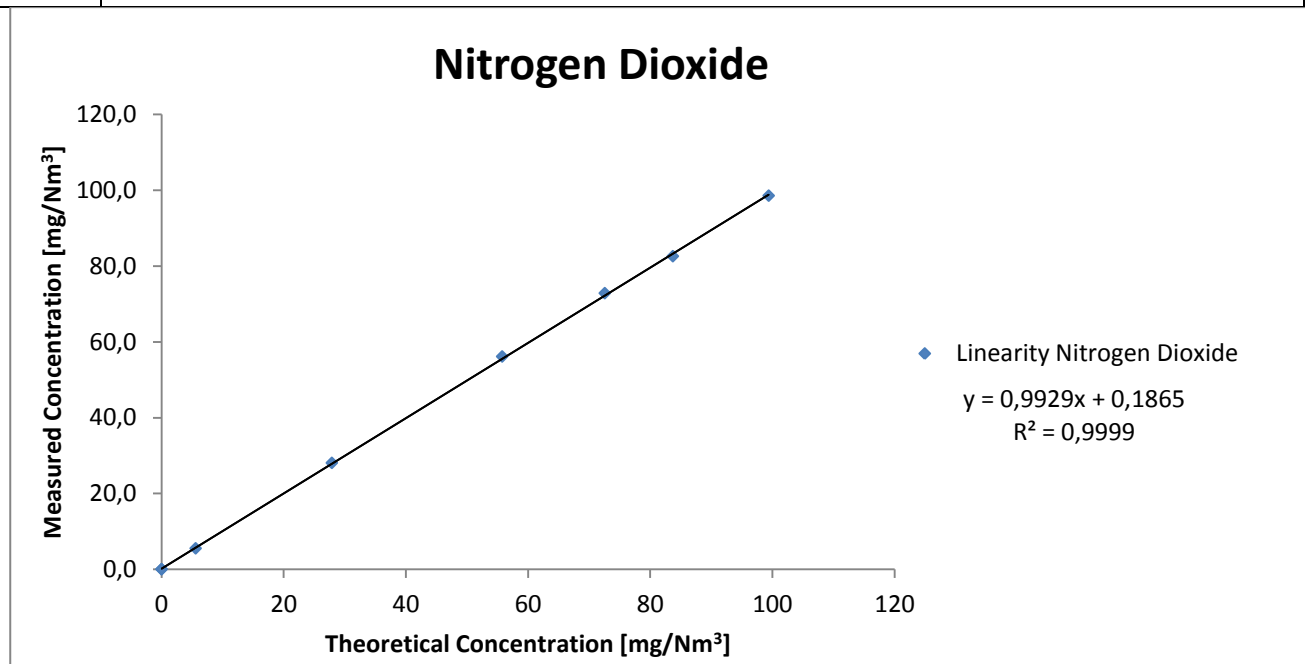
◆ Linearity Nitrogen monoxide

$$y = 0,9744x + 1,1599$$
$$R^2 = 0,9998$$



## 12.3 TEST LINEARITY OF NITROGEN DIOXIDE

Stack		6B		Data materials used					
Customer		D3 POWER GENERATION LIMITED		Cylinder Producer		SAPIO			
Parameter		NO <sub>2</sub>		Serial/Certificate		MP311905			
Analyzer		SICK MCS 100 E		Concentration		81,6	ppm		
Full Scale set		0- 100	mg/Nm3	Expiration		30/03/2018			
Date measurements		07/11/2017		Diluter		Beta CAP30RK			
Measurements and calculations									
NO2 mg/Nm3	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0,1	0	0	0,0	-0,15	-0,2	Positive
	1	5,58	5,64	5,53	5,45	5,5	-0,19	-0,2	Positive
	2	27,88	28,08	28,09	28,08	28,1	0,22	0,2	Positive
	3	55,76	56,21	56,1	56,15	56,2	0,60	0,6	Positive
	4	72,56	72,92	72,82	72,85	72,9	0,63	0,6	Positive
	5	83,7	83,15	82,34	82,34	82,6	-0,68	-0,7	Positive
	6	99,39	98,77	98,86	98,15	98,6	-0,28	-0,3	Positive
	0	0	0,1	0	0	0,0	-0,15	-0,2	Positive
		Y <sub>z</sub>	43,1	A'	43,0	B	0,993	A	0,1865
Legend									
Y <sub>i</sub> : concentration of reference material; X <sub>i</sub> : AMS measure corresponding to the Reference Material Concentration Level; Y <sub>z</sub> : 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									



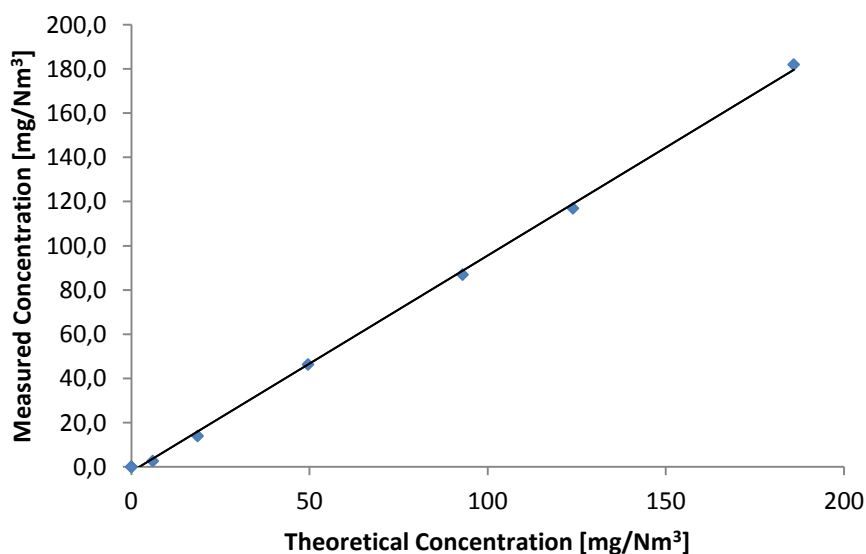




## 12.4 TEST LINEARITY OF SULFUR DIOXIDE

Stack		6B		Data materials used					
Customer		D3 POWER GENERATION LIMITED		Cylinder Producer		SAPIO			
Parameter		SO <sub>2</sub>		Serial/Certificate		MP9/1309			
Analyzer		SICK MCS 100 E		Concentration		65,1 ppm			
Full Scale set		0- 2000	mg/Nm3	Expiration		01/08/2019			
Date measurements		07/11/2017		Diluter		Beta CAP30RK			
Measurements and calculations									
SO2 mg/Nm3	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0	0	0	0,0	2,15	0,1	Positive
	1	6,01	2	3	3	2,7	-1,06	-0,1	Positive
	2	18,59	14	14	14	14,0	-2,03	-0,1	Positive
	3	49,57	46	47	46	46,3	0,02	0,0	Positive
	4	92,94	87	87	87	87,0	-1,71	-0,1	Positive
	5	123,92	117	117	117	117,0	-2,00	-0,1	Positive
	6	185,88	182	182	182	182,0	2,42	0,1	Positive
	0	0	0,1	0	0,1	0,1	2,21	0,1	Positive
		Y <sub>z</sub>	59,6	A'	56,1	B	0,978	A	-2,1475
Legend									
Y <sub>i</sub> : concentration of reference material; X <sub>i</sub> : AMS measure corresponding to the Reference Material Concentration Level; Y <sub>z</sub> : 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

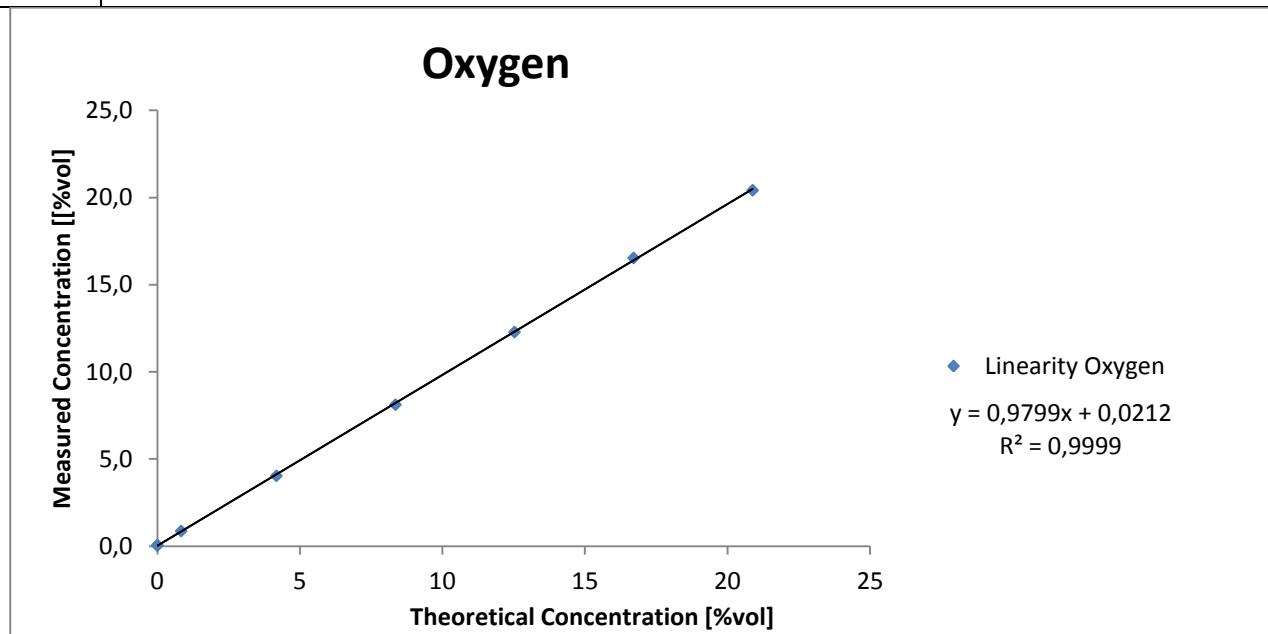


◆ Linearity Sulfur Dioxide  
 $y = 0,9776x - 2,1475$   
 $R^2 = 0,9991$



## 12.5 TEST LINEARITY OF OXYGEN

Stack		6B		Data materials used					
Customer		D3 POWER GENERATION LIMITED		Cylinder Producer		SAPIO			
Parameter		O <sub>2</sub>		Serial/Certificate		P33021			
Analyzer		SICK MCS 100 E		Concentration		25,06	%vol		
Full Scale set		0- 21	%vol	Expiration		30/03/2020			
Date measurements		07/11/2017		Diluter		Beta CAP30RK			
Measurements and calculations									
O2 %vol	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
	Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )						
	0	0	0	0,1	0	0,0	0,01	0,1	Positive
	1	0,835	0,87	0,87	0,87	0,9	0,03	0,1	Positive
	2	4,177	4,04	4,04	4,04	4,0	-0,07	-0,4	Positive
	3	8,353	8,12	8,12	8,12	8,1	-0,09	-0,4	Positive
	4	12,53	12,25	12,27	12,34	12,3	-0,01	-0,1	Positive
	5	16,707	16,51	16,58	16,52	16,5	0,14	0,7	Positive
	6	20,883	20,47	20,4	20,4	20,4	-0,06	-0,3	Positive
	0	0	0,1	0	0,1	0,1	0,05	0,2	Positive
		Y <sub>z</sub>	7,9	A'	7,8	B	0,980	A	0,0212
Legend									
Y <sub>i</sub> : concentration of reference material; X <sub>i</sub> : AMS measure corresponding to the Reference Material Concentration Level; Y <sub>z</sub> : 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									

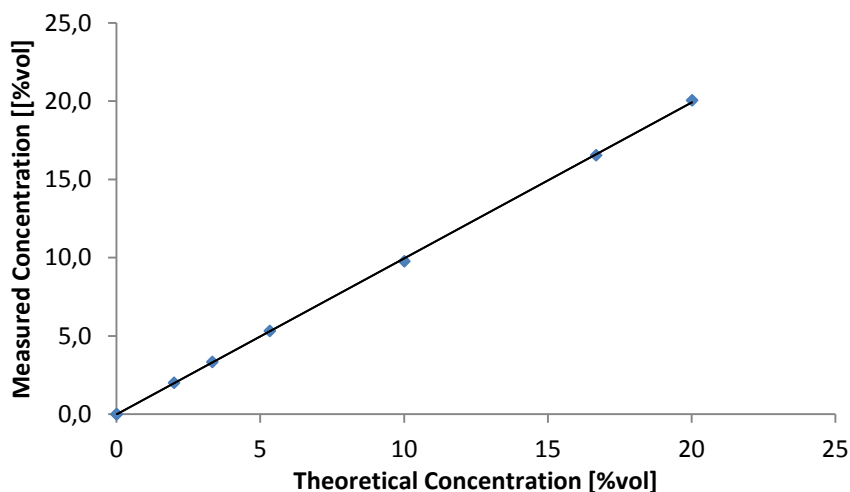




## 12.6 TEST LINEARITY OF CARBON DIOXIDE

Stack			6B			Data materials used			
Customer			D3 POWER GENERATION LIMITED			Cylinder Producer		SAPIO	
Parameter			CO <sub>2</sub>			Serial/Certificate		MP9/1309	
Analyzer			SICK MCS 100 E			Concentration		20,02	%vol
Full Scale set			0- 25		%vol	Expiration		01/08/2019	
Date measurements			07/11/2017			Diluter		Beta CAP30RK	
Measurements and calculations									
CO2 %vol	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0,01	0	0	0,0	0,02	0,1	Positive
	1	2	2,01	2,01	2,01	2,0	0,03	0,1	Positive
	2	3,33	3,34	3,34	3,34	3,3	0,04	0,1	Positive
	3	5,33	5,32	5,32	5,32	5,3	0,02	0,1	Positive
	4	10,01	9,77	9,77	9,77	9,8	-0,19	-0,7	Positive
	5	16,68	16,55	16,53	16,55	16,5	-0,06	-0,2	Positive
	6	20,02	20,05	20,05	20,05	20,1	0,12	0,5	Positive
	0	0	0	0	0	0,0	0,01	0,0	Positive
	Y <sub>z</sub>	7,2	A'	7,1	B	0,996	A	-0,0122	
Legend									
Yi: concentration of reference material; Xi: AMS measure corresponding to the Reference Material Concentration Level; Yz: 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



◆ Linearity Carbon Dioxide

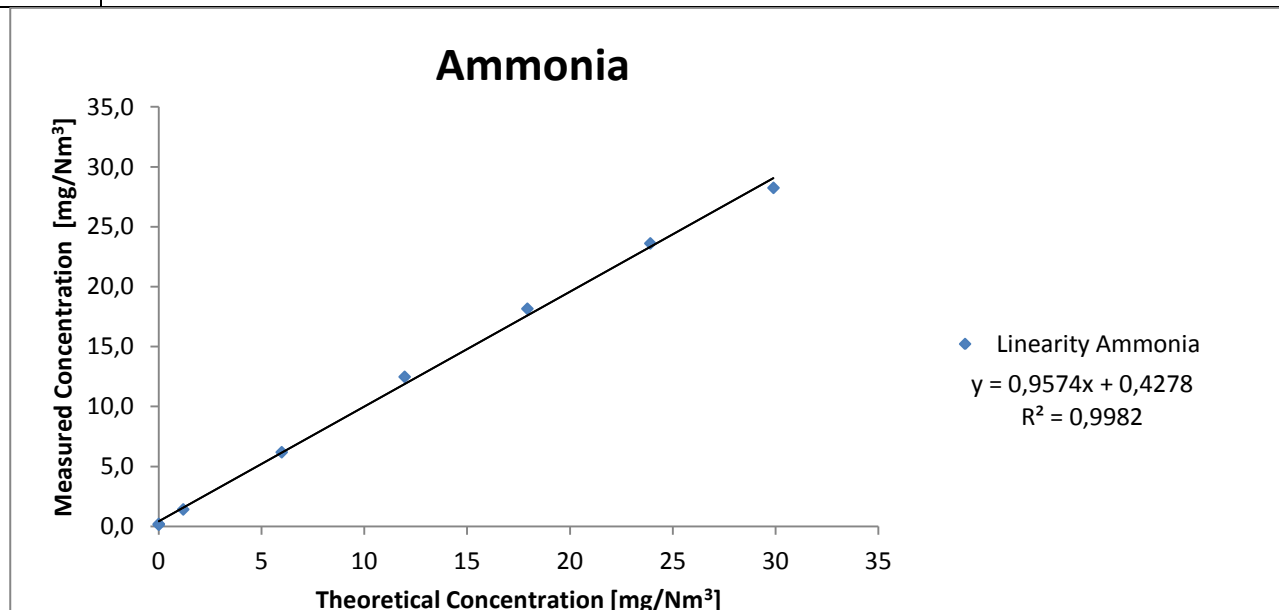
$$y = 0,9959x - 0,0122$$

$$R^2 = 0,9999$$



## 12.7 TEST LINEARITY OF AMMONIA

Stack		6B		Data materials used					
Customer		D3 POWER GENERATION LIMITED		Cylinder Producer		SAPIO			
Parameter		NH <sub>3</sub>		Serial/Certificate		MP17107			
Analyzer		SICK MCS 100 E		Concentration		47,3	ppm		
Full Scale set		0- 30	mg/Nm3	Expiration		31/12/2017			
Date measurements		07/11/2017		Diluter		Beta CAP30RK			
Measurements and calculations									
NH3 mg/Nm3	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0,3	0,3	0	0,2	-0,23	-0,8	Positive
	1	1,19	1,53	1,44	1,27	1,4	-0,15	-0,5	Positive
	2	5,98	6,32	6,15	6,09	6,2	0,03	0,1	Positive
	3	11,96	12,52	12,45	12,46	12,5	0,60	2,0	Positive
	4	17,93	18,21	18,14	18,12	18,2	0,56	1,9	Positive
	5	23,91	23,63	23,62	23,58	23,6	0,29	1,0	Positive
	6	29,9	28,13	28,25	28,35	28,2	-0,81	-2,7	Positive
	0	0	0,2	0,2	0	0,1	-0,29	-1,0	Positive
	Y <sub>z</sub>	11,4	A'	11,3	B	0,957	A	0,4278	
Legend									
Y <sub>i</sub> : concentration of reference material; X <sub>i</sub> : AMS measure corresponding to the Reference Material Concentration Level; Y <sub>z</sub> : 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									





## 13 ANNEX 3 - TEST REPORT

### 13.1 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 <sub>2</sub> )				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	30435	k =0,8296; Type Pitot (S)			
Emission Point Information							
Stack Diameter [m]		2,00	Height from Ground[m]			65	
Stack Surface [m <sup>2</sup> ]		3,14	Height from sampling point to the ground [m]			Verticale	
Technical personnel who performed the sampling							
Dott. Giorgio Rocchia							
Determination of the velocity profile							09/11/2017
Point	Diameter	Grid Sampling	Temperatura [°C]	Δpi [Pa]	Velocity [m/s]	Auxiliary Parameter	
1	1	9	168,2	404,1	26,7	Oxygen [% vol]	13,2
2	1	29	169	406,0	26,8		
3	1	59	168	406,5	26,8		
4	1	141	168,5	408,0	26,8	Carbon dioxide [%vol]	4,4
5	1	171	168	410,0	26,9		
6	1	191	168	406,0	26,7		
7						Water vapor [% vol]	9,88
8							
9							
10						Density - ρ (Kg/m <sup>3</sup> )	1,304
11	2	9	169	405,0	26,7		
12	2	29	169	407,0	26,8		
13	2	59	169	408,0	26,8	Pressione Emissione [kPa]	102
14	2	141	168	405,0	26,7		
15	2	171	166	409,0	26,8		
16	2	191	165	408,0	26,7	Ambient Temperature [°C]	20
17							
18							
19						Ambient Pressure [hPa]	1018
20							



Determination of the velocity profile							10/11/2017	
Point	Diameter	Grid Sampling	Temperatura [°C]	Δpi [Pa]	Velocity [m/s]	Auxiliary Parameter		
1	1	9	161	261,0	21,4	Oxygen [% vol]	12	
2	1	29	161,4	260,0	21,3			
3	1	59	161,5	271,0	21,8			
4	1	141	161,6	282,0	22,2	Carbon dioxide [%vol]	4	
5	1	171	162	280,0	22,1			
6	1	191	161	281,0	22,1			
7						Water vapor [% vol]	11,00	
8								
9								
10						Density - ρ (Kg/m³)	1,299	
11	2	9	162	264,0	21,5			
12	2	29	163	261,0	21,4			
13	2	59	161	262,0	21,4	Pressione Emissione [kPa]	102	
14	2	141	161	262,0	21,4			
15	2	171	162	261,0	21,4			
16	2	191	161	260,0	21,3	Ambient Temperature [°C]	20	
17								
18								
19						Ambient Pressure [hPa]	1014	
20								
Determination of the velocity profile							11/11/2017	
Point	Diameter	Grid Sampling	Temperatura [°C]	Δpi [Pa]	Velocity [m/s]	Auxiliary Parameter		
1	1	9	155	107,8	13,7	Oxygen [% vol]	12,7	
2	1	29	154	108,0	13,7			
3	1	59	152	108,4	13,7			
4	1	141	155	108,9	13,8	Carbon dioxide [%vol]	4,55	
5	1	171	155	107,0	13,6			
6	1	191	155	107,3	13,7			
7						Water vapor [% vol]	11,03	
8								
9								
10						Density - ρ (Kg/m³)	1,304	
11	2	9	155	107,3	13,7			
12	2	29	155	108,6	13,7			
13	2	59	154	108,7	13,7	Pressione Emissione [kPa]	101	
14	2	141	154	108,4	13,7			
15	2	171	154	108,5	13,7			
16	2	191	155	108,6	13,7	Ambient Temperature [°C]	19	
17								
18								
19						Ambient Pressure [hPa]	101	
20								



## 13.2 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 <sub>2</sub> )				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	30435	k =0,8296; 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							
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 <sup>3</sup> ] <sup>(1)</sup>
Method Blank		09/11/2017	/	FN13	0,03	0,00	1,066
2125828-001	Reply 1	09/11/2017 09:05	60	FN14	2,11	0,09	1,075
2125828-002	Reply 2	09/11/2017 10:15	60	FN15	3,20	0,09	1,064
2125828-003	Reply 3	09/11/2017 11:25	60	FN16	3,06	0,09	1,068
2125828-004	Reply 4	09/11/2017 12:32	60	FN17	2,14	0,09	1,063
2125828-005	Reply 5	09/11/2017 13:50	60	FN18	4,09	0,09	1,060
Method Blank		10/11/2017	/	FN19	0,05	0,00	0,863
2125828-006	Reply 6	10/11/2017 08:35	60	FN20	2,67	0,09	0,862
2125828-007	Reply 7	10/11/2017 09:40	60	FN21	2,69	0,09	0,865
2125828-008	Reply 8	10/11/2017 10:50	60	FN22	4,43	0,11	0,865
2125828-009	Reply 9	10/11/2017 12:35	60	FN23	2,51	0,11	0,855
2125828-010	Reply 10	10/11/2015 14:00	60	FN24	8,61	0,11	0,868
Method Blank		11/11/2017	/	FN25	0,05	0,00	0,593
2125828-011	Reply 11	11/11/2017 08:30	60	FN26	1,03	0,11	0,578
2125828-012	Reply 12	11/11/2017 09:35	60	FN27	1,18	0,11	0,684
2125828-013	Reply 13	11/11/2017 10:45	60	FN28	1,22	0,11	0,568
2125828-014	Reply 14	11/11/2017 11:45	60	FN29	0,79	0,11	0,566
2125828-015	Reply 15	11/11/2017 12:50	60	FN30	1,46	0,11	0,571

<sup>(1)</sup> The pressure, temperature and volume data related to the Method Blank are obtained from the average of the values of the 5 replies of the day.





Dust - Sampling and analysis Data							2
I.D. Sample	Stack Speed [m/s]	Temperature [°C]	Pressure [kPa]	H <sub>2</sub> O [%v/v]	O <sub>2</sub> [%v/v]	Dust Concentration [mg/Nm <sup>3</sup> ] <sup>(2)</sup>	Dust Concentration correct with O <sub>2</sub> [mg/Nm <sup>3</sup> ] <sup>(3)</sup>
Method Blank	/	168,90	101,8	10,76	13,17	0,03	0,02
2125828-001	27,16	168,44	101,9	9,90	13,34	2,05	1,60
2125828-002	27,19	168,82	101,9	11,00	13,27	3,09	2,40
2125828-003	27,31	169,02	101,8	11,00	13,29	2,95	2,29
2125828-004	27,22	169,20	101,7	11,00	13,22	2,10	1,62
2125828-005	27,11	169,04	101,6	10,90	12,71	3,95	2,86
Method Blank	/	165,18	101,3	11,00	12,56	0,06	0,04
2125828-006	25,75	168,85	101,3	11,00	12,34	3,20	2,22
2125828-007	21,73	162,46	101,3	10,90	12,32	3,22	2,22
2125828-008	21,85	164,73	101,2	11,00	12,30	5,25	3,62
2125828-009	21,95	164,84	101,3	11,10	12,37	3,06	2,13
2125828-010	21,85	165,00	101,4	11,00	13,48	10,05	8,02
Method Blank	/	162,53	100,8	10,68	12,74	0,08	0,06
2125828-011	14,43	159,81	100,7	11,00	12,75	1,97	1,44
2125828-012	17,10	162,73	100,8	10,80	12,77	1,89	1,38
2125828-013	14,14	163,32	100,8	10,80	12,73	2,34	1,70
2125828-014	14,13	163,67	100,8	10,80	12,69	1,59	1,15
2125828-015	14,07	163,11	100,7	10,00	12,73	2,75	2,00
<sup>(2)</sup> Dust Concentration (Wet).							
<sup>(3)</sup> 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 [%] <sup>(4)</sup>	Result	Dust Concentration correct with O <sub>2</sub> [mg/Nm <sup>3</sup> ] - Blank	Result <sup>(5)</sup>
Method Blank		09/11/2017	/			0,02	Positive
2125828-001	Reply 1	09/11/2017 09:05	60	0	Positive		
2125828-002	Reply 2	09/11/2017 10:15	60	0	Positive		
2125828-003	Reply 3	09/11/2017 11:25	60	0	Positive		
2125828-004	Reply 4	09/11/2017 12:32	60	0	Positive		
2125828-005	Reply 5	09/11/2017 13:50	60	0	Positive		
Method Blank		10/11/2017	/			0,04	Positive
2125828-006	Reply 6	10/11/2017 08:35	60	0	Positive		
2125828-007	Reply 7	10/11/2017 09:40	60	0	Positive		
2125828-008	Reply 8	10/11/2017 10:50	60	0	Positive		
2125828-009	Reply 9	10/11/2017 12:35	60	0	Positive		
2125828-010	Reply 10	10/11/2015 14:00	60	0	Positive		
Method Blank		11/11/2017	/			0,06	Positive
2125828-011	Reply 11	11/11/2017 08:30	60	0	Positive		
2125828-012	Reply 12	11/11/2017 09:35	60	0	Positive		
2125828-013	Reply 13	11/11/2017 10:45	60	0	Positive		
2125828-014	Reply 14	11/11/2017 11:45	60	0	Positive		
2125828-015	Reply 15	11/11/2017 12:50	60	0	Positive		
<sup>(4)</sup> Dust sampling must be done in isocinetics. The isocinetic value must be within the Range -5% <G <+ 15%.							
<sup>(5)</sup> 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).							



### 13.3 COMBUSTION GAS REPORT

Nitrogen Oxides, Carbon Monoxide, Sulfur Dioxide, Oxygen and Carbon Dioxide - Sampling and Analysis Report					
Oxygen (O <sub>2</sub> )				UNI EN 14789:2017	
Nitrogen Oxide (NO)				UNI EN 14792:2017	
Carbon Monoxide (CO)				UNI EN 15058:2017	
Sulfur Dioxide (SO <sub>2</sub> )				ISO 11042-1:1996	
Carbon Dioxide (CO <sub>2</sub> )				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					
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/Nm <sup>3</sup> ] (2)	Oxygen (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2125828-001	Reply 1	09/11/2017 10:04	60	20,51	13,34
2125828-002	Reply 2	09/11/2017 11:14	60	19,33	13,27
2125828-003	Reply 3	09/11/2017 12:24	60	19,42	13,29
2125828-004	Reply 4	09/11/2017 13:31	60	19,39	13,22
2125828-005	Reply 5	09/11/2017 14:49	60	20,93	12,71
2125828-006	Reply 6	10/11/2017 09:34	60	10,06	12,34
2125828-007	Reply 7	10/11/2017 10:39	60	10,37	12,32
2125828-008	Reply 8	10/11/2017 11:49	60	10,55	12,30
2125828-009	Reply 9	10/11/2017 13:59	60	11,88	12,37
2125828-010	Reply 10	10/11/2017 14:59	60	9,97	13,48
2125828-011	Reply 11	11/11/2017 09:29	60	21,09	12,75
2125828-012	Reply 12	11/11/2017 10:34	60	20,06	12,77
2125828-013	Reply 13	11/11/2017 11:44	60	20,42	12,73
2125828-014	Reply 14	11/11/2017 12:44	60	21,12	12,69
2125828-015	Reply 15	11/11/2017 13:49	60	20,24	12,73
Notes:					
(1) The oxygen value reported refers to the same measurement period of the parameter on which QAL2 (NO) is performed.					
(2) The Nitric Oxide (NO) value is not corrected for the reference oxygen, is normalized by temperature and pressure and is expressed on a dry basis.					



<b>Determination of Carbon Monoxide (CO) - Sampling and analysis Data</b>	<b>2</b>
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I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Carbon Monoxide (CO) - [mg/Nm <sup>3</sup> ]	Oxygen (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2125828-001	Reply 1	09/11/2017 10:04	60	3,16	13,34
2125828-002	Reply 2	09/11/2017 11:14	60	3,22	13,27
2125828-003	Reply 3	09/11/2017 12:24	60	3,09	13,29
2125828-004	Reply 4	09/11/2017 13:31	60	3,02	13,22
2125828-005	Reply 5	09/11/2017 14:49	60	3,39	12,71
2125828-006	Reply 6	10/11/2017 09:34	60	1,34	12,34
2125828-007	Reply 7	10/11/2017 10:39	60	1,21	12,32
2125828-008	Reply 8	10/11/2017 11:49	60	1,17	12,30
2125828-009	Reply 9	10/11/2017 13:59	60	1,16	12,37
2125828-010	Reply 10	10/11/2017 14:59	60	0,96	13,48
2125828-011	Reply 11	11/11/2017 09:29	60	3,64	12,75
2125828-012	Reply 12	11/11/2017 10:34	60	3,68	12,77
2125828-013	Reply 13	11/11/2017 11:44	60	3,66	12,73
2125828-014	Reply 14	11/11/2017 12:44	60	3,69	12,69
2125828-015	Reply 15	11/11/2017 13:49	60	3,67	12,73

Notes:

(1) The oxygen value reported refers to the same measurement period of the parameter on which QAL2 (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.

<b>Determination of Sulfur Dioxide (SO<sub>2</sub>) - Sampling and analysis Data</b>	<b>3</b>
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I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Sulfur Dioxide (SO <sub>2</sub> ) - [mg/Nm <sup>3</sup> ]	Oxygen (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2125828-001	Reply 1	09/11/2017 10:04	60	< 1	/
2125828-002	Reply 2	09/11/2017 11:14	60	< 1	/
2125828-003	Reply 3	09/11/2017 12:24	60	< 1	/
2125828-004	Reply 4	09/11/2017 13:31	60	< 1	/
2125828-005	Reply 5	09/11/2017 14:49	60	< 1	/
2125828-006	Reply 6	10/11/2017 09:34	60	< 1	/
2125828-007	Reply 7	10/11/2017 10:39	60	< 1	/
2125828-008	Reply 8	10/11/2017 11:49	60	< 1	/
2125828-009	Reply 9	10/11/2017 13:59	60	< 1	/
2125828-010	Reply 10	10/11/2017 14:59	60	< 1	/
2125828-011	Reply 11	11/11/2017 09:29	60	< 1	/
2125828-012	Reply 12	11/11/2017 10:34	60	< 1	/
2125828-013	Reply 13	11/11/2017 11:44	60	< 1	/
2125828-014	Reply 14	11/11/2017 12:44	60	< 1	/
2125828-015	Reply 15	11/11/2017 13:49	60	< 1	/

Notes:

(1) The oxygen value reported refers to the same measurement period of the parameter on which QAL2 (SO<sub>2</sub>) is performed.

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



<b>Determination of Oxygen (O<sub>2</sub>) - Sampling and analysis Data</b>	<b>4</b>
---	----------

I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Oxygen (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2125828-001	Reply 1	09/11/2017 18:59	60	12,68
2125828-002	Reply 2	09/11/2017 19:59	60	12,68
2125828-003	Reply 3	09/11/2017 20:59	60	12,68
2125828-004	Reply 4	09/11/2017 21:59	60	12,67
2125828-005	Reply 5	09/11/2017 22:59	60	12,70
2125828-006	Reply 6	10/11/2017 18:59	60	12,50
2125828-007	Reply 7	10/11/2017 19:59	60	12,48
2125828-008	Reply 8	10/11/2017 20:59	60	12,42
2125828-009	Reply 9	10/11/2017 21:59	60	12,35
2125828-010	Reply 10	10/11/2017 22:59	60	12,40
2125828-011	Reply 11	11/11/2017 09:29	60	12,75
2125828-012	Reply 12	11/11/2017 10:34	60	12,77
2125828-013	Reply 13	11/11/2017 11:44	60	12,73
2125828-014	Reply 14	11/11/2017 12:44	60	12,69
2125828-015	Reply 15	11/11/2017 13:49	60	12,73

Notes:

(1) The Oxygen value reported refers to the values used to construct the QAL2 calibration function.

<b>Determination of Carbon Dioxide (CO<sub>2</sub>) - Sampling and analysis Data</b>	<b>5</b>
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I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Carbon Dioxide (CO <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2125828-001	Reply 1	09/11/2017 18:59	60	4,59
2125828-002	Reply 2	09/11/2017 19:59	60	4,59
2125828-003	Reply 3	09/11/2017 20:59	60	4,59
2125828-004	Reply 4	09/11/2017 21:59	60	4,59
2125828-005	Reply 5	09/11/2017 22:59	60	4,58
2125828-006	Reply 6	10/11/2017 18:59	60	4,68
2125828-007	Reply 7	10/11/2017 19:59	60	4,68
2125828-008	Reply 8	10/11/2017 20:59	60	4,71
2125828-009	Reply 9	10/11/2017 21:59	60	4,75
2125828-010	Reply 10	10/11/2017 22:59	60	4,72
2125828-011	Reply 11	11/11/2017 09:29	60	4,54
2125828-012	Reply 12	11/11/2017 10:34	60	4,54
2125828-013	Reply 13	11/11/2017 11:44	60	4,55
2125828-014	Reply 14	11/11/2017 12:44	60	4,56
2125828-015	Reply 15	11/11/2017 13:49	60	4,54

Notes:

(1) The value of Carbon Dioxide reported refers to the values used to construct the QAL2 calibration function.



## 13.4 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 <sub>2</sub> )				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	30435	k =0,8296; Type Pitot (S)			
Sampling material							
Filter Material		Glass Fiber Filter		Absorption solution		H <sub>2</sub> SO <sub>4</sub> - 0,1 N	
Filtration Temperature		Stack Temperature		Conditioning Temperature [° C]		180	
Technical personnel who performed the sampling							
Dott. Giorgio Rocchia							
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Sampling Volume [Nm <sup>3</sup> ] <sup>(1)</sup>	Impinger G1 [mg]	Impinger G2 [mg]	Concentration [mg/Nm <sup>3</sup> ]
Method Blank		09/11/2017	60	1,066	0,000	0,000	/
2125828-001	Reply 1	09/11/2017 09:05	60	1,075	0,000	0,000	< 0,1
2125828-002	Reply 2	09/11/2017 10:15	60	1,064	0,000	0,000	< 0,1
2125828-003	Reply 3	09/11/2017 11:25	60	1,068	0,000	0,000	< 0,1
2125828-004	Reply 4	09/11/2017 12:32	60	1,063	0,000	0,000	< 0,1
2125828-005	Reply 5	09/11/2017 13:50	60	1,060	0,000	0,000	< 0,1
Method Blank		10/11/2017	60	0,863	0,000	0,000	/
2125828-006	Reply 6	10/11/2017 08:35	60	0,862	0,000	0,000	< 0,1
2125828-007	Reply 7	10/11/2017 09:40	60	0,865	0,000	0,000	< 0,1
2125828-008	Reply 8	10/11/2017 10:50	60	0,865	0,000	0,000	< 0,1
2125828-009	Reply 9	10/11/2017 12:35	60	0,855	0,000	0,000	< 0,1
2125828-010	Reply 10	10/11/2015 14:00	60	0,868	0,000	0,000	< 0,1
Method Blank		11/11/2017	60	0,593	0,000	0,000	/
2125828-011	Reply 11	11/11/2017 08:30	60	0,578	0,000	0,000	< 0,1
2125828-012	Reply 12	11/11/2017 09:35	60	0,684	0,000	0,000	< 0,1
2125828-013	Reply 13	11/11/2017 10:45	60	0,568	0,000	0,000	< 0,1
2125828-014	Reply 14	11/11/2017 11:45	60	0,566	0,000	0,000	< 0,1
2125828-015	Reply 15	11/11/2017 12:50	60	0,571	0,000	0,000	< 0,1

<sup>(1)</sup> The pressure, temperature and volume data related to the Method Blank are obtained from the average of the values of the 5 replies of the day.

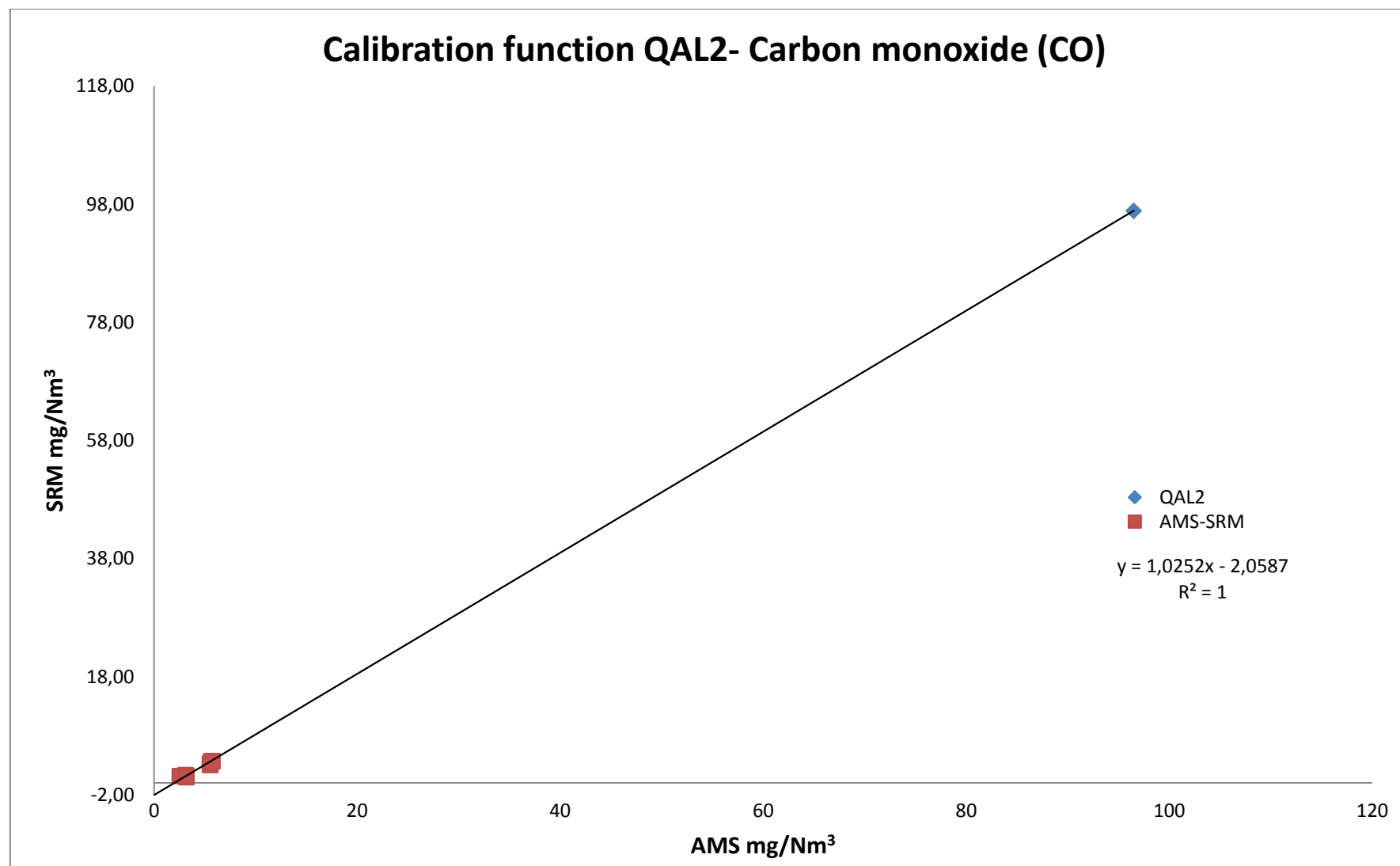




## 14 ANNEX 4 - QAL2 REPORT

### 14.1 CARBON MONOXIDE - QAL2

Parameter				CO			Emission Point			6B						
O <sub>2</sub> rif %	15	SRM				AMS							Calculations			
N. Test	DATE/TIME	Y <sub>i</sub>	Yi-Ym	O <sub>2</sub>	Y <sub>i,s</sub>	x <sub>i</sub>	O <sub>2</sub>	xi-xm	(xi-xm) <sup>2</sup>	(xi-xm)*(Yi-Ym)	ŷ <sub>i</sub>	ŷ <sub>i,s</sub>	D <sub>i</sub> = Y <sub>i,s</sub> -ŷ <sub>i,s</sub>	D <sub>i</sub> -đ	(D <sub>i</sub> -đ) <sup>2</sup>	
1	9/11/17 10:04	3,16	-4,91	13,34	2,47	5,48	11,39	-4,39	19,31	21,56	3,56	2,22	0,25	0,06	0,00	
2	9/11/17 11:14	3,22	-4,84	13,27	2,50	5,52	11,39	-4,35	18,93	21,06	3,60	2,25	0,25	0,05	0,00	
3	9/11/17 12:24	3,09	-4,97	13,29	2,41	5,53	11,40	-4,35	18,89	21,60	3,61	2,25	0,15	-0,04	0,00	
4	9/11/17 13:31	3,02	-5,04	13,22	2,33	5,53	11,40	-4,34	18,87	21,90	3,61	2,26	0,07	-0,12	0,01	
5	9/11/17 14:49	3,39	-4,68	12,71	2,45	5,54	11,41	-4,33	18,78	20,27	3,62	2,26	0,19	-0,01	0,00	
6	10/11/17 9:34	1,34	-6,72	12,34	0,93	3,09	11,41	-6,78	45,96	45,56	1,11	0,70	0,23	0,04	0,00	
7	10/11/17 10:39	1,21	-6,85	12,32	0,84	3,15	11,38	-6,72	45,19	46,05	1,17	0,73	0,11	-0,09	0,01	
8	10/11/17 11:49	1,17	-6,89	12,30	0,81	3,16	11,39	-6,71	45,03	46,24	1,18	0,74	0,07	-0,13	0,02	
9	10/11/17 13:59	1,16	-6,90	12,37	0,81	2,52	13,78	-7,36	54,10	50,75	0,52	0,43	0,37	0,18	0,03	
10	10/11/17 14:59	0,96	-7,10	13,48	0,77	3,17	11,41	-6,70	44,87	47,58	1,20	0,75	0,02	-0,18	0,03	
11	11/11/17 9:29	3,64	-4,42	12,75	2,65	5,61	11,63	-4,27	18,20	18,86	3,69	2,36	0,29	0,09	0,01	
12	11/11/17 10:34	3,68	-4,38	12,77	2,68	5,69	11,66	-4,19	17,52	18,35	3,77	2,42	0,26	0,06	0,00	
13	11/11/17 11:44	3,66	-4,40	12,73	2,66	5,69	11,64	-4,19	17,52	18,41	3,77	2,42	0,24	0,05	0,00	
14	11/11/17 12:44	3,69	-4,38	12,69	2,66	5,72	11,64	-4,16	17,27	18,19	3,80	2,44	0,23	0,03	0,00	
15	11/11/17 13:49	3,67	-4,40	12,73	2,66	5,75	11,62	-4,12	17,01	18,13	3,83	2,45	0,21	0,01	0,00	
16	zero	0,00	-8,06	15,00	0,00	0,20	15,00	-9,67	93,57	78,00	-1,85	-1,85				
17	span	97,00	88,94	15,00	97,00	96,50	15,00	86,63	7504,19	7704,32	96,87	96,87				
Average													0,20			
Sum										8015,22	8216,83					0,13
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		110	Yaverage	8,06	x average	9,87	Z	/	Procedure for the determination of the calibration fuction							
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		16,5	m	1,025	i	-2,059	r	0,99970	Method C				Calibration Function			
Ys Max-Ys min		1,92	ŷs, max	2,45	Calibration Range				0 - 22 [mg/Nm3 rif O2]				Y= 1,025X + -2,058			
Test of Variability																
Maximum permissible uncertainty (95% confidence interval)		10	Test value for variability (k <sub>v</sub> )		0,9761	σ0kv		5,478	Result of Variability Test (s <sub>0</sub> ≤σ <sub>0</sub> k <sub>v</sub> )							
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,0951	Standard Deviation (σ <sub>0</sub> )		5,61	Experimental Confidence interval [%]		0,17	Positive							

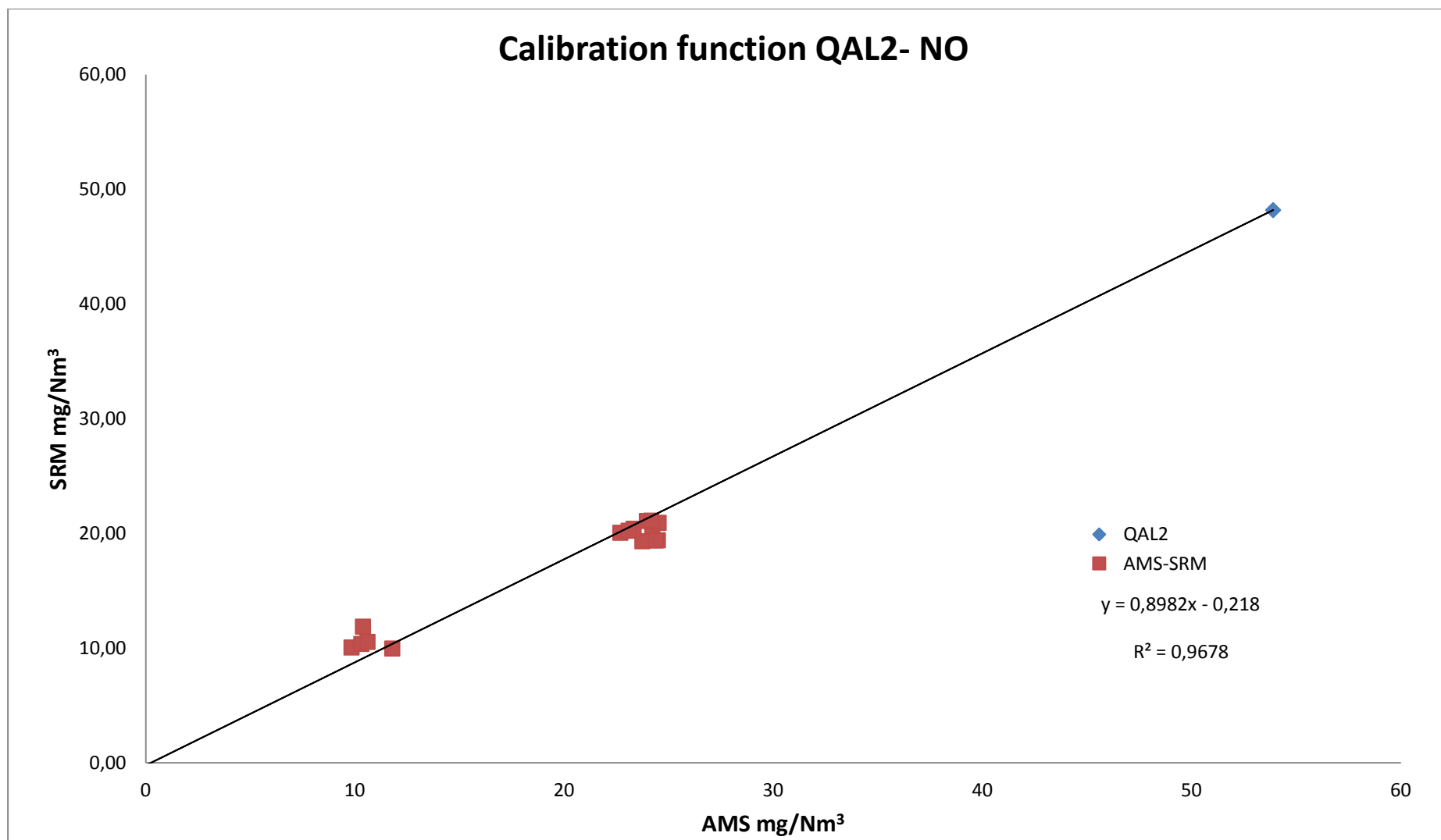






## 14.2 NITROGEN OXIDE - QAL2

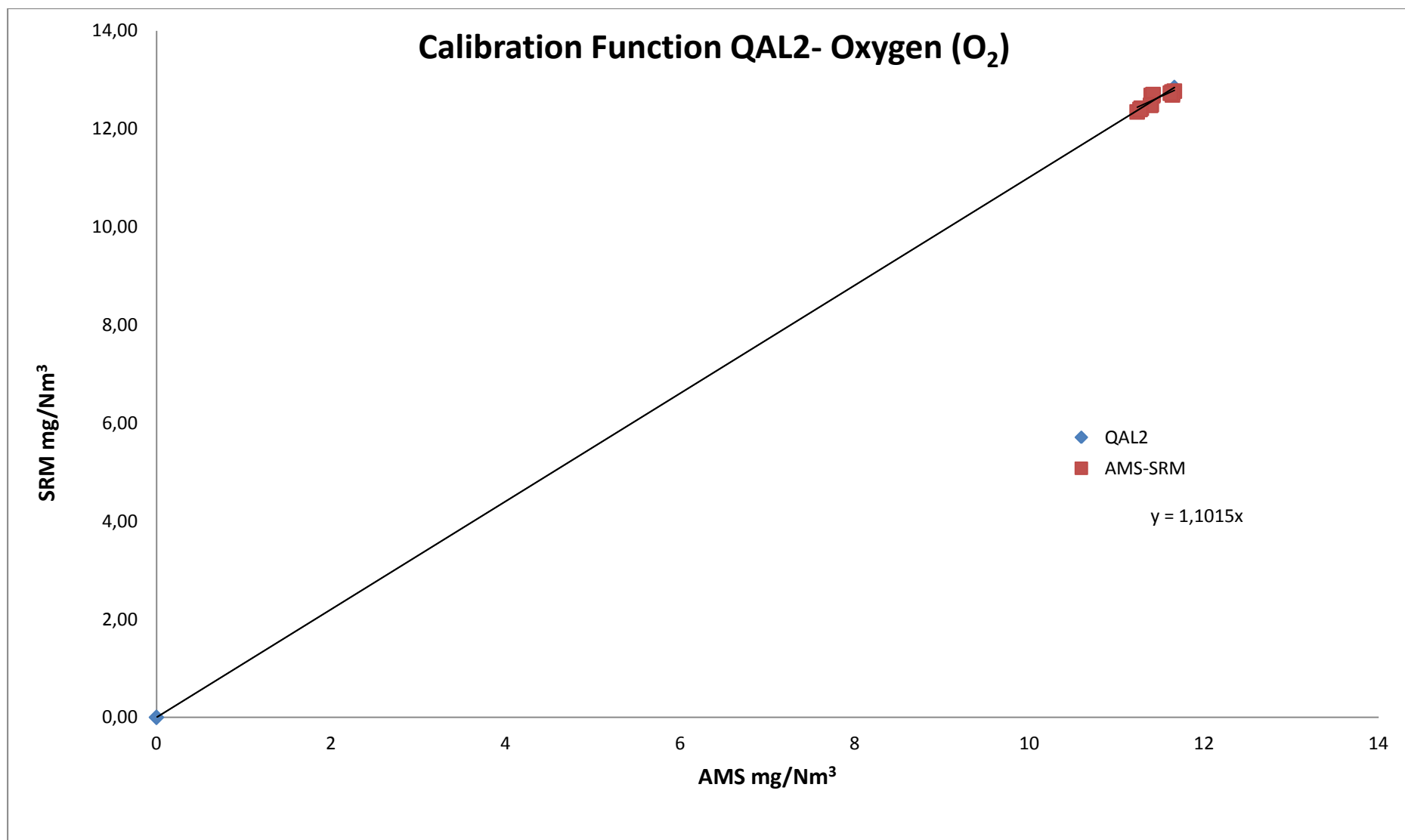
Parameter				NO			Emission Point			6B						
O2 rif %	15	SRM				AMS							Calculations			
N. Test	DATE/TIME	Y <sub>i</sub>	Yi-Ym	O <sub>2</sub>	Y <sub>i,s</sub>	x <sub>i</sub>	O <sub>2</sub>	xi-xm	(xi-xm) <sup>2</sup>	(xi-xm)*(Yi-Ym)	ŷ <sub>i</sub>	ŷ <sub>i,s</sub>	D <sub>i</sub> = y <sub>i,s</sub> -ŷ <sub>i,s</sub>	D <sub>i</sub> -đ	(D <sub>i</sub> -đ) <sup>2</sup>	
1	9/11/17 10:04	20,51	2,48	13,34	16,08	24,22	11,39	3,89	15,17	9,64	21,54	13,44	2,64	1,07	1,14	
2	9/11/17 11:14	19,33	1,29	13,27	15,00	23,75	11,39	3,42	11,72	4,41	21,11	13,19	1,81	0,24	0,06	
3	9/11/17 12:24	19,42	1,38	13,29	15,10	24,49	11,40	4,16	17,32	5,73	21,78	13,61	1,49	-0,07	0,01	
4	9/11/17 13:31	19,39	1,36	13,22	14,96	24,38	11,40	4,06	16,45	5,50	21,68	13,56	1,41	-0,16	0,03	
5	9/11/17 14:49	20,93	2,89	12,71	15,15	24,52	11,41	4,20	17,61	12,13	21,81	13,64	1,51	-0,06	0,00	
6	10/11/17 9:34	10,06	-7,98	12,34	6,97	9,84	11,41	-10,48	109,89	83,61	8,62	5,40	1,57	0,00	0,00	
7	10/11/17 10:39	10,37	-7,67	12,32	7,17	10,31	11,38	-10,02	100,32	76,78	9,04	5,64	1,53	-0,04	0,00	
8	10/11/17 11:49	10,55	-7,49	12,30	7,27	10,60	11,39	-9,72	94,49	72,80	9,31	5,81	1,46	-0,11	0,01	
9	10/11/17 13:59	11,88	-6,16	12,37	8,26	10,39	13,78	-9,94	98,76	61,21	9,11	7,58	0,68	-0,89	0,78	
10	10/11/17 14:59	9,97	-8,07	13,48	7,95	11,79	11,41	-8,54	72,87	68,88	10,37	6,49	1,47	-0,10	0,01	
11	11/11/17 9:29	21,09	3,05	12,75	15,35	23,96	11,63	3,64	13,22	11,10	21,30	13,65	1,70	0,13	0,02	
12	11/11/17 10:34	20,06	2,03	12,77	14,63	22,69	11,66	2,37	5,61	4,80	20,17	12,96	1,67	0,11	0,01	
13	11/11/17 11:44	20,42	2,38	12,73	14,82	23,33	11,64	3,00	9,01	7,13	20,73	13,29	1,52	-0,04	0,00	
14	11/11/17 12:44	21,12	3,08	12,69	15,26	24,17	11,64	3,84	14,77	11,85	21,49	13,77	1,48	-0,08	0,01	
15	11/11/17 13:49	20,24	2,21	12,73	14,69	23,09	11,62	2,76	7,63	6,09	20,52	13,12	1,57	0,00	0,00	
16	zero	0,00	-18,04	15,00	0,00	0,10	15,00	-20,22	409,03	364,81	-0,13	-0,13				
17	span	51,30	33,26	15,00	51,30	53,90	15,00	33,58	1127,31	1116,78	48,20	48,20				
Average													1,57			
Sum									2141,2	1923,3					2,08	
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		55	Yaverage	18,04	x average	20,32	Z	//	Procedure for the determination of the calibration fuction							
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		8,25	m	0,898	i	-0,218	r	0,984	Method C				Calibration Function			
Ys Max-Ys min		9,11	ŷs, max	13,77	Calibration Range				0 - 15,15 [mg/Nm3 rif O2]				Y= 0,898X - 0,218			
Test of Variability																
Maximum permissible uncertainty (95% confidence interval)		20	Test value for variability (k <sub>v</sub> )		0,9761	σ0kv		5,478	Result of Variability Test (s <sub>0</sub> ≤σ <sub>0</sub> k <sub>v</sub> )							
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,3858	Standard Deviation (σ <sub>0</sub> )		5,61	Experimental Confidence interval [%]		1,37	Positive							





## 14.3 OXYGEN - QAL2

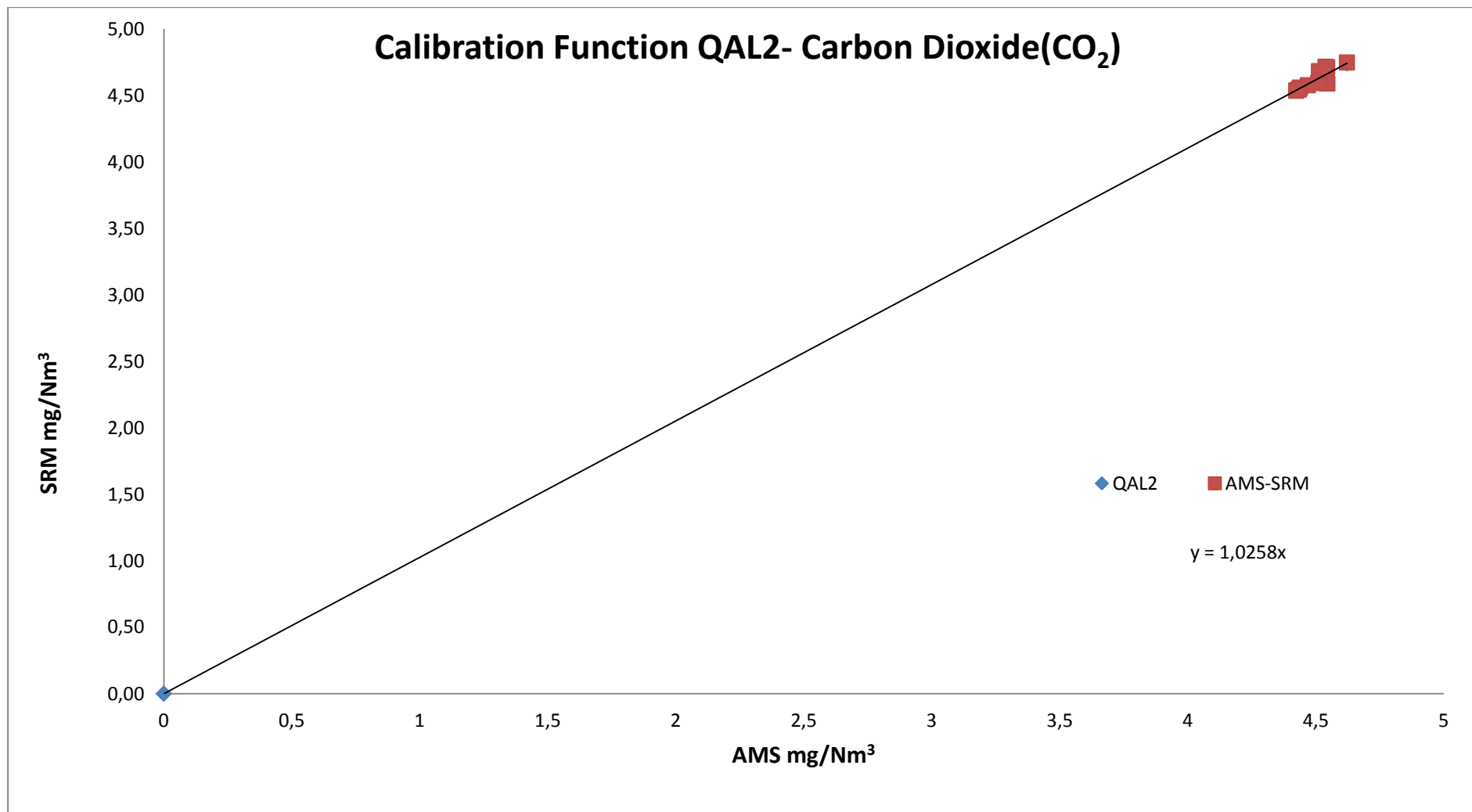
Parameter				O <sub>2</sub>		Emission Point			6B						
O2 rif %	15	SRM				AMS						Calculations			
N. Test	DATE/TIME	Y <sub>i</sub>	Yi-Ym	O <sub>2</sub>	Y <sub>i,s</sub>	x <sub>i</sub>	O <sub>2</sub>	xi-xm	(xi-xm) <sup>2</sup>	(xi-xm)*(Yi-Ym)	ŷ <sub>i</sub>		D <sub>i</sub> = y <sub>i,s</sub> -ŷ <sub>i,s</sub>	D <sub>i</sub> -đ	(D <sub>i</sub> -đ) <sup>2</sup>
1	9/11/17 18:59	12,68	0,07			11,40		-0,06	0,00	0,00	12,55		0,13	0,13	0,02
2	9/11/17 19:59	12,68	0,06			11,40		-0,05	0,00	0,00	12,56		0,12	0,12	0,01
3	9/11/17 20:59	12,68	0,06			11,41		-0,04	0,00	0,00	12,57		0,11	0,11	0,01
4	9/11/17 21:59	12,67	0,06			11,41		-0,04	0,00	0,00	12,57		0,11	0,11	0,01
5	9/11/17 22:59	12,70	0,09			11,42		-0,04	0,00	0,00	12,58		0,13	0,13	0,02
6	10/11/17 18:59	12,50	-0,12			11,40		-0,06	0,00	0,01	12,55		-0,06	-0,06	0,00
7	10/11/17 19:59	12,48	-0,14			11,39		-0,07	0,00	0,01	12,54		-0,06	-0,06	0,00
8	10/11/17 20:59	12,42	-0,19			11,28		-0,17	0,03	0,03	12,43		0,00	0,00	0,00
9	10/11/17 21:59	12,35	-0,27			11,24		-0,22	0,05	0,06	12,38		-0,03	-0,03	0,00
10	10/11/17 22:59	12,40	-0,22			11,27		-0,19	0,03	0,04	12,41		-0,01	-0,01	0,00
11	11/11/17 9:29	12,75	0,14			11,63		0,18	0,03	0,03	12,82		-0,06	-0,06	0,00
12	11/11/17 10:34	12,77	0,16			11,66		0,21	0,04	0,03	12,85		-0,07	-0,07	0,01
13	11/11/17 11:44	12,73	0,12			11,64		0,19	0,04	0,02	12,82		-0,09	-0,09	0,01
14	11/11/17 12:44	12,69	0,08			11,64		0,19	0,03	0,01	12,82		-0,13	-0,13	0,02
15	11/11/17 13:49	12,73	0,11			11,62		0,16	0,03	0,02	12,80		-0,07	-0,07	0,00
Average													0,00		
Sum									0,30	0,24					0,12
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		21	Yaverage	12,62	x average	11,45	Z	0,00	Procedure for the determination of the calibration fuction						
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		3,15	m	1,102	i	0,000	r	0,82961165	Method B				Calibration Function		
Ys Max-Ys min		0,42	ŷs, max	12,85	Calibration Range				0 - 14,13 [% Vol.]				Y= 1,101X		
Test of Variability															
Maximum permissible uncertainty (95% confidence interval)		10	Test value for variability (k <sub>v</sub> )		0,9761	σ0kv		1,046	Result of Variability Test (s <sub>0</sub> ≤σ <sub>0</sub> k <sub>v</sub> )						
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,091	Standard Deviation (σ <sub>0</sub> )		1,07	Experimental Confidence interval [%]		0,85	Positive						





## 14.4 CARBON DIOXIDE – QAL2

Parameter				CO <sub>2</sub>		Emission Point			6B								
O <sub>2</sub> rif %	15	SRM				AMS							Calculations				
N. Test	DATE/TIME	Y <sub>i</sub>	Yi-Ym	O <sub>2</sub>	Y <sub>i,s</sub>	x <sub>i</sub>	O <sub>2</sub>	xi-xm	(xi-xm) <sup>2</sup>	(xi-xm)*(Yi-Ym)	ŷ <sub>i</sub>		D <sub>i</sub> = y <sub>i,s</sub> -ŷ <sub>i,s</sub>	D <sub>i</sub> -đ	(D <sub>i</sub> -đ) <sup>2</sup>		
1	9/11/17 18:59	4,59	-0,02			4,55		0,05	0,00	0,00	4,66		-0,07	-0,07	0,01		
2	9/11/17 19:59	4,59	-0,02			4,54		0,04	0,00	0,00	4,66		-0,06	-0,06	0,00		
3	9/11/17 20:59	4,59	-0,02			4,51		0,01	0,00	0,00	4,63		-0,03	-0,03	0,00		
4	9/11/17 21:59	4,59	-0,02			4,51		0,02	0,00	0,00	4,63		-0,04	-0,04	0,00		
5	9/11/17 22:59	4,58	-0,04			4,47		-0,03	0,00	0,00	4,58		-0,01	-0,01	0,00		
6	10/11/17 18:59	4,68	0,07			4,51		0,02	0,00	0,00	4,63		0,05	0,05	0,00		
7	10/11/17 19:59	4,68	0,07			4,51		0,02	0,00	0,00	4,63		0,05	0,05	0,00		
8	10/11/17 20:59	4,71	0,10			4,54		0,05	0,00	0,00	4,66		0,05	0,05	0,00		
9	10/11/17 21:59	4,75	0,13			4,62		0,12	0,02	0,02	4,74		0,01	0,01	0,00		
10	10/11/17 22:59	4,72	0,10			4,54		0,04	0,00	0,00	4,66		0,06	0,06	0,00		
11	11/11/17 9:29	4,54	-0,08			4,42		-0,07	0,01	0,01	4,54		0,00	0,00	0,00		
12	11/11/17 10:34	4,54	-0,08			4,42		-0,07	0,01	0,01	4,54		0,00	0,00	0,00		
13	11/11/17 11:44	4,55	-0,07			4,43		-0,06	0,00	0,00	4,55		0,00	0,00	0,00		
14	11/11/17 12:44	4,56	-0,05			4,44		-0,06	0,00	0,00	4,55		0,01	0,01	0,00		
15	11/11/17 13:49	4,54	-0,07			4,43		-0,06	0,00	0,00	4,55		0,00	0,00	0,00		
Average													0,00				
Sum									0,05	0,05							
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		25	Yaverage	4,61	x average	4,50	Z	0,00	Procedure for the determination of the calibration fuction								
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		3,75	m	1,026	i	0,000	r	0,82906906	Method B				Calibration Function				
Ys Max-Ys min		0,21	ŷs, max	4,74	Calibration Range				0 - 5,22 [% Vol.]				Y= 1,025X				
Test of Variability																	
Maximum permissible uncertainty (95% confidence interval)		10	Test value for variability (k <sub>v</sub> )		0,9761	σ0kv		1,245	Result of Variability Test (s <sub>0</sub> ≤σ <sub>0</sub> k <sub>v</sub> )								
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,041	Standard Deviation (σ <sub>0</sub> )		1,28	Experimental Confidence interval [%]		0,32	Positive								





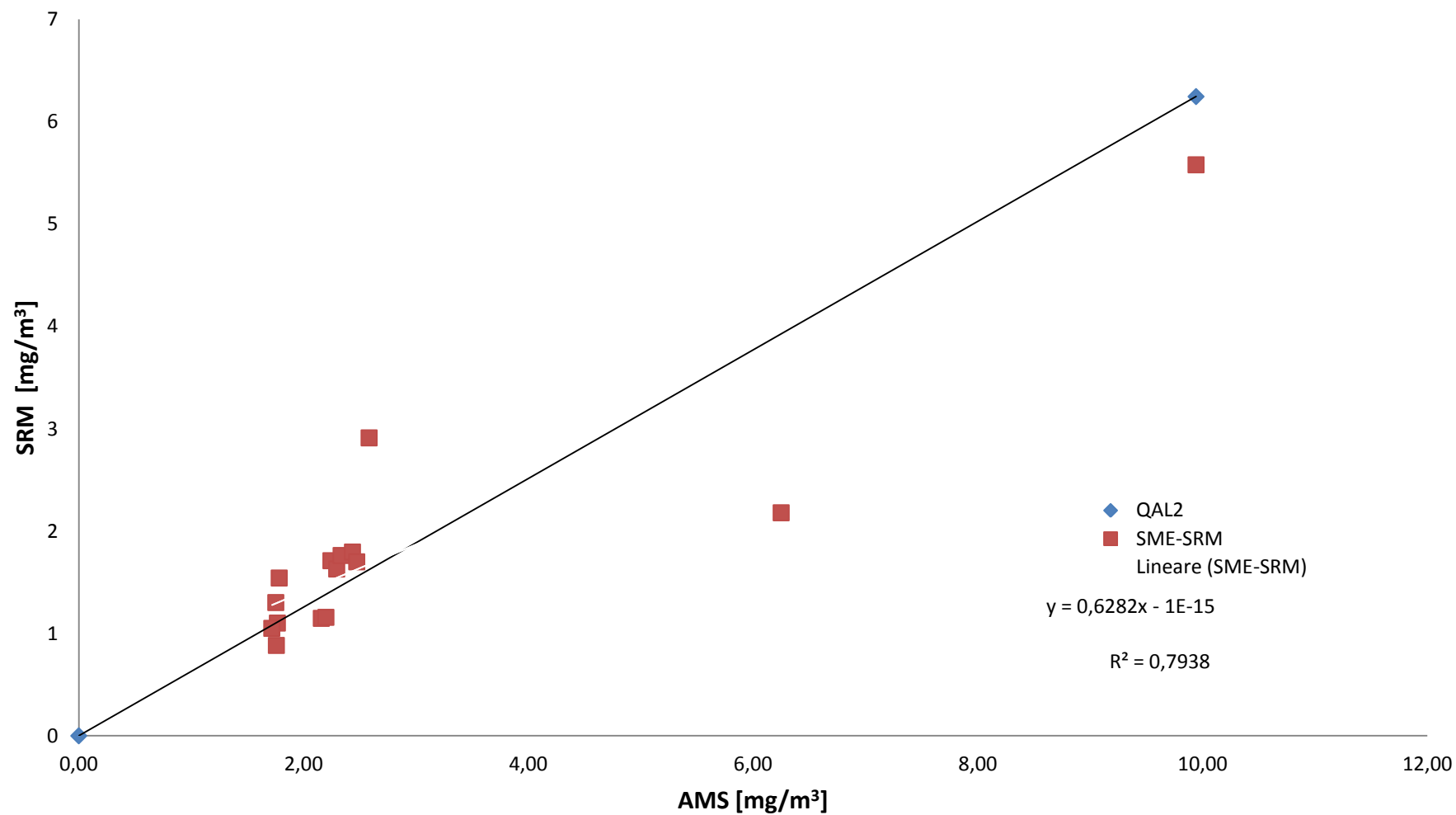
## 14.5 DUST – QAL2

Parameter									Dust		Emission Point					6B						
O <sub>2</sub> rif. %	15	SRM							AMS										Calculations			
N. Test	DATE/TIME	Y <sub>i</sub> [mg/m <sup>3</sup> ]	O <sub>2</sub> [%vol]	T [°C]	P [KPa]	U [%]	Y <sub>i</sub> -Y <sub>m</sub>	Y <sub>i,s</sub> [mg/Nm <sup>3</sup> ]	x <sub>i</sub> [mg/m3]	O <sub>2</sub> [%vol]	T [°C]	P [hPa]	U [%]	x <sub>i</sub> -x <sub>m</sub>	(x <sub>i</sub> -x <sub>m</sub> ) <sup>2</sup>	(x <sub>i</sub> -x <sub>m</sub> )* (Y <sub>i</sub> -Y <sub>m</sub> )	Ŷ <sub>i</sub> [mg/m <sup>3</sup> ]	Ŷ <sub>i,s</sub> [mg/Nm <sup>3</sup> ]	D <sub>i</sub> = Y <sub>i,s</sub> -Ŷ <sub>i,s</sub>	D <sub>i</sub> -d	(D <sub>i</sub> -d) <sup>2</sup>	
1	09/11/2017 10:04	1,15	13,34	168,44	101,85	9,90	-0,68	1,60	2,16	11,39	168,61	992,43	9,97	-0,75	0,57	0,52	1,36	1,55	0,05	-0,25	0,06	
2	09/11/2017 11:14	1,71	13,27	168,82	101,85	11,00	-0,12	2,40	2,24	11,39	169,09	992,36	10,03	-0,67	0,45	0,08	1,41	1,62	0,78	0,48	0,23	
3	09/11/2017 12:24	1,63	13,29	169,02	101,80	11,00	-0,20	2,29	2,30	11,40	169,31	992,21	10,08	-0,62	0,38	0,12	1,44	1,66	0,64	0,34	0,11	
4	09/11/2017 13:31	1,16	13,22	169,20	101,69	11,00	-0,67	1,62	2,20	11,40	169,50	992,07	10,12	-0,71	0,51	0,48	1,38	1,59	0,03	-0,27	0,07	
5	09/11/2017 14:49	2,18	12,71	169,04	101,63	10,90	0,35	2,86	6,25	11,41	169,39	991,97	10,15	3,34	11,14	1,17	3,93	4,52	-1,67	-1,97	3,86	
6	10/11/2017 09:34	1,76	12,34	168,85	101,31	11,00	-0,07	2,22	2,33	11,41	164,15	991,32	10,86	-0,58	0,33	0,04	1,47	1,68	0,53	0,23	0,05	
7	10/11/2017 10:39	1,80	12,32	162,46	101,26	10,90	-0,03	2,22	2,44	11,38	162,68	991,18	10,91	-0,48	0,23	0,02	1,53	1,75	0,47	0,18	0,03	
8	10/11/2017 11:49	2,91	12,30	164,73	101,16	11,00	1,08	3,62	2,58	11,39	164,98	991,01	10,97	-0,33	0,11	-0,36	1,62	1,87	1,75	1,45	2,11	
9	10/11/2017 13:58	1,70	12,37	164,84	101,34	11,10	-0,13	2,13	2,47	13,78	164,25	990,96	8,05	-0,44	0,19	0,06	1,55	2,30	-0,17	-0,47	0,22	
10	10/11/2017 14:58	5,58	13,48	165,00	101,35	11,00	3,75	8,02	9,94	11,41	164,71	990,65	10,77	7,03	49,41	26,35	6,25	7,18	0,84	0,54	0,29	
11	11/11/2017 09:29	1,10	12,75	159,81	100,73	11,00	-0,73	1,44	1,77	11,63	159,78	990,16	10,23	-1,15	1,31	0,83	1,11	1,28	0,15	-0,15	0,02	
12	11/11/2017 10:34	1,05	12,77	162,73	100,80	10,80	-0,78	1,38	1,72	11,66	162,82	990,20	10,27	-1,20	1,43	0,93	1,08	1,26	0,11	-0,18	0,03	
13	11/11/2017 11:44	1,30	12,73	163,32	100,80	10,80	-0,53	1,70	1,75	11,64	163,49	990,20	10,35	-1,16	1,35	0,61	1,10	1,29	0,41	0,11	0,01	
14	11/11/2017 12:44	0,88	12,69	163,67	100,75	10,80	-0,95	1,15	1,76	11,64	163,85	990,10	10,43	-1,15	1,33	1,09	1,10	1,29	-0,14	-0,44	0,20	
15	11/11/2017 13:49	1,54	12,73	163,11	100,72	10,00	-0,29	2,00	1,78	11,62	163,26	990,06	10,40	-1,13	1,28	0,33	1,12	1,31	0,69	0,39	0,15	
Average																			0,30			
Sum															70,02	32,27						7,48
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		5	Yaverag e	1,83	x average	2,91	Z		Procedure for the determination of the calibration fuction					Calibration Function								
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		0,75	m	0,628	i	0,000 0	r	0,89	Method B					Y= 0,628X + 0								
Ys Max-Ys min		6,87	ŷs, max	7,18	Calibration Range				0 - 7,89 [mg/Nm3 rif O2]													
Test of Variability																						
Maximum permissible uncertainty (95% confidence interval)		30	Test value for variability (k <sub>v</sub> )				0,976 1	σ0kv		0,747	Result of Variability Test (s <sub>0</sub> ≤σ <sub>0</sub> k <sub>v</sub> )											
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,731	Standard Deviation (σ <sub>0</sub> )			0,77	Experimental Confidence interval [%]			28,64	Positive			Note: Method B was used to process the results in order to obtain a proper calibration function.								





## Calibration function QAL2- Dust





## 15 ANNEX 5 – IAR REPORT

### 15.1 WATER VAPOUR – IAR

Parameter		Water Vapour		
N. Test	DATE/TIME	SRM [%]	AMS [%]	Absolute Differences (X <sub>i</sub> )
1	09/11/2017 10:04	9,9	10,0	0
2	09/11/2017 11:14	11,0	10,0	1
3	09/11/2017 12:24	11,0	10,1	1
4	09/11/2017 13:31	11,0	10,1	1
5	09/11/2017 14:49	10,9	10,2	1
Average		10,8	10,1	0,7
t student 0,95 (N-1)		2,78		
Standard Deviation (S <sub>D</sub> )		0,37		
Confidence Interval (I <sub>c</sub> )		0,46		
<b>I.A.R</b>		<b>89,1</b>		

### 15.2 TEMPERATURE – IAR

Parameter		Temperature		
N. Test	DATE/TIME	SRM [°C]	AMS [°C]	Absolute Differences (X <sub>i</sub> )
1	09/11/2017 10:04	168,4	168,6	0
2	09/11/2017 11:14	168,8	169,1	0
3	09/11/2017 12:24	169,0	169,3	0
4	09/11/2017 13:31	169,2	169,5	0
5	09/11/2017 14:49	169,0	169,4	0
Average		168,9	169,2	0,3
t student 0,95 (N-1)		2,78		
Dev. Standard (S <sub>D</sub> )		0,07		
Intervallo di Confidenza (I <sub>c</sub> )		0,08		
<b>I.A.R</b>		<b>99,8</b>		



### 15.3 PRESSURE - IAR

Parameter		Pressure		
N. Test	DATE/TIME	SRM [hPa]	SME [hPa]	Absolute Differences ( $X_i$ )
1	09/11/2017 10:04	1019	992	26
2	09/11/2017 11:14	1019	992	26
3	09/11/2017 12:24	1018	992	26
4	09/11/2017 13:31	1017	992	25
5	09/11/2017 14:49	1016	992	24
Average		1018	992	25
t student 0,95 (N-1)		2,78		
Standard Deviation ( $S_D$ )		0,81		
Confidence Interval ( $I_c$ )		1,00		
<b>I.A.R</b>		<b>97,4</b>		

### 15.4 FLOW - IAR

Parameter			Flow	
N. Test	DATE/TIME	SRM [Nm <sup>3</sup> /h]	AMS [Nm <sup>3</sup> /h]	Absolute Differences ( $X_i$ )
1	09/11/2017 10:04	190931	226520	35589
2	09/11/2017 11:14	190978	226594	35616
3	09/11/2017 12:24	191640	226584	34944
4	09/11/2017 13:31	190724	226541	35817
5	09/11/2017 14:49	189910	226513	36603
Average		190837	226550	35714
t student 0,95 (N-1)		2,78		
Standard Deviation ( $S_D$ )		596		
Confidence Interval ( $I_c$ )		739		
<b>I.A.R</b>		<b>80,9</b>		



## 16 ANNEX 6 – QAL1 CERTIFIED SRM ANALYZER

	
<h1>CERTIFICATE</h1> <p>on Product Conformity (QAL1)</p>	
Certificate No.: 0000032301	
<b>Certified AMS:</b>	PG-350E for NO <sub>x</sub> , SO <sub>2</sub> , CO, CO <sub>2</sub> and O <sub>2</sub>
<b>Manufacturer:</b>	HORIBA Europe GmbH Julius-Kronenberg-Str. 9 42799 Leichlingen Germany
<b>Test Institute:</b>	TÜV Rheinland Energie und Umwelt GmbH
<p><b>This is to certify that the AMS has been tested and found to comply with:</b></p> <p><b>EN 15267-1: 2009, EN 15267-2: 2009, EN 15267-3: 2007 and EN 14181: 2004</b></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"><li>• EN 15267-3 tested</li><li>• QAL1 certified</li><li>• TÜV approved</li><li>• Annual inspection</li></ul>	
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
<a href="http://www.umwelt-tuv.de">www.umwelt-tuv.de</a> / <a href="http://www.eco-tuv.com">www.eco-tuv.com</a> 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.	
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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<sub>x</sub>, SO<sub>2</sub>, CO, CO<sub>2</sub> and O<sub>2</sub>

**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 <sub>x</sub>	0 - 205 <sup>1)</sup>	0 - 2050 <sup>2)</sup>	mg/m <sup>3</sup>
SO <sub>2</sub>	0 - 143	0 - 1430	mg/m <sup>3</sup>
CO	0 - 75	0 - 1250	mg/m <sup>3</sup>
CO <sub>2</sub>	0 - 20	-	Vol.-%
O <sub>2</sub>	0 - 25	0 - 10	Vol.-%

<sup>1)</sup> as NO<sub>2</sub>, this corresponds to apx 0 - 134 mg/m<sup>3</sup> NO

<sup>2)</sup> as NO<sub>2</sub>, this corresponds to apx. 0 - 1340 mg/m<sup>3</sup> NO

**Software version:**

P2000788001D / 1.11

**Restrictions:**

None

**Notes:**

1. The maintenance interval is four weeks.
2. The certification range for the component SO<sub>2</sub> 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 SO<sub>2</sub> 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 <sub>x</sub>	Chemiluminescence
CO, SO <sub>2</sub> , CO <sub>2</sub>	Non-dispersive absorption (NDIR) Infrared
O <sub>2</sub>	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](http://qal1.de).

Certification of PG-350E for NO<sub>x</sub>, SO<sub>2</sub>, CO, CO<sub>2</sub> and O<sub>2</sub> 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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	<p align="center"><b>Certificate:</b> 0000032301 / 22 March 2013</p>	
<p align="center"><b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b></p>		
<b>Measuring system</b>		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB0 / XL7LTUL1	
Measuring principle	Chemiluminescence	
<b>Test report</b>	21217817/A	
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
<b>Measured component</b>	NO <sub>x</sub> as NO	
Certification range	0 - 134 mg/m <sup>3</sup>	
<b>Evaluation of the cross sensitivity (CS)</b> (system with largest CS)		
Sum of positive CS at zero point	0,84	mg/m <sup>3</sup>
Sum of negative CS at zero point	0,00	mg/m <sup>3</sup>
Sum of positive CS at reference point	0,00	mg/m <sup>3</sup>
Sum of negative CS at reference point	-0,70	mg/m <sup>3</sup>
Maximum sum of cross sensitivities	0,84	mg/m <sup>3</sup>
Uncertainty of cross sensitivity	0,487	mg/m <sup>3</sup>
<b>Calculation of the combined standard uncertainty</b>		
<b>Tested parameter</b>		<b>u<sup>2</sup></b>
Standard deviation from paired measurements under field conditions *	u <sub>D</sub>	0,797 (mg/m <sup>3</sup> ) <sup>2</sup>
Lack of fit	u <sub>LF</sub>	0,336 (mg/m <sup>3</sup> ) <sup>2</sup>
Zero drift from field test	u <sub>0,z</sub>	0,082 (mg/m <sup>3</sup> ) <sup>2</sup>
Span drift from field test	u <sub>0,s</sub>	4,141 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of ambient temperature at span	u <sub>t</sub>	1,774 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of supply voltage	u <sub>v</sub>	0,084 (mg/m <sup>3</sup> ) <sup>2</sup>
Cross sensitivity (interference)	u <sub>i</sub>	0,238 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of sample gas flow	u <sub>g</sub>	0,013 (mg/m <sup>3</sup> ) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	u <sub>rm</sub>	1,173 (mg/m <sup>3</sup> ) <sup>2</sup>
Converter efficiency for AMS measuring NO <sub>x</sub>	u <sub>ce</sub>	10,583 (mg/m <sup>3</sup> ) <sup>2</sup>
* The larger value is used: * Repeatability standard deviation at span* or * Standard deviation from paired measurements under field conditions"		
Combined standard uncertainty (u <sub>c</sub> )	$u_c = \sqrt{\sum (u_{max,j})^2}$	4,38 mg/m <sup>3</sup>
Total expanded uncertainty	$U = u_c \cdot k = u_c \cdot 1.96$	8,59 mg/m <sup>3</sup>
Relative total expanded uncertainty	U in % of the ELV 131 mg/m <sup>3</sup>	6.6
Requirement of 2000/76/EC and 2001/80/EC	U in % of the ELV 131 mg/m <sup>3</sup>	20.0
Requirement of EN 15267-3	U in % of the ELV 131 mg/m <sup>3</sup>	15.0

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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

SO<sub>2</sub>  
Certification range 0 - 143 mg/m<sup>3</sup>

Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point 0.54 mg/m<sup>3</sup>  
Sum of negative CS at zero point -0.69 mg/m<sup>3</sup>  
Sum of positive CS at reference point 0.70 mg/m<sup>3</sup>  
Sum of negative CS at reference point -2.60 mg/m<sup>3</sup>  
Maximum sum of cross sensitivities -2.60 mg/m<sup>3</sup>  
Uncertainty of cross sensitivity -1.503 mg/m<sup>3</sup>

Calculation of the combined standard uncertainty

Tested parameter

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

\* The larger value is used:

"Repeatability standard deviation at span" or

"Standard deviation from paired measurements under field conditions"



Combined standard uncertainty (u<sub>c</sub>)  $u_c = \sqrt{\sum (u_{max,i})^2}$  4.23 mg/m<sup>3</sup>  
Total expanded uncertainty  $U = u_c \cdot k = u_c \cdot 1.96$  8.30 mg/m<sup>3</sup>

Relative total expanded uncertainty

Requirement of 2000/76/EC and 2001/80/EC U in % of the ELV 60 mg/m<sup>3</sup> 13.8

Requirement of EN 15267-3 U in % of the ELV 60 mg/m<sup>3</sup> 20.0





	<p><b>Certificate:</b> 0000032301 / 22 March 2013</p>	
<p>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</p>		
<b>Measuring system</b>		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB0 / XL7LTUL1	
Measuring principle	NDIR	
<b>Test report</b>	21217617/A	
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
<b>Measured component</b>	CO	
Certification range	0 - 75 mg/m³	
<b>Evaluation of the cross sensitivity (CS)</b> (system with largest CS)		
Sum of positive CS at zero point	0.00 mg/m³	
Sum of negative CS at zero point	0.00 mg/m³	
Sum of positive CS at reference point	0.50 mg/m³	
Sum of negative CS at reference point	-0.65 mg/m³	
Maximum sum of cross sensitivities	-0.65 mg/m³	
Uncertainty of cross sensitivity	-0.377 mg/m³	
<b>Calculation of the combined standard uncertainty</b>		
<b>Tested parameter</b>		
Standard deviation from paired measurements under field conditions *	$u_D$	0.356 (mg/m³)²
Lack of fit	$u_{of}$	0.070 (mg/m³)²
Zero drift from field test	$u_{z,d}$	0.706 (mg/m³)²
Span drift from field test	$u_{s,d}$	0.456 (mg/m³)²
Influence of ambient temperature at span	$u_t$	0.750 (mg/m³)²
Influence of supply voltage	$u_v$	0.062 (mg/m³)²
Cross sensitivity (interference)	$u_i$	0.142 (mg/m³)²
Influence of sample gas flow	$u_p$	0.001 (mg/m³)²
Uncertainty of reference material at 70% of certification range	$u_{rm}$	0.368 (mg/m³)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/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	3.35 mg/m³
<b>Relative total expanded uncertainty</b>	<b>U in % of the ELV 50 mg/m³</b>	<b>6.7</b>
Requirement of 2000/76/EC and 2001/80/EC	<b>U in % of the ELV 50 mg/m³</b>	<b>10.0</b>
Requirement of EN 15267-3	<b>U in % of the ELV 50 mg/m³</b>	<b>7.5</b>



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	<p align="center"><b>Certificate:</b> 0000032301 / 22 March 2013</p>	
<p align="center"><b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b></p>		
<b>Measuring system</b>		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB9 / XL7LTUL1	
Measuring principle	NDIR	
<b>Test report</b>	21217617/A	
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
<b>Measured component</b>	CO <sub>2</sub>	
Certification range	0 - 20 Vol.-%	
<b>Evaluation of the cross sensitivity (CS)</b> (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.-%
<b>Calculation of the combined standard uncertainty</b>		
<b>Tested parameter</b>		<b>U<sup>2</sup></b>
Standard deviation from paired measurements under field conditions *	U <sub>D</sub>	Vol.-% 0.000 (Vol.-%) <sup>2</sup>
Lack of fit	U <sub>LOF</sub>	Vol.-% 0.013 (Vol.-%) <sup>2</sup>
Zero drift from field test	U <sub>0Z</sub>	Vol.-% 0.071 (Vol.-%) <sup>2</sup>
Span drift from field test	U <sub>SD</sub>	0.238 Vol.-% 0.057 (Vol.-%) <sup>2</sup>
Influence of ambient temperature at span	U <sub>t</sub>	0.115 Vol.-% 0.013 (Vol.-%) <sup>2</sup>
Influence of supply voltage	U <sub>v</sub>	0.051 Vol.-% 0.003 (Vol.-%) <sup>2</sup>
Cross sensitivity (interference)	U <sub>i</sub>	Vol.-% 0.004 (Vol.-%) <sup>2</sup>
Influence of sample gas flow	U <sub>g</sub>	Vol.-% 0.000 (Vol.-%) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	U <sub>rm</sub>	Vol.-% 0.026 (Vol.-%) <sup>2</sup>
* The larger value is used : "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"		
Combined standard uncertainty (u <sub>c</sub> )	$u_c = \sqrt{\sum (u_{max,i})^2}$	0.43 Vol.-%
Total expanded uncertainty	$U = u_c \cdot k = u_c \cdot 1.96$	0.85 Vol.-%
<b>Relative total expanded uncertainty</b>	<b>U in % of the range 20 Vol.-%</b>	<b>4.2</b>
Requirement of 2000/76/EC and 2001/80/EC	<b>U in % of the range 20 Vol.-%</b>	<b>10.0**</b>
Requirement of EN 15267-3	<b>U in % of the range 20 Vol.-%</b>	<b>7.5</b>
** 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.		
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	<p align="center"><b>Certificate:</b> 0000032301 / 22 March 2013</p>	
<p align="center"><b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b></p>		
<b>Measuring system</b>		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB9 / XL7LTUL1	
Measuring principle	Paramagnetism	
<b>Test report</b>	21217617/A	
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
<b>Measured component</b>	O <sub>2</sub>	
Certification range	0 - 25 Vol.-%	
<b>Evaluation of the cross sensitivity (CS)</b> (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.-%	
<b>Calculation of the combined standard uncertainty</b>		
<b>Tested parameter</b>		<b>u<sup>2</sup></b>
Standard deviation from paired measurements under field conditions *	u <sub>D</sub> Vol.-%	0.004 (Vol.-%) <sup>2</sup>
Lack of fit	u <sub>lof</sub> Vol.-%	0.000 (Vol.-%) <sup>2</sup>
Zero drift from field test	u <sub>dz</sub> Vol.-%	0.006 (Vol.-%) <sup>2</sup>
Span drift from field test	u <sub>ds</sub> 0.092 Vol.-%	0.008 (Vol.-%) <sup>2</sup>
Influence of ambient temperature at span	u <sub>t</sub> 0.064 Vol.-%	0.007 (Vol.-%) <sup>2</sup>
Influence of supply voltage	u <sub>v</sub> 0.018 Vol.-%	0.000 (Vol.-%) <sup>2</sup>
Cross sensitivity (Interference)	u <sub>i</sub> Vol.-%	0.000 (Vol.-%) <sup>2</sup>
Influence of sample gas flow	u <sub>g</sub> Vol.-%	0.000 (Vol.-%) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	u <sub>rm</sub> Vol.-%	0.041 (Vol.-%) <sup>2</sup>
* The larger value is used : "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"		
Combined standard uncertainty (u <sub>c</sub> )	$u_c = \sqrt{\sum (u_{max,i})^2}$	0.26 Vol.-%
Total expanded uncertainty	$U = u_c \cdot k = u_c \cdot 1.96$	0.51 Vol.-%
<b>Relative total expanded uncertainty</b>	<b>U in % of the range 25 Vol.-%</b>	<b>2.0</b>
Requirement of 2000/76/EC and 2001/80/EC	<b>U in % of the range 25 Vol.-%</b>	<b>10.0**</b>
Requirement of EN 15267-3	<b>U in % of the range 25 Vol.-%</b>	<b>7.5</b>
** 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.		
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## 17 ANNEX 7 – 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  
DAK-17588-01-00

als Kalibrierlaboratorium im / as calibration laboratory in the

**Deutschen Kalibrierdienst**

**DKD**

Kalibrierschein  
Calibration certificate

Kalibrierzeichen  
Calibration mark

09830
D-K- 17588-01-00
2017-10

Gegenstand Object	Gasteller
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, Italien

Auftragsnummer Order No.	PK752
Anzahl der Seiten des Kalibrierscheines Number of pages of the certificate	3
Datum der Kalibrierung Date of calibration	04.10.2017

Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung sowohl der Deutschen Akkreditierungsstelle GmbH 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 Deutsche Akkreditierungsstelle GmbH and the issuing laboratory. Calibration certificates without signature are not valid.

Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI). Der DAkkS ist Unterzeichner der multilateralen Übereinkommen der European co-operation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine. Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI). The DAkkS is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates. The user is obliged to have the object recalibrated at appropriate intervals.

Datum Date	Leiter des Kalibrierlaboratoriums Head of the calibration laboratory
04.10.2017	Dr.rer.nat. Johannes Schubert

Bearbeiter Person in charge
Dr. Marc Plüschau

TetraTec Instruments GmbH · Gewerbestraße 8 · 71144 Steinbronn  
Tel 07157/53870 · Fax 07157/538710 · [www.tetratec.de](http://www.tetratec.de) · [info@tetratec.de](mailto:info@tetratec.de)

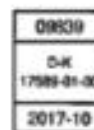
File: CAL055133  
DA9999 VQ350 R00





Calibration Laboratory of TetraTec Instruments GmbH

Seite 2 of 3  
Page english version



1.) Calibration object: Gas Blender  
Type: BetaCAP30 RK  
Manufacturer: Bu.T.A. strumentazione  
Serial-No.: 300229  
Meas.range: ca. 3.990 sm<sup>3</sup>/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: 50MK10-6 50MJ10-14 50MJ10-13  
Serial-No.: 752050-2 776810-N7 789090-S5  
Meas.range: 3,3...65 ml/min 133...4100 ml/min 300...7300 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, 1300 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:  $969,3 \pm 1,0$  hPa  
room temperature:  $23,0 \pm 1,0$  °C  
atmospheric humidity:  $39,9 \pm 5,0$  %r.F.

5.) Uncertainties of measurement

volume flow: 0,43% o.r. for  $Q \geq 10$  l/h  
0,38% 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: CAL055133



Calibration Laboratory of TetraTec Instruments GmbH

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D-K 17589-01-00
2017-10

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

$$\text{dev.} = c_I - c_S$$

unc.: uncertainty of  $c_I$  due to uncertainties of the measured flows

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

All measurements were performed at an entrance pressure of the gas-blender of ca. 1300 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	3975,7	3975,7	0,00	0,00	0,00	0,00
1	137,64	3847,7	3985,4	3,33	3,45	0,12	0,02
2	272,18	3718,3	3990,5	6,67	6,82	0,15	0,04
4	543,07	3448,3	3991,4	13,33	13,61	0,27	0,07
8	1081,69	2910,2	3991,9	26,67	27,10	0,43	0,15
15	1989,6	2002,0	3991,6	50,00	49,85	-0,15	0,27
30	4005,4	0,0	4005,4	100,00	100,00	0,00	0,00

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File: CAL055133



## 18 ANNEX 8 - 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 del Laboratorio 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](http://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](http://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)



## 19 ANNEX 9 - CERTIFICATES REFERENCE MATERIAL

		SAPIO PRODUZIONE IDROGENO OSSIGENO S.r.l.	
		SEDE LEGALE: VIA SAN MARCELLO 13, 20137 MILANO UFFICIO OPERATIVO VIA SEPIATORE SAN GIOVANNI 17, 20097, ORZINUOVI (MI) TELEFONO: 02.657891 / TELEFAX: 02.657892	
CERTIFICATO DI ANALISI Certificate of analysis			
C-38-05			
CLIENTE: CHIMICA APPLICATA DEPURAZIONE ACQUE Customer:			
INDIRIZZO: VIA PIO LA TORRE 13 - AREA PIP MENFI 92013 AG Address:			
NUMERO ORDINE: 2726323 Order number:	CODICE RICORDO: PISA42177P Code reminder:	PER RICORDO: <a href="#">vedi sito internet</a> Numero verde: 800418110	
MATRICOLO: MPN1386 Serial number:	CAPACITA' (litri): 20 Capacity (liters):	SCADENZA PROVA IDRAULICA: 08/2019 Expiration hydraulic test:	
CONTENUTO: MISCELA DI GAS Content:	RECIPIENTE: BOMBOLA GRUPPO 5-UN11146 Vessel:		
METODO DI PREPARAZIONE: GRAVIMETRICO SECONDO NORME ISO 6142 - ISO 6143 Method of preparation:			
COMPONENTE Component	RICHIESTA Request	CONCENTRAZIONE (C) Concentration (C)	INCERTEZZA RELATIVA (RC%) Relative Uncertainty (RC%)
ELUIBRO (B LARSENIO)	10,00 %	10,00 %	0,0%
OSSIGENO (B CARBONIO)	27,0 ppm	27,0 ppm	0,0%
OSSIGENO (B AZOTO)	27,0 ppm	27,0 ppm	0,0%
ANIDRIDE SOLFORICA	10,0 ppm	10,0 ppm	0,0%
OSSIGENO AZOTO TOTALE	-	27,0 ppm	0,0%
Completamento: AZOTO Balance:		Concentrazione (C) espressa in termini di: mol/m <sup>3</sup> Concentration (C) expressed in terms of:	
L'incertezza relativa (RC%) riportata è espressa come incertezza estesa relativa con fattore di copertura k=2, corrispondente ad un livello di fiducia del 95% circa.			
Ripetibilità: La lettura del ricettore di massa utilizzato per la preparazione della miscela è effettuata utilizzando masse certificate del centro di taratura LAT s'p'oss.			
Trazionalità: La lettura delle masse è eseguita in conformità alla procedura PT54 (EURAMET go-12 v. 4.0); i certificati di riferimento delle masse utilizzate sono: LAT06 0642017, 0652017, 4010215, 5722015.			
Note:			
Note:			
PRESSIONE DI RIMPIEMBIMENTO (bar) Filling pressure (bar):	150,0	RISCHI PER LA SALUTE: Health hazard:	NOGIVO
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:	08/2019
Data certificato: 01/06/2017 Certification date:		Numero certificato: 201705601 Certificate number:	
		Operatore: F. Giglio Operator:	

Pagina 1 di 1



SAPIO PRODUZIONE IDROGENO OSSIGENO S.r.l.

SEDE LEGALE: VIA SAN MAURELIO 13, 20123, MILANO  
UFFICIO OPERATIVO: VIA SENATORI SIMONE TTA 27, 20067, CAPONAGO (MB)  
TELEFONO: 02.957051 / TELEFAX: 02.9574084

**CERTIFICATO DI ANALISI**  
Certificate of analysis

G-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](mailto: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](mailto: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 (ΔC%) Relative Uncertainty (ΔC%)
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 (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 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 RIPIEMIMENTO (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 E.V.)

SEDE LEGALE: VIA SAN MARINO 12, 20122, MILANO  
UFFICIO OPERATIVO VIA SIVARIONE 5/A, 20122, CAPONNARO (MI)  
TELEFONO: 02 87061 / TELEFAX: 02 8706162

### CERTIFICATO DI ANALISI Certificate of analysis

CLIENTE: CHIMICA APPLICATA DEPURAZIONE ACQUE  
Customer:

INDIRIZZO: VIA PIO LA TORRE 13 - AREA P.I.P. MENFI 92013 AG  
Address:

NUMERO ORDINE: 3832384  
Order number:

CODICE RICORDO: IP614R5YDFN  
Code reminding:

PER RICORDO: [ordini@sapiogroup.it](mailto:ordini@sapiogroup.it)  
Numero verde: 800416118

MATRICOLA: MP17187  
Serial number:

CAPACITA' (litri): 18  
Capacity (liters):

SCADENZA  
PROVA IDRAULICA: 03/2024  
Expiration hydraulic test:

CONTENUTO: MISCELA DI GAS  
Content:

RECIPIENTE: BOMBOLA GRUPPO S-UNIT1144  
BOMX  
Vessel:

METODO DI PREPARAZIONE: GRAMMETRICO SECONDO NORME ISO 8142 - ISO 8143  
Method of preparation:

COMPONENTE Component	RICHESTA Request	CONCENTRAZIONE (C) Concentration (C)	Incertezza Relativa (IC%) Relative Uncertainty (IC%)
ARMONICA	98.0 ppm	97.3 ppm	0.8%
Completamento: AZOTO Addition:		Concentrazione (C) espressa in termini di: multipli Concentration (C) expressed in terms of:	

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

Ripetibilità: La taratura dei misuratori di massa utilizzato per la preparazione della miscela è effettuata utilizzando masse certificate del centro di taratura LAT n°066.  
Ripetibilità: La taratura delle masse è eseguita in conformità alla procedura PT04 (EURAMET go-18 v. 4.0).  
I certificati di riferimento delle masse utilizzate sono: LAT065 064/2017; 065/2017; 431/2015; 572/2015.

Note:  
Note:

PRESSIONE DI RIEMPIIMENTO (bar): Filling pressure (bar):	150	RISCHI PER LA SALUTE: Health hazard:	ASPIRANTE 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:	12/2017

Data certificato: 24/03/2017  
Certification date:

Numero certificato: 201702042  
Certificate number:

Operatore: M. BUCCHETTI  
Operator:



**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

### **QAL 2 REPORT ON AUTOMATED MEASURING SYSTEM INSTALLED FOR CONTINUOUS MONITORING OF EMISSIONS OF STACK 6C**

performed on behalf of

**SUN LAB GROUP Ltd**

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

**June, 2017**



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# 1 INTRODUCTION

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SUNLAB Ltd commissioned to CADA snc di F.Giglio & C. the calibration activities (QAL2) in accordance to the EN 14181:2015 on Automated Measuring System (AMS) installed for continuous monitoring of Stack 6C emissions at the Delimara Power Station, Marsaxlokk, Malta .

In this technical report, we describe the linearity test performed on AMS Stack 6C after change over to the methane conversion of the plant.

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),
- ⇒ Calibration function created on 15 parallel measurements.

The technical activity has been performed on 10<sup>th</sup>, 11<sup>th</sup> and 17<sup>th</sup> 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	6C	
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	
GPS Coordinates (N - E)	35°49'57.12"	14°33'27.87"
Pollution abatement system	SCR/Denox + DeSOx + Filter	
Authorization decree	IPPC IP 0002/07/Fii	
Reference Oxygen for Correction of Results	15 % Vol.	

The emission limits with Natural Gas 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 <sup>3</sup>	5
Nitrogen Oxides	mg/Nm <sup>3</sup>	55
Sulfur Dioxide	mg/Nm <sup>3</sup>	100
Carbon Monoxide	mg/Nm <sup>3</sup>	110
Ammonia	mg/Nm <sup>3</sup>	2,6
<b>Note:</b> 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 “6C” 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 <sup>2</sup> ]	3,14
Number of Sampling Lines (Access Ports)	2
Conformance of the Sampling Platform	
Sampling platform area > 5 m <sup>2</sup> 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 have been changed, this operation represents the normal plant conditions and increase the variability of data to implement the calibration.

**Table 4 - Plant Load during the measurements**

Plant Load during the measurements				
Fuel	Natural Gas	Other Fuel	/	
Day	Time	Source of emission	Load	
10/05/2017	07:30 - 22:30	Diesel Engine 45 & 46	32MW	100%
11/05/2017	07:30 - 22:30	Diesel Engine 45 & 46	26MW	80%
17/05/2017	07:30 - 22:30	Diesel Engine 45	16MW	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 <sub>3</sub>	EPA CTM 027:1997	Procedure for collection and analysis of ammonia in stationary sources.
NO <sub>x</sub>	UNI EN 14792:2006	Stationary source emissions. Determination of mass concentration of nitrogen oxides (NO <sub>x</sub> ). Reference method: Chemiluminescence.
SO <sub>2</sub>	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 <sub>2</sub>	ISO 11042-1:1996	Gas turbines - Exhaust gas emission - Part 1: Measurement and evaluation. Principle of Measurement: Non-dispersive infrared (NDIR).
O <sub>2</sub>	UNI EN 14789:2006	Determination of volume concentration of oxygen (O <sub>2</sub> ). Reference method - Paramagnetism.
H <sub>2</sub> 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 <sub>3</sub>	Dado Lab - ST5	Sampling	
NOx	Horiba / PG - 350 E	CLD chemiluminescence	0-25/50/100/250/ 500/1000/2500 ppm
SO <sub>2</sub>	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 <sub>2</sub>	Horiba / PG - 350 E	ND-IR	0-10/20/30 %
O <sub>2</sub>	Horiba / PG - 350 E	Paramagnetic	0-/10/25 %
H <sub>2</sub> O	Tecora - Ayrton	Sampling	Only Sampling

In Annex 6 and 7, 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 6C.

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 (SO<sub>2</sub>), nitrogen monoxide (NO), nitrogen dioxide (NO<sub>2</sub>), carbon dioxide (CO<sub>2</sub>), ammonia (NH<sub>3</sub>) and water vapor (H<sub>2</sub>O).

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 <sup>3</sup>
		MCS 100 E	ZrO <sub>2</sub>	O <sub>2</sub>	0 - 21 %
			IR Non-Dispersive (NDIR)	CO	0 - 300 mg/Nm <sup>3</sup>
				CO <sub>2</sub>	0 - 25 %
				NO	0 - 300 mg/Nm <sup>3</sup>
				NO <sub>2</sub>	0 - 100 mg/Nm <sup>3</sup>
				SO <sub>2</sub>	0 - 2000 mg/Nm <sup>3</sup>
				NH <sub>3</sub>	0 - 30 mg/Nm <sup>3</sup>



## 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 8<sup>th</sup> 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.

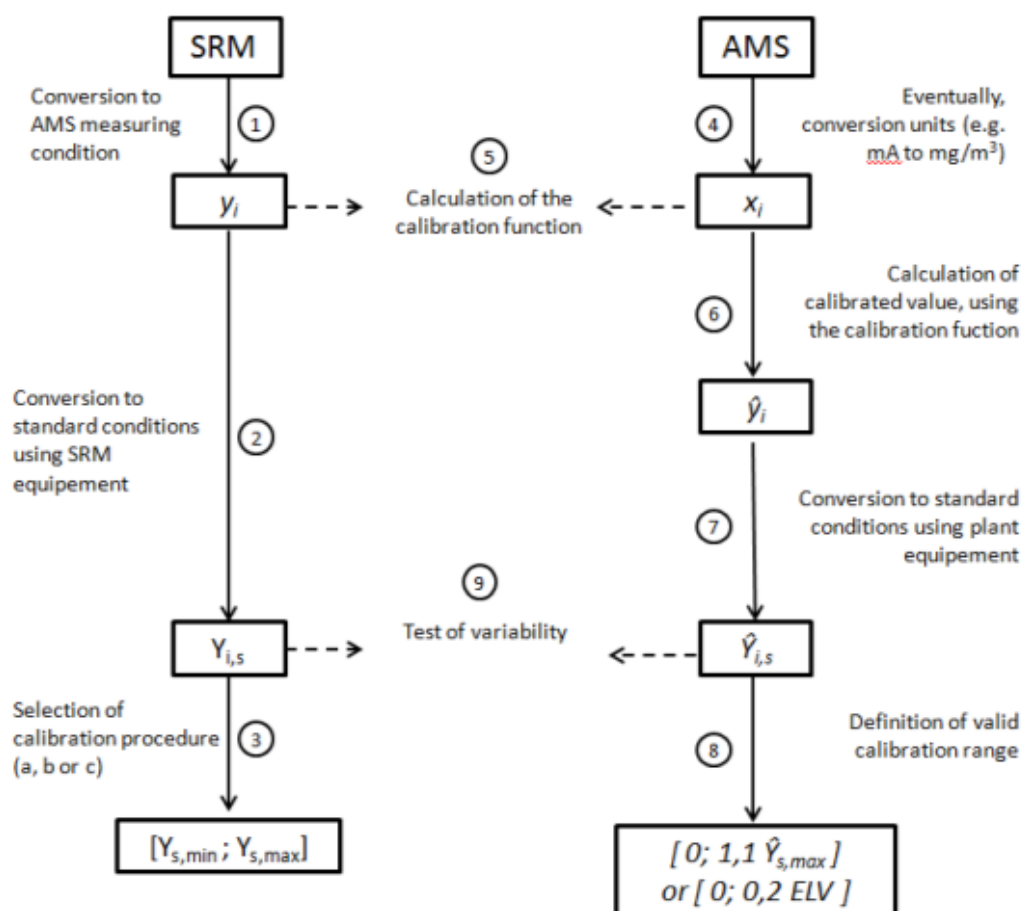
## 7 CALIBRATION and VALIDATION OF THE AMS (QAL2)

### 7.1 DETERMINATION OF THE CALIBRATION FUNCTION

The calibration of the AMS measurement should be performed on at least fifteen parallel measurements with an SRM distributed in a period of 6-8 hours for three days. The object of the parallel measurements was to calibrate and validate the AMS through an independent method (SRM). The tests were carried out over a period of three days in order to take measurements during different states of the system (for example changes of load).

Below it is shown flowchart that describes the steps of the calibration process.

Figure 1 - Flowchart of calibration process



The standard assumes that the calibration function is linear with a constant residual standard deviation. The calibration function is described by the following model.(See ISO 11095):



$$y_i = a + bx_i + \varepsilon_i \quad (9)$$

Where

- $x_i$  is the result  $i^{\text{th}}$  of the AMS;  $i$ =from 1 to N;  $N \geq 15$ ;  
 $y_i$  is the result  $i^{\text{th}}$  of the SRM;  $i$ =from 1 to N;  $N \geq 15$ ;  
 $\varepsilon_i$  is the deviation between  $y_i$  and the expected value;  
 $a$  is the intercept of calibration function;  
 $b$  is the slope of the calibration function.

The following quantities shall be calculated, average value of the AMS ( $\bar{x}$ ) and SRM ( $\bar{y}$ ):

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

$$\bar{y} = \frac{1}{N} \sum_{i=1}^N y_i \quad (11)$$

Following, the difference between the highest and lowest measured SRM concentration at standard condition shall be calculated ( $y_{s,max} - y_{s,min}$ ). Depending on the range of concentrations ( $y_{s,max} - y_{s,min}$ ) reported during the measurement one has to choose the method of calculation of the calibration function.

**Method a:** if ( $y_{s,max} - y_{s,min}$ )  $\geq$  maximum permissible uncertainty.

The parameters of the calibration function shall be calculated according to Formula (12) and Formula (13):

$$\hat{b} = \frac{\sum_{i=1}^N (x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^N (x_i - \bar{x})^2} \quad (12)$$

$$\hat{a} = \bar{y} - \hat{b}\bar{x} \quad (13)$$

**Method b:** if ( $y_{s,max} - y_{s,min}$ )  $<$  maximum permissible uncertainty and  $y_{s,min} \geq 15\%$  of Limit Emission Value (ELV). The parameters of the calibration function shall be calculated according to Formula (14) and Formula (15):



$$\hat{b} = \frac{\bar{y}}{\bar{x} - Z} \quad (14)$$

$$\hat{a} = -\hat{b}Z \quad (15)$$

Where

Z is the difference between the zero reading of the AMS and the zero.

**Method c:** if  $(y_{s,max} - y_{s,min}) < \text{maximum permissible uncertainty}$  and  $y_{s,min} < 15\%$  of Limit Emission Value (ELV). The function is constructed with the same formulas of *Method a* (12 - 13). In addition, two points "surrogate" of Zero and Span (*near the ELV*) are used using gaseous standards.

The calibration function is valid when the plant is operated within the valid calibration range. This valid calibration range is either the calibration range from zero to the maximum value  $y_{s,max}$  of calibrated AMS measured value at standard conditions, determined the QAL2 procedure, plus an extension of 10% of  $y_{s,max}$ , or to 20% of ELV, whichever is greater.

## 7.2 TEST OF VARIABILITY

In order to validate the calibration function obtained in this way, will be executed the test of variability.

The data pairs (SRM and AMS calibrated) thus obtained are normalized and reported to the standard conditions of the plant using auxiliary measures supplied with measurement systems.

For the series of data are calculated:

$$D_i = y_{i,s} - \hat{y}_{i,s} \quad (16)$$

Where

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

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

Mean differences, Formula 17:





$$\bar{D} = \frac{1}{N} \sum_{i=1}^N D_i \quad (17)$$

Standard deviation of differences, Formula 18:

$$S_D = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (D_i - \bar{D})^2} \quad (18)$$

The AMS passes the variability test when:

$$S_D \leq \sigma_0 k_v \quad (16)$$

where

$\sigma_0$  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 factors is:

$$\sigma_0 = \frac{P \times ELV}{1,96} \quad (17)$$

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

$k_v$  is a value from  $\chi^2$ -test with a  $\beta$ -value of 50%. The  $k_v$  value depending on the number of tests conducted.

Table 9-  $k_v$  values

Number of parallel measurement	$k_v(N)$
15	0,9761
16	0,9777
17	0,9791
18	0,9803



## 8 ACCURACY INDEX ACCORDING TO LEGISLATIVE DECREE. 152/06 (IAR)

To verify that the analyzer correctly measures the auxiliary parameters, it has been used Accuracy Index (IAR). This index is reported on Italian Legislative Decree N. 152/2006 - Part V, Annex VI "Criteria for conformity assessment of the measured values to the emission limit values".

In this law the calculation of the IAR (accuracy relative index) was calculated according to the following formula:

$$IAR = 100 \times \left(1 - \frac{M + I_c}{M_r}\right) \quad (18)$$

where

- $M$  It is the arithmetic average of  $N$  values  $X_i$ .
- $X_i$  It represents the absolute value of the difference of the concentrations measured by the two measuring systems (stationary analyzer "AMS" and reference analyzer "SRM").
- $M_r$  It represents the average of the values of the concentrations measured by the reference system (SRM).
- $I_c$  It represents the absolute value of the confidence range calculated for the average of  $N$  values  $X_i$  namely.

$$I_c = t_n \frac{S}{\sqrt{N}} \quad (19)$$

where

- $N$  number of measurements performed.
- $S$  It represents the standard deviation of values  $X_i$ .
- $t_n$  Represents the t Student calculated for the level of confidence of 95% and for (n) degrees of freedom equal to (N-1);



Table 10 - t Student values

N	t <sub>n</sub>
3	4,303
4	3,182
5	2,776
6	2,571
7	2,447
8	2,365
9	2,306
10	2,262
11	2,229
12	2,201
13	2,179
14	2,16
15	2,145
16	2,131

The AMS system is considered verified if the value of the **IAR** is above **80%**. The result of IAR test are in Annex 5.

## 8.1 DETERMINATION OF HOMOGENEITY OF THE SAMPLING POINT

During the Accuracy test (IAR), the homogeneity testing of the sampling point is performed in according to Technical standard UNI EN 15259:2006, *paragraph 8.3 - Determination of homogeneity*. The procedure involves measuring one parameter, such as Oxygen (O<sub>2</sub>) and its spatial and temporal variations shall be applied to determine the homogeneity. Below, the procedure:

- ⇒ determine the sampling points for the grid measurement;
- ⇒ install the probe of the measuring system for the grid measurement;
- ⇒ install the probe of an independent measuring system (reference measurement) at a fixed point in the measurement section;
- ⇒ adjust the sample flow in both systems in order to obtain equal response times;
- ⇒ perform a grid measurement and in parallel measurements at a fixed point in the measurement section, with a sampling time of at least four times the response time of the measuring system but not less than three minutes for each sampling point;



- ⇒ Record for each sampling point  $i$  the actual value  $y_{i,grid}$  of the measurand in the grid and the value  $y_{i,ref}$  of the reference measurement;
- ⇒ For each sample point  $i$ , determines the ratio  $r_i$  defined as follows:

$$r_i = \frac{y_{i,grid}}{y_{i,ref}} \quad (20)$$

- ⇒ average  $\bar{r}$  of the ratios  $r_i$  according to Equation (21):

$$\bar{r} = \frac{1}{N} \sum_{i=1}^N r_i \quad (21)$$

- ⇒ standard deviation  $s_{grid}$  of the grid measurements according to Equation (22):

$$s_{grid} = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (y_{i,grid} - \bar{y}_{grid})^2} \quad (22)$$

- ⇒ standard deviation  $s_{ref}$  of the reference measurements according to Equation (23):

$$s_{ref} = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (y_{i,ref} - \bar{y}_{ref})^2} \quad (23)$$

If  $s_{grid} < s_{ref}$ , the distribution of the gas in the measuring section can be considered homogeneous and sampling can therefore be performed in any point of the section occurred.

The result of Homogeneity of sampling point are in Annex 1.



## 9 RESULTS

Below a summary of the results obtained from the QAL2 test performed on the analyzer (AMS) installed on the stack 6C. Note that for ammonia and sulfur dioxide the QAL2 procedure is not applicable because the parameters concentration are below the detection limit (LOD).

In Annex 4, there are reports for single parameter.

Table 11 - Results of QAL2

Summary Report of QAL2							
Parameter	Slope	Intercept	Range of Validity	Procedure for the determination of the calibration function	Maximum permissible uncertainty (95% confidence interval)	Experimental Confidence interval [%]	Emission Limit Value (ELV)
Dust	0,569	0,000	0 - 4,33 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	Method B	30	28,87	5
Nitrogen Oxide (NO)	0,805	-3,093	0 - 73,13 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	Method A	20	7,32	55
Carbon Monoxide (CO)	0,992	-1,898	0 - 22 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	Method C	10	0,61	110
Oxygen (O <sub>2</sub> )	1,092	0,000	0 - 15,26 [% Vol.]	Method B	10	2,17	/
Carbon Dioxide (CO <sub>2</sub> )	1,044	0,010	0 - 5,37 [% Vol.]	Method B	10	0,72	/

As regards carbon monoxide, the range of validity is lower than the emission limit value - ELV (110 mg / Nm<sup>3</sup>), then the consideration of Chapter 6.5 "Calibration Function of the AMS and its validity" of the technical standard EN 14181 : 2015 are applied.

Table 12 - Zero Verify

Zero verify for single parameter (Rif. 6.5 - Calibration Function of the AMS and its validity EN 14181 : 2015)						
Parameter	Emission Limit Value (ELV)	Range of Validity	Reference Concentration (ZERO)	AMS Response	Deviation of the AMS calibrated value compared to the reference concentration	Result (Deviation < 10 % ELV)
Carbon Monoxide (CO)	110	0 - 22 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	0	0	1,90	Positive



Table 13 - Span/ELV Verify

Span/ELV Verify for single parameter (Rif. 6.5 - Calibration Function of the AMS and its validity EN 14181 : 2014)								
Parameter	Emission Limit Value (ELV)	Range of Validity	Reference Concentration (ELV - SPAN)	AMS Response	Deviation of the AMS calibrated value compared to the reference concentration	Maximum permissible uncertainty (95% confidence interval)	Maximum permissible uncertainty (95% confidence interval) at ELV	Result (Deviation < I.C. 95% - ELV)
Carbon Monoxide (CO)	110	0 - 22 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	115,4	111,2	7,00	10	11	Positive

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

Table 14 - IAR Values

I <sub>AR</sub> Water Vapour	I <sub>AR</sub> Temperature	I <sub>AR</sub> Pressure	I <sub>AR</sub> Flow Rate
89,3	92,4	99,7	84,1



## 10 CONCLUSIONS AND COMMENTS

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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 QAL2. 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.

The Ammonia and Sulfur Dioxide parameters are in concentrations below instrumental detection limits, so it has not been possible to construct the QAL2 calibration. However, the analyzer can still correctly record the two parameters, this is noted by the linearity test.

Auxiliary parameter analyzers respond positively to the accuracy test, this shows that they work properly.





## 11 ANNEX 1 – FUNCTIONAL TEST

1	ALIGNMENT AND CLEANLINESS (ONLY NON-EXTRACTIVE SYSTEM)	
	Type of Verification (visual)	Notes / Comments
a	Obstruction Optical path	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. The visual checks required by EN 14181 were positive.
b	Cleaning of Optical Components	
c	Alignment	
d	Presence of Air Purge	

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 )	
a	Description of the test		Result
	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 <sup>(1)</sup>					
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	288,57	292
				0,2		291
				0		292
NO	mg/Nm3	0	0	0,2	256,98	239
				0		244
				0		246
SO <sub>2</sub>	mg/Nm3	0	0	0	140,77	138
				0,3		137
				0,2		137
O <sub>2</sub>	% Vol	0	0	0	16,707	16,33
				0		16,45
				0		16,53
CO <sub>2</sub>	% Vol	0	0	0	16,78	16,7
				0,2		16,7
				0		16,7
NH <sub>3</sub>	mg/Nm3	0	0	0	17,93	17,46
				0,1		17,48
				0		17,54
NO <sub>2</sub>	mg/Nm3	0	0	0,1	83,73	82,5
				0		79,76
				0		79,8
Notes / Comments: (*) Values recorded by linearity tests.						



7	<i>Linearity (*)</i>				
Parameter	Full Scale set	Slope (B)	Intercept (A)	d <sub>c,rel</sub> [%]	Results
CO	0 - 300 mg/Nm3	1,001	-1,081	1,3	Positive
NO	0 - 300 mg/Nm3	0,950	0,011	4,1	Positive
SO <sub>2</sub>	0 - 2000 mg/Nm3	0,955	-1,574	0,2	Positive
O <sub>2</sub>	0 - 21 %vol	0,986	0,019	0,4	Positive
CO <sub>2</sub>	0 - 25 %vol	0,988	-0,162	1,2	Positive
NH <sub>3</sub>	0 - 30 mg/Nm3	0,942	0,180	1,5	Positive
NO <sub>2</sub>	0 - 100 mg/Nm3	0,969	-0,416	4,7	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

Determination of homogeneity of the Sampling Point (Rif. 8.3 Determination of homogeneity - UNI EN 15259:2006)							
Point	Grid Sampling	Diameter	O <sub>2</sub> [% vol] SRM	S <sub>grid</sub> O <sub>2</sub> SRM	O <sub>2</sub> [% vol] AMS	S <sub>grid</sub> O <sub>2</sub> AMS	Result
1	9	1	12,05	0,02	11,28	0,03	Positive
2	29	1	12,01		11,24		
3	59	1	12,01		11,24		
4	141	1	12,03		11,22		
5	171	1	12,00		11,24		
6	191	1	12,03		11,26		
7							
8							
9							
10							
11	9	2	12,04		11,30		
12	29	2	12,05		11,24		
13	59	2	12,02		11,23		
14	141	2	12,06		11,26		
15	171	2	12,01		11,19		
16	191	2	12,04		11,23		
17							
18							
19							
20							

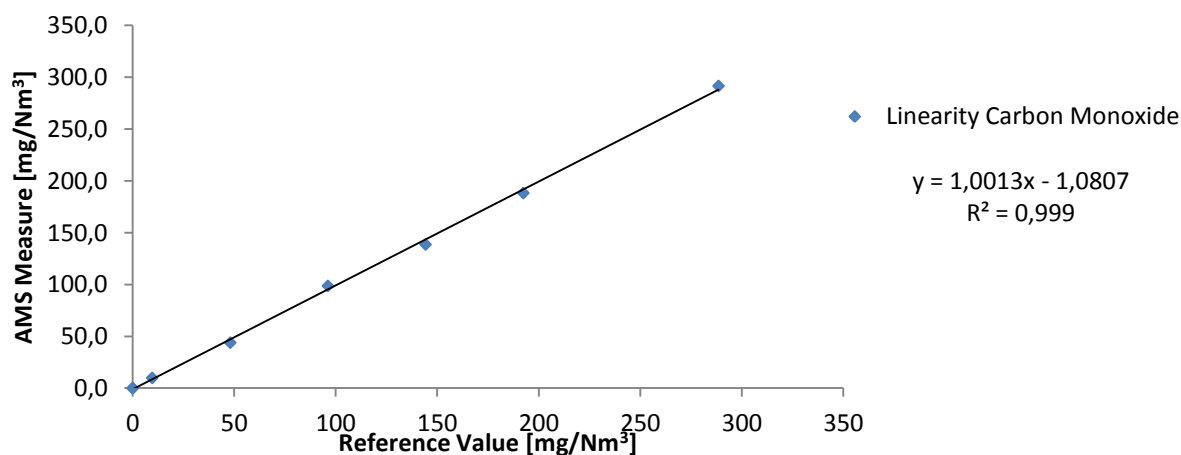


## 12 ANNEX 2 – TEST LINEARITY RESULTS

### 12.1 TEST LINEARITY OF CARBON MONOXIDE

Stack		6C		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		08/05/2017		Diluter		Beta CAP30RK			
Measurements and calculations									
CO mg/Nm3	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0	0,2	0	0,1	1,15	0,4	Positive
	1	9,62	10,2	9,9	9,8	10,0	1,41	0,5	Positive
	2	48,09	44	44	43,9	44,0	-3,10	-1,0	Positive
	3	96,18	98,5	98,8	99	98,8	3,54	1,2	Positive
	4	144,28	140	137	139	138,7	-4,72	-1,6	Positive
	5	192,4	188	189	188	188,3	-3,23	-1,1	Positive
	6	288,57	292	291	292	291,7	3,81	1,3	Positive
	0	0	0,1	0,1	0	0,1	1,15	0,4	Positive
		Y <sub>z</sub>	97,4	A'	96,4	B	1,001	A	-1,0807
	Legend								
Y <sub>i</sub> : concentration of reference material; Xi: AMS measure corresponding to the Reference Material Concentration Level; Y <sub>z</sub> : 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 monoxide





## 12.2 TEST LINEARITY OF NITROGEN OXIDE

Stack	6C	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/Nm <sup>3</sup>	Expiration	30/03/2019
Date measurements	08/05/2017	Diluter	Beta CAP30RK

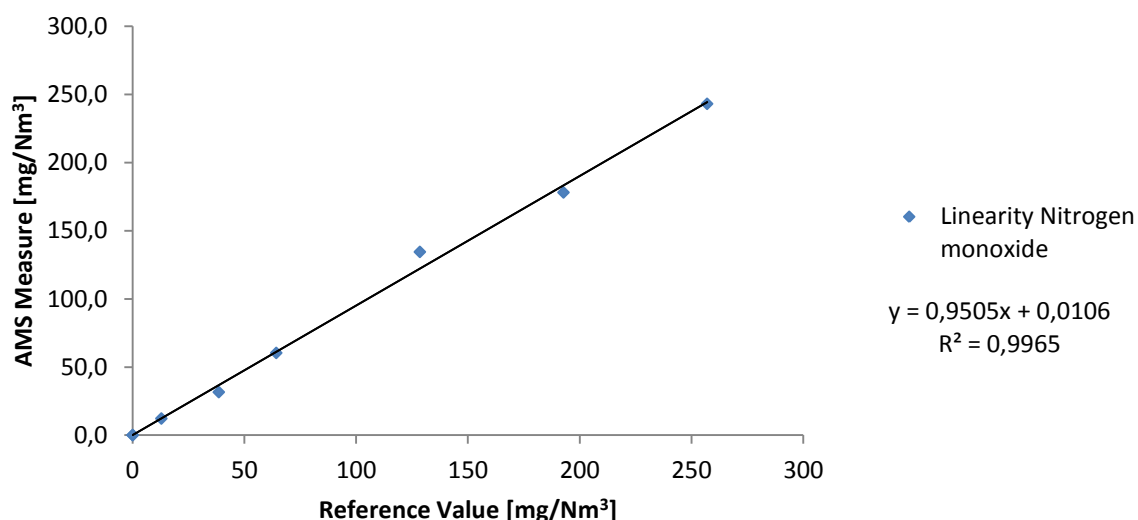
### Measurements and calculations

NO mg/Nm <sup>3</sup>	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0,2	0	0	0,1	0,06	0,0	Positive
	1	12,84	12,3	12,2	12,1	12,2	-0,01	0,0	Positive
	2	38,54	31,6	31,5	31,6	31,6	-5,08	-1,7	Positive
	3	64,24	63,7	59,8	57,4	60,3	-0,77	-0,3	Positive
	4	128,49	133,2	134,8	135,2	134,4	12,26	4,1	Positive
	5	192,74	180	175	179	178,0	-5,21	-1,7	Positive
	6	256,98	239	244	246	243,0	-1,27	-0,4	Positive
	0	0	0,1	0	0	0,0	0,02	0,0	Positive
		Y <sub>z</sub>	86,7	A'	82,4	B	0,950	A	0,0106

### Legend

Y<sub>i</sub>: concentration of reference material;  
X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  
Y<sub>z</sub>: 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





## 12.3 TEST LINEARITY OF NITROGEN DIOXIDE

Stack	6C		Data materials used	
Customer	D3 POWER GENERATION LIMITED		Cylinder Producer	SAPIO
Parameter	NO <sub>2</sub>		Serial/Certificate	P61YZ3YDFN
Analyzer	SICK MCS 100 E		Concentration	81,6 ppm
Full Scale set	0- 100	mg/Nm <sup>3</sup>	Expiration	30/03/2018
Date measurements	08/05/2017		Diluter	Beta CAP30RK

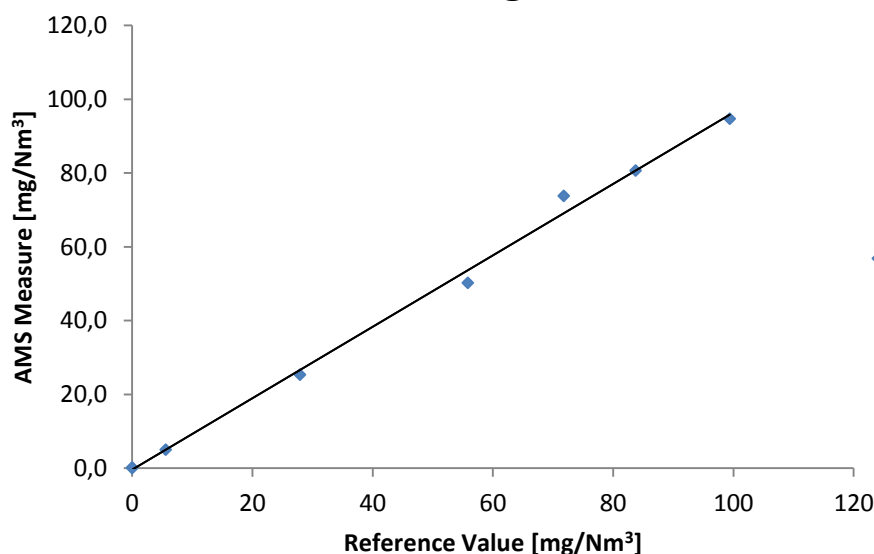
### Measurements and calculations

NO <sub>2</sub> mg/Nm <sup>3</sup>	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0,1	0	0	0,0	0,45	0,4	Positive
	1	5,58	4,98	5,1	5	5,0	0,04	0,0	Positive
	2	27,91	24,99	25,02	26,04	25,4	-1,27	-1,3	Positive
	3	55,82	50,28	50,33	50,12	50,2	-3,41	-3,4	Positive
	4	71,78	73,28	74,12	74,06	73,8	4,71	4,7	Positive
	5	83,73	82,5	79,76	79,8	80,7	0,00	0,0	Positive
	6	99,39	96,56	93,81	93,81	94,7	-1,13	-1,1	Positive
	0	0	0,2	0,2	0,2	0,2	0,62	0,6	Positive
		Y <sub>z</sub>	43,0	A'	41,3	B	0,969	A	-0,4156

### Legend

Y<sub>i</sub>: concentration of reference material;  
X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  
Y<sub>z</sub>: 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 Dioxide



$$y = 0,9686x - 0,4156$$
$$R^2 = 0,9965$$



## 12.4 TEST LINEARITY OF SULFUR DIOXIDE

Stack	6C		Data materials used	
Customer	D3 POWER GENERATION LIMITED		Cylinder Producer	SAPIO
Parameter	SO <sub>2</sub>		Serial/Certificate	P69313YDEN
Analyzer	SICK MCS 100 E		Concentration	49,3 ppm
Full Scale set	0- 2000	mg/Nm <sup>3</sup>	Expiration	30/03/2019
Date measurements	08/05/2017		Diluter	Beta CAP30RK

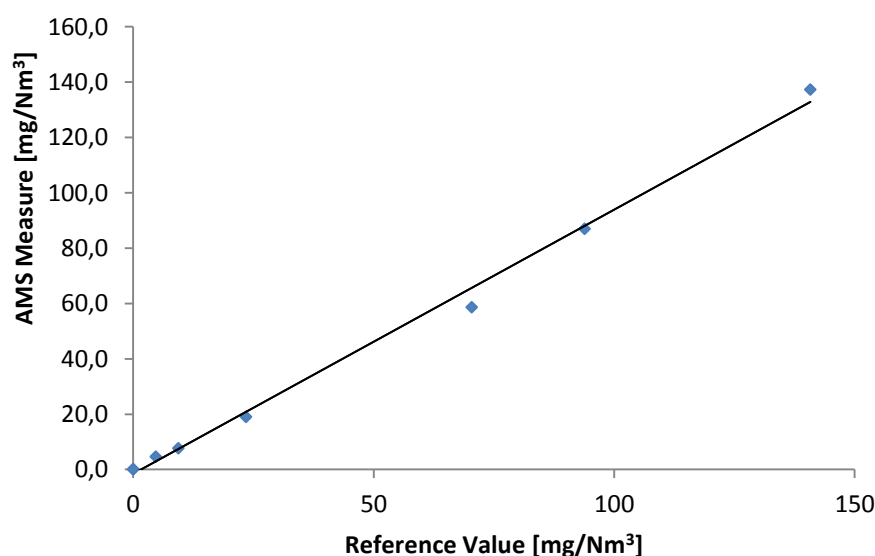
### Measurements and calculations

SO <sub>2</sub> mg/Nm <sup>3</sup>	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0	0,3	0,2	0,2	1,74	0,1	Positive
	1	4,7	5	4	5	4,7	1,75	0,1	Positive
	2	9,39	8	8,1	7	7,7	0,30	0,0	Positive
	3	23,46	19,2	19	18,9	19,0	-1,80	-0,1	Positive
	4	70,38	59	58	59	58,7	-6,99	-0,3	Positive
	5	93,85	87	88	86	87,0	-1,08	-0,1	Positive
	6	140,77	138	137	137	137,3	4,44	0,2	Positive
	0	0	0,1	0	0,1	0,1	1,64	0,1	Positive
		Y <sub>z</sub>	42,8	A'	39,3	B	0,955	A	-1,5739

### Legend

Y<sub>i</sub>: concentration of reference material;  
X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  
Y<sub>z</sub>: 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

$$y = 0,9553x - 1,5739$$
$$R^2 = 0,9954$$





## 12.5 TEST LINEARITY OF OXYGEN

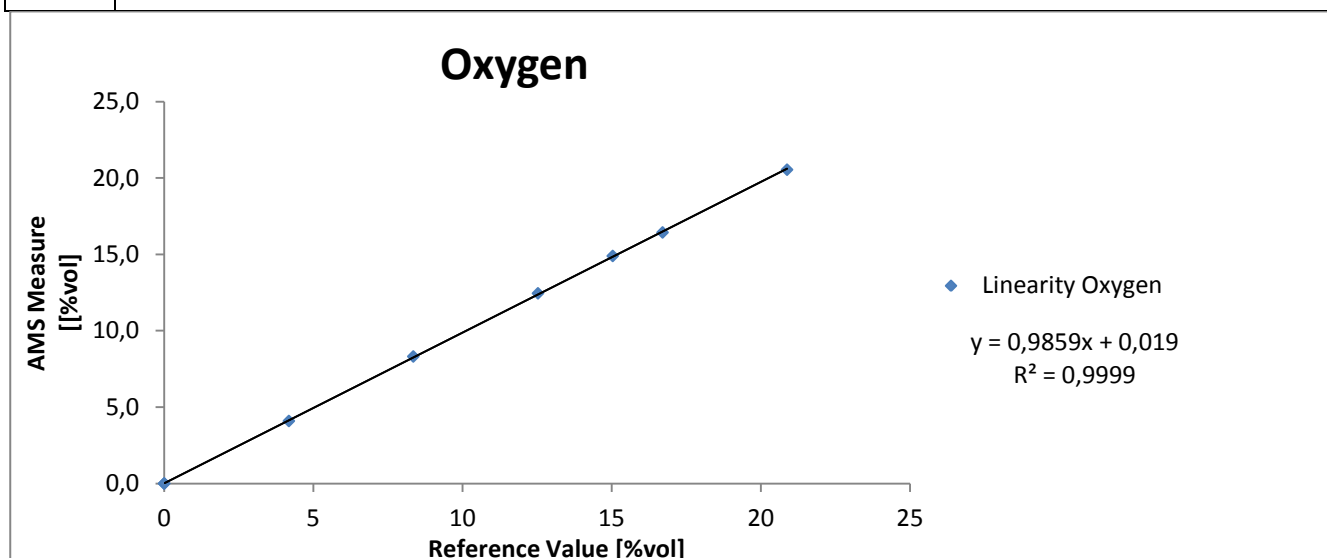
Stack	6C		Data materials used	
Customer	D3 POWER GENERATION LIMITED		Cylinder Producer	SAPIO
Parameter	O <sub>2</sub>		Serial/Certificate	P61LB2BDFN
Analyzer	SICK MCS 100 E		Concentration	25,06 %vol
Full Scale set	0- 21	%vol	Expiration	30/03/2020
Date measurements	08/05/2017		Diluter	Beta CAP30RK

### Measurements and calculations

O <sub>2</sub> %vol	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0	0	0	0,0	-0,02	-0,1	Positive
	1	4,18	3,92	4,18	4,18	4,1	-0,05	-0,2	Positive
	2	8,35	8,13	8,33	8,49	8,3	0,07	0,3	Positive
	3	12,53	12,36	12,45	12,54	12,5	0,08	0,4	Positive
	4	15,036	14,89	14,9	14,9	14,9	0,05	0,3	Positive
	5	16,707	16,33	16,45	16,53	16,4	-0,05	-0,3	Positive
	6	20,88	20,49	20,55	20,59	20,5	-0,06	-0,3	Positive
	0	0	0	0	0	0,0	-0,02	-0,1	Positive
		Y <sub>z</sub>	9,7	A'	9,6	B	0,986	A	0,0190

### Legend

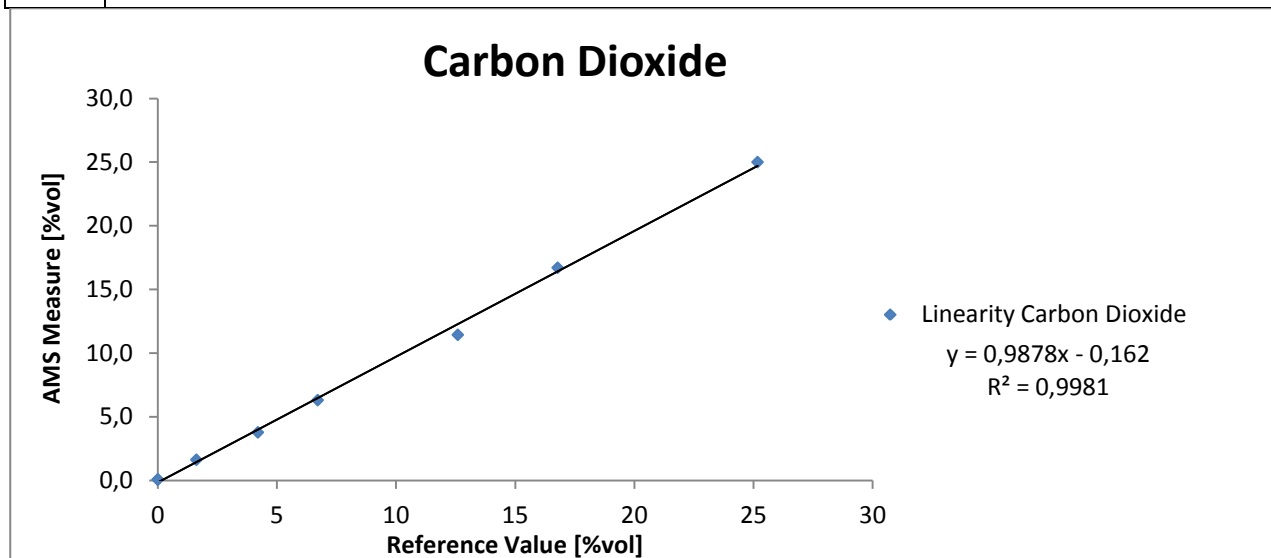
Y<sub>i</sub>: concentration of reference material;  
X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  
Y<sub>z</sub>: average concentration of reference material;  
A': the mean value of the Instrument's readings (AMS);  
B: Linear regression line coefficient;  
A: Linear regression line intercept





## 12.6 TEST LINEARITY OF CARBON DIOXIDE

Stack			6C			Data materials used			
Customer			D3 POWER GENERATION LIMITED			Cylinder Producer		SAPIO	
Parameter			CO <sub>2</sub>			Serial/Certificate		P69313YDEN	
Analyzer			SICK MCS 100 E			Concentration		25,17	%vol
Full Scale set			0- 25		%vol	Expiration		30/03/2019	
Date measurements			08/05/2017			Diluter		Beta CAP30RK	
Measurements and calculations									
CO <sub>2</sub> %vol	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0	0,2	0	0,1	0,23	0,9	Positive
	1	1,62	1,62	1,62	1,62	1,6	0,18	0,7	Positive
	2	4,2	3,77	3,77	3,77	3,8	-0,22	-0,9	Positive
	3	6,71	6,3	6,3	6,3	6,3	-0,17	-0,7	Positive
	4	12,59	11,5	11,4	11,4	11,4	-0,84	-3,4	Positive
	5	16,78	16,7	16,7	16,7	16,7	0,29	1,1	Positive
	6	25,17	25	25	25	25,0	0,30	1,2	Positive
	0	0	0,1	0,1	0	0,1	0,23	0,9	Positive
		Y <sub>z</sub>	8,4	A'	8,1	B	0,988	A	-0,1620
Legend									
Y <sub>i</sub> : concentration of reference material; X <sub>i</sub> : AMS measure corresponding to the Reference Material Concentration Level; Y <sub>z</sub> : 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									





## 12.7 TEST LINEARITY OF AMMONIA

Stack	6C		Data materials used	
Customer	D3 POWER GENERATION LIMITED		Cylinder Producer	SAPIO
Parameter	NH <sub>3</sub>		Serial/Certificate	P61AR3YDFN
Analyzer	SICK MCS 100 E		Concentration	47,3 ppm
Full Scale set	0- 30	mg/Nm <sup>3</sup>	Expiration	30/09/2017
Date measurements	08/05/2017		Diluter	Beta CAP30RK

### Measurements and calculations

g/Nm3	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0	0,1	0	0,0	-0,15	-0,5	Positive
	1	2,39	2,94	2,72	2,7	2,8	0,36	1,2	Positive
	2	5,98	5,29	5,2	5,25	5,2	-0,57	-1,9	Positive
	3	11,96	11,89	11,92	11,85	11,9	0,44	1,5	Positive
	4	17,93	17,46	17,48	17,54	17,5	0,42	1,4	Positive
	5	23,92	22,59	22,89	22,97	22,8	0,10	0,3	Positive
	6	29,9	27,82	27,95	28	27,9	-0,43	-1,4	Positive
	0	0	0	0	0	0,0	-0,18	-0,6	Positive
	Y <sub>c</sub>	11,5	A'	11,0	B	0,942	A	0,1798	



## 13 ANNEX 3 - TEST REPORT

### 13.1 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 <sub>2</sub> )				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 <sup>2</sup> ]		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							17/04/2017
Point	Diameter	Grid Sampling	Temperatura [°C]	Δpi [Pa]	Velocity [m/s]	Auxiliary Parameter	
1	1	9	165	258,9	21,3	Oxygen [% vol]	12,1
2	1	29	164	259,2	21,3		
3	1	59	165	257,1	21,3		
4	1	141	164	258,0	21,3	Carbon dioxide [%vol]	4,5
5	1	171	165	257,2	21,3		
6	1	191	164	256,0	21,2		
7						Water vapor [% vol]	8,30
8							
9							
10						Density - ρ (Kg/m <sup>3</sup> )	1,302
11	2	9	165	257,0	21,2		
12	2	29	165	257,0	21,2		
13	2	59	165	258,1	21,3	Pressione Emissione [kPa]	101
14	2	141	165	257,2	21,3		
15	2	171	165	258,3	21,3		
16	2	191	164	258,0	21,3	Ambient Temperature [°C]	25
17							
18							
19						Ambient Pressure [hPa]	1011
20							



Determination of the velocity profile							11/05/2017	
Point	Diameter	Grid Sampling	Temperatura [°C]	Δpi [Pa]	Velocity [m/s]	Auxiliary Parameter		
1	1	9	163	242,0	20,2	Oxygen [% vol]	12,4	
2	1	29	164	249,1	20,6			
3	1	59	163	248,2	20,5			
4	1	141	163	247,0	20,4	Carbon dioxide [%vol]	4,1	
5	1	171	163	247,2	20,5			
6	1	191	163	247,3	20,5			
7						Water vapor [% vol]	0,93	
8								
9								
10						Density - ρ (Kg/m³)	1,300	
11	2	9	164	247,3	20,5			
12	2	29	164	247,4	20,5			
13	2	59	163	248,0	20,5	Pressione Emissione [kPa]	102	
14	2	141	162	248,5	20,5			
15	2	171	163	249,0	20,5			
16	2	191	161	249,0	20,5	Ambient Temperature [°C]	28	
17								
18								
19						Ambient Pressure [hPa]	1011	
20								
Determination of the velocity profile							17/05/2017	
Point	Diameter	Grid Sampling	Temperatura [°C]	Δpi [Pa]	Velocity [m/s]	Auxiliary Parameter		
1	1	9	163	87,8	12,2	Oxygen [% vol]	13,0	
2	1	29	163	88,0	12,2			
3	1	59	163	87,9	12,2			
4	1	141	164	88,6	12,2	Carbon dioxide [%vol]	4,3	
5	1	171	165	88,9	12,3			
6	1	191	166	88,0	12,2			
7						Water vapor [% vol]	0,92	
8								
9								
10						Density - ρ (Kg/m³)	1,303	
11	2	9	165	88,8	12,3			
12	2	29	166	89,1	12,3			
13	2	59	164	89,5	12,3	Pressione Emissione [kPa]	102	
14	2	141	163	89,6	12,3			
15	2	171	164	88,0	12,2			
16	2	191	162	88,6	12,2	Ambient Temperature [°C]	32	
17								
18								
19						Ambient Pressure [hPa]	102	
20								



## 13.2 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 <sub>2</sub> )				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 <sup>3</sup> ] <sup>(1)</sup>
Method Blank		10/05/2017	/	FE92	0,00	0,03	1,000
2123746-001	Reply 1	10/05/2017 13:59	60	FE93	1,18	0,03	0,753
2123746-002	Reply 2	10/05/2017 14:59	60	FE94	0,85	0,05	0,690
2123746-003	Reply 3	10/05/2017 15:59	60	FE95	1,02	0,05	1,287
2123746-004	Reply 4	10/05/2017 17:59	60	FE96	1,00	0,05	0,972
2123746-005	Reply 5	10/05/2017 18:59	60	FE97	1,01	0,06	0,991
Method Blank		11/05/2017	/	FE98	0,00	0,05	1,000
2123746-006	Reply 1	11/05/2017 09:59	60	FE99	0,72	0,05	1,168
2123746-007	Reply 2	11/05/2017 10:59	60	FF00	0,88	0,06	1,148
2123746-008	Reply 3	11/05/2017 11:59	60	FF01	0,90	0,03	1,226
2123746-009	Reply 4	11/05/2017 12:59	60	FF02	2,88	0,04	1,209
2123746-010	Reply 5	11/05/2017 13:59	60	FF03	0,90	0,04	1,156
Method Blank		17/05/2017	/	FF22	0,00	0,04	1,000
2123746-011	Reply 1	17/05/2017 14:59	60	FF23	1,23	0,04	0,997
2123746-012	Reply 2	17/05/2017 15:59	60	FF24	1,44	0,04	0,869
2123746-013	Reply 3	17/05/2017 16:59	60	FF25	0,55	0,04	0,995
2123746-014	Reply 4	17/05/2017 17:59	60	FF26	0,80	0,05	0,955
2123746-015	Reply 5	17/05/2017 18:59	60	FF27	1,09	0,05	0,998

<sup>(1)</sup> For Blanks of the method is considered a volume of 1 m<sup>3</sup>



Dust - Sampling and analysis Data							2
I.D. Sample	Stack Speed [m/s]	Temperature [°C]	Pressure [kPa]	H <sub>2</sub> O [%v/v]	O <sub>2</sub> [%v/v]	Dust Concentration [mg/Nm <sup>3</sup> ] <sup>(2)</sup>	Dust Concentration correct with O <sub>2</sub> [mg/Nm <sup>3</sup> ] <sup>(3)</sup>
Method Blank	/	163,00	101,2	9,19	12,34	0,03	0,02
2123746-001	12,35	165,40	101,2	8,28	12,01	1,61	1,08
2123746-002	16,43	164,40	101,1	9,21	12,00	1,31	0,87
2123746-003	38,29	165,70	101,1	8,43	12,07	0,83	0,56
2123746-004	24,08	165,60	100,9	10,92	12,16	1,09	0,74
2123746-005	24,65	165,50	100,8	9,05	12,23	1,08	0,74
Method Blank	/	163,00	101,2	9,19	12,34	0,05	0,04
2123746-006	20,24	163,10	100,6	9,97	12,39	0,66	0,46
2123746-007	20,96	163,10	100,8	10,24	12,42	0,82	0,57
2123746-008	20,85	161,80	100,8	8,10	12,33	0,76	0,53
2123746-009	20,90	163,10	100,9	9,62	12,33	2,41	1,68
2123746-010	20,94	162,65	100,7	10,50	12,34	0,81	0,56
Method Blank	/	163,00	101,2	9,19	12,34	0,04	0,03
2123746-011	12,39	161,31	101,7	10,85	12,71	1,28	0,92
2123746-012	10,84	164,20	101,5	8,70	12,51	1,70	1,20
2123746-013	13,91	160,77	101,5	7,29	12,51	0,59	0,42
2123746-014	11,79	159,37	101,5	8,36	12,52	0,89	0,63
2123746-015	12,40	159,56	101,5	8,38	12,56	1,15	0,82

<sup>(2)</sup> Dust Concentration (Wet).

<sup>(3)</sup> 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 [%] <sup>(4)</sup>	Result	Dust Concentration correct with O <sub>2</sub> [mg/Nm <sup>3</sup> ] - Blank	Result <sup>(5)</sup>
Method Blank		10/05/2017	/			0,02	Positive
2123746-001	Reply 1	10/05/2017 13:59	60	-1,8	Positive		
2123746-002	Reply 2	10/05/2017 14:59	60	-3,7	Positive		
2123746-003	Reply 3	10/05/2017 15:59	60	-1,7	Positive		
2123746-004	Reply 4	10/05/2017 17:59	60	-0,1	Positive		
2123746-005	Reply 5	10/05/2017 18:59	60	-0,1	Positive		
Method Blank		11/05/2017	/			0,04	Positive
2123746-006	Reply 1	11/05/2017 09:59	60	-0,1	Positive		
2123746-007	Reply 2	11/05/2017 10:59	60	-3,2	Positive		
2123746-008	Reply 3	11/05/2017 11:59	60	-0,1	Positive		
2123746-009	Reply 4	11/05/2017 12:59	60	-1,5	Positive		
2123746-010	Reply 5	11/05/2017 13:59	60	-5	Positive		
Method Blank		17/05/2017	/			0,03	Positive
2123746-011	Reply 1	17/05/2017 14:59	60	0	Positive		
2123746-012	Reply 2	17/05/2017 15:59	60	0	Positive		
2123746-013	Reply 3	17/05/2017 16:59	60	0	Positive		
2123746-014	Reply 4	17/05/2017 17:59	60	0	Positive		
2123746-015	Reply 5	17/05/2017 18:59	60	0	Positive		

<sup>(4)</sup> Dust sampling must be done in isocinetics. The isocinet value must be within the Range -5% <G <+ 15%.

<sup>(5)</sup> 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).





### 13.3 COMBUSTION GAS REPORT

Nitrogen Oxides, Carbon Monoxide, Sulfur Dioxide, Oxygen and Carbon Dioxide - Sampling and Analysis Report					
Oxygen (O <sub>2</sub> )					UNI EN 14789:2017
Nitrogen Oxide (NO)					UNI EN 14792:2017
Carbon Monoxide (CO)					UNI EN 15058:2017
Sulfur Dioxide (SO <sub>2</sub> )					ISO 11042-1:1996
Carbon Dioxide (CO <sub>2</sub> )					ISO 11042-1:1996
Information on the instrumentatio 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 Oxides (NO <sub>x</sub> ) - 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 (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2123746-001	Reply 1	10/05/2017 13:59	60	16,69	12,01
2123746-002	Reply 2	10/05/2017 14:59	60	17,37	12,00
2123746-003	Reply 3	10/05/2017 15:59	60	16,70	12,07
2123746-004	Reply 4	10/05/2017 18:59	60	11,98	12,23
2123746-005	Reply 5	10/05/2017 19:59	60	9,61	12,31
2123746-006	Reply 6	11/05/2017 09:59	60	6,59	12,39
2123746-007	Reply 7	11/05/2017 10:59	60	6,62	12,42
2123746-008	Reply 8	11/05/2017 17:59	60	6,64	12,93
2123746-009	Reply 9	11/05/2017 18:59	60	13,75	12,41
2123746-010	Reply 10	11/05/2017 19:59	60	12,71	12,33
2123746-011	Reply 11	17/05/2017 12:59	60	93,24	13,38
2123746-012	Reply 12	17/05/2017 14:59	60	30,74	12,71
2123746-013	Reply 13	17/05/2017 15:59	60	17,54	12,51
2123746-014	Reply 14	17/05/2017 16:59	60	17,33	12,51
2123746-015	Reply 15	17/05/2017 17:59	60	17,85	12,52
Notes:					
(1) The oxygen value reported refers to the same measurement period of the parameter on which QAL2 (NOx) is performed.					
(2) The Nitric Oxide (NOx) value is not 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
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Carbon Monoxide (CO) - [mg/Nm <sup>3</sup> ]	Oxygen (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2123746-001	Reply 1	10/05/2017 13:59	60	2,67	12,01
2123746-002	Reply 2	10/05/2017 14:59	60	2,81	12,00
2123746-003	Reply 3	10/05/2017 15:59	60	2,89	12,07
2123746-004	Reply 4	10/05/2017 18:59	60	3,30	12,23
2123746-005	Reply 5	10/05/2017 19:59	60	3,21	12,31
2123746-006	Reply 6	11/05/2017 11:59	60	1,68	12,33
2123746-007	Reply 7	11/05/2017 12:59	60	1,67	12,33
2123746-008	Reply 8	11/05/2017 13:59	60	1,55	12,34
2123746-009	Reply 9	11/05/2017 14:59	60	1,72	12,36
2123746-010	Reply 10	11/05/2017 15:59	60	1,56	13,02
2123746-011	Reply 11	17/05/2017 13:59	60	2,42	12,46
2123746-012	Reply 12	17/05/2017 14:59	60	2,28	12,71
2123746-013	Reply 13	17/05/2017 15:59	60	2,44	12,51
2123746-014	Reply 14	17/05/2017 16:59	60	2,37	12,51
2123746-015	Reply 15	17/05/2017 17:59	60	2,30	12,52
Notes: (1) The oxygen value reported refers to the same measurement period of the parameter on which QAL2 (CO) is performed. (2) The carbon monoxide (CO) value is not corrected for the reference oxygen, is normalized by temperature and pressure and is expressed on a dry basis.					

Determination of Sulfur Dioxide (SO <sub>2</sub> ) - Sampling and analysis Data					3
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Sulfur Dioxide (SO <sub>2</sub> ) - [mg/Nm <sup>3</sup> ]	Oxygen (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2123746-001	Reply 1	10/05/2017 13:59	60	< 1	12,01
2123746-002	Reply 2	10/05/2017 14:59	60	< 1	12,00
2123746-003	Reply 3	10/05/2017 15:59	60	< 1	12,07
2123746-004	Reply 4	10/05/2017 18:59	60	< 1	12,23
2123746-005	Reply 5	10/05/2017 19:59	60	< 1	12,31
2123746-006	Reply 6	11/05/2017 09:59	60	< 1	12,39
2123746-007	Reply 7	11/05/2017 10:59	60	< 1	12,42
2123746-008	Reply 8	11/05/2017 17:59	60	< 1	12,93
2123746-009	Reply 9	11/05/2017 18:59	60	< 1	12,41
2123746-010	Reply 10	11/05/2017 19:59	60	< 1	12,33
2123746-011	Reply 11	17/05/2017 12:59	60	< 1	13,38
2123746-012	Reply 12	17/05/2017 14:59	60	< 1	12,71
2123746-013	Reply 13	17/05/2017 15:59	60	< 1	12,51
2123746-014	Reply 14	17/05/2017 16:59	60	< 1	12,51
2123746-015	Reply 15	17/05/2017 17:59	60	< 1	12,52
Notes: (1) The oxygen value reported refers to the same measurement period of the parameter on which QAL2 (SO <sub>2</sub> ) is performed. (2) The sulfur dioxide (SO <sub>2</sub> ) value is not corrected for the reference oxygen, is normalized by temperature and pressure and is expressed on a dry basis.					



Determination of Oxygen (O <sub>2</sub> ) - Sampling and analysis Data				3
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Oxygen (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2123746-001	Reply 1	10/05/2017 13:59	60	12,01
2123746-002	Reply 2	10/05/2017 14:59	60	12,00
2123746-003	Reply 3	10/05/2017 15:59	60	12,07
2123746-004	Reply 4	10/05/2017 18:59	60	12,23
2123746-005	Reply 5	10/05/2017 19:59	60	12,31
2123746-006	Reply 6	11/05/2017 09:59	60	12,39
2123746-007	Reply 7	11/05/2017 10:59	60	12,42
2123746-008	Reply 8	11/05/2017 17:59	60	12,93
2123746-009	Reply 9	11/05/2017 18:59	60	12,41
2123746-010	Reply 10	11/05/2017 19:59	60	12,33
2123746-011	Reply 11	17/05/2017 12:59	60	13,38
2123746-012	Reply 12	17/05/2017 14:59	60	12,71
2123746-013	Reply 13	17/05/2017 15:59	60	12,51
2123746-014	Reply 14	17/05/2017 16:59	60	12,51
2123746-015	Reply 15	17/05/2017 17:59	60	12,52
Notes: (1) The Oxygen value reported refers to the values used to construct the QAL2 calibration function.				

Determination of Carbon Dioxide (CO <sub>2</sub> ) - Sampling and analysis Data				4
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Carbon Dioxide (CO <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2123746-001	Reply 1	10/05/2017 13:59	60	12,01
2123746-002	Reply 2	10/05/2017 14:59	60	12,01
2123746-003	Reply 3	10/05/2017 15:59	60	12,01
2123746-004	Reply 4	10/05/2017 18:59	60	12,01
2123746-005	Reply 5	10/05/2017 19:59	60	12,01
2123746-006	Reply 6	11/05/2017 09:59	60	12,01
2123746-007	Reply 7	11/05/2017 10:59	60	12,01
2123746-008	Reply 8	11/05/2017 17:59	60	12,01
2123746-009	Reply 9	11/05/2017 18:59	60	12,01
2123746-010	Reply 10	11/05/2017 19:59	60	12,01
2123746-011	Reply 11	17/05/2017 12:59	60	12,01
2123746-012	Reply 12	17/05/2017 14:59	60	12,01
2123746-013	Reply 13	17/05/2017 15:59	60	12,01
2123746-014	Reply 14	17/05/2017 16:59	60	12,01
2123746-015	Reply 15	17/05/2017 17:59	60	12,01
Notes: (1) The value of Carbon Dioxide reported refers to the values used to construct the QAL2 calibration function.				



## 13.4 AMMONIA REPORT

Sampling and Analysis Report - Ammonia							
Ammonia				EPA CTM 027:1997			
Auxiliary Parameter							
Velocity and Flow				UNI EN ISO 16911-1:2013 Annex A			
Oxygen (O <sub>2</sub> )				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 <sub>2</sub> SO <sub>4</sub> - 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 <sup>3</sup> ] <sup>(1)</sup>	Impinger G1 [mg]	Impinger G2 [mg]	Concentration [mg/Nm <sup>3</sup> ]
Method Blank		10/05/2017	/	/	0,000	0,000	/
2123746-001	Reply 1	10/05/2017 13:59	60	0,753	0,000	0,000	0,00
2123746-002	Reply 2	10/05/2017 14:59	60	0,690	0,450	0,080	0,77
2123746-003	Reply 3	10/05/2017 15:59	60	1,287	0,230	0,120	0,27
2123746-004	Reply 4	10/05/2017 17:59	60	0,972	0,200	0,100	0,31
2123746-005	Reply 5	10/05/2017 18:59	60	0,991	0,130	0,110	0,24
Method Blank		11/05/2017	/	/	0,000	0,000	/
2123746-006	Reply 6	11/05/2017 09:59	60	1,168	0,060	0,000	0,05
2123746-007	Reply 7	11/05/2017 10:59	60	1,148	0,000	0,000	0,00
2123746-008	Reply 8	11/05/2017 11:59	60	1,226	0,000	0,000	0,00
2123746-009	Reply 9	11/05/2017 12:59	60	1,209	0,120	0,000	0,10
2123746-010	Reply 10	11/05/2017 13:59	60	1,156	0,000	0,000	0,00
Method Blank		17/05/2017	/	/	0,000	0,000	/
2123746-011	Reply 11	17/05/2017 14:59	60	0,997	0,170	0,000	0,17
2123746-012	Reply 12	17/05/2017 15:59	60	0,869	0,200	0,000	0,23
2123746-013	Reply 13	17/05/2017 16:59	60	0,995	0,110	0,000	0,11
2123746-014	Reply 14	17/05/2017 17:59	60	0,955	0,060	0,000	0,06
2123746-015	Reply 15	17/05/2017 18:59	60	0,998	0,110	0,000	0,11

<sup>(1)</sup> For Blanks of the method is considered a volume of 1 m<sup>3</sup>

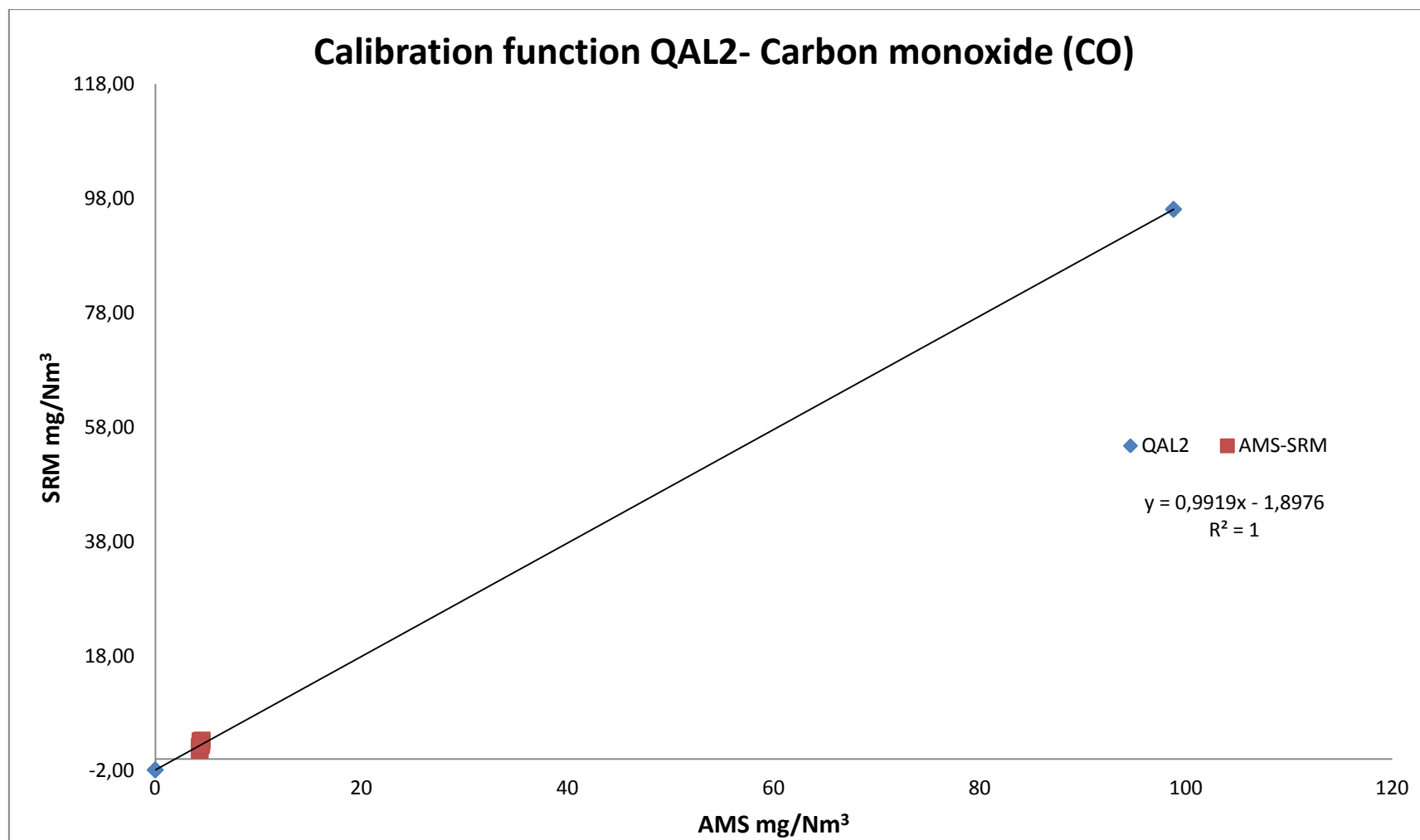




## 14 ANNEX 4 - QAL2 REPORT

### 14.1 CARBON MONOXIDE - QAL2

Parameter				CO		Emission Point			6C								
O <sub>2</sub> rif %	15	SRM				AMS							Calculations				
N. Test	DATE/TIME	Y <sub>i</sub>	Yi-Ym	O <sub>2</sub>	Y <sub>I,s</sub>	x <sub>i</sub>	O <sub>2</sub>	xi-xm	(xi-xm) <sup>2</sup>	(xi-xm)*(Yi-Ym)	ŷ <sub>i</sub>	ŷ <sub>I,s</sub>	D <sub>i</sub> = y <sub>i,s</sub> -ŷ <sub>i,s</sub>	D <sub>i</sub> -d̄	(D <sub>i</sub> -d̄) <sup>2</sup>		
1	10/5/17 13:59	2,67	-5,04	12,01	1,78	4,43	11,24	-5,25	27,60	26,50	2,50	1,54	0,24	0,15	0,02		
2	10/5/17 14:59	2,81	-4,90	12,00	1,88	4,49	11,13	-5,19	26,97	25,43	2,56	1,55	0,32	0,22	0,05		
3	10/5/17 15:59	2,89	-4,82	12,07	1,94	4,49	11,11	-5,19	26,94	25,01	2,56	1,55	0,39	0,29	0,08		
4	10/5/17 18:59	3,30	-4,41	12,23	2,26	4,55	11,16	-5,14	26,38	22,64	2,61	1,59	0,66	0,57	0,32		
5	10/5/17 19:59	3,21	-4,50	12,31	2,22	4,37	11,24	-5,32	28,30	23,91	2,43	1,49	0,72	0,63	0,39		
6	11/5/17 11:59	1,68	-6,03	12,33	1,16	4,28	11,16	-5,41	29,26	32,61	2,34	1,43	-0,27	-0,36	0,13		
7	11/5/17 12:59	1,67	-6,04	12,33	1,15	4,28	11,14	-5,40	29,21	32,64	2,35	1,43	-0,27	-0,37	0,14		
8	11/5/17 13:59	1,55	-6,15	12,34	1,08	4,30	11,15	-5,38	28,99	33,14	2,37	1,44	-0,37	-0,46	0,21		
9	11/5/17 14:59	1,72	-5,99	12,36	1,19	4,33	11,15	-5,35	28,62	32,05	2,40	1,46	-0,27	-0,37	0,14		
10	11/5/17 15:59	1,56	-6,14	13,02	1,18	4,34	11,16	-5,35	28,59	32,85	2,41	1,47	-0,29	-0,39	0,15		
11	17/5/17 13:59	2,42	-5,29	12,46	1,70	4,48	11,51	-5,21	27,12	27,57	2,54	1,61	0,09	-0,01	0,00		
12	17/5/17 14:59	2,28	-5,43	12,71	1,65	4,29	11,75	-5,40	29,11	29,30	2,36	1,53	0,12	0,02	0,00		
13	17/5/17 15:59	2,44	-5,27	12,51	1,72	4,40	11,63	-5,28	27,88	27,82	2,47	1,58	0,14	0,05	0,00		
14	17/5/17 16:59	2,37	-5,34	12,51	1,68	4,35	11,60	-5,34	28,51	28,49	2,41	1,54	0,14	0,04	0,00		
15	17/5/17 17:59	2,30	-5,41	12,52	1,62	4,36	11,39	-5,32	28,30	28,80	2,43	1,52	0,11	0,01	0,00		
16	zero	0,00	-7,71	15,00	0,00	0,10	15,00	-9,58	91,87	73,89	-1,80	-1,80					
17	span	96,18	88,47	15,00	96,18	98,80	15,00	89,12	7941,50	7884,10	96,10	96,10					
Average												0,10					
Sum									8455,15	8386,75					1,64		
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		110	Yaverage	7,71	x average	9,68	Z	/	Procedure for the determination of the calibration fuction								
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		16,5	m	0,992	i	-1,898	r	0,99956	Method C				Calibration Function				
Ys Max-Ys min		1,18	ŷs, max	1,61	Calibration Range				0 - 22 [mg/Nm3 rif O2]				Y= 0,992X -1,897				
Test of Variability																	
Maximum permissible uncertainty (95% confidence interval)		10	Test value for variability (k <sub>v</sub> )		0,9761	σ0kv		5,478	Result of Variability Test (s <sub>0</sub> ≤σ <sub>0kv</sub> )								
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,342647	Standard Deviation (σ <sub>0</sub> )		5,61	Experimental Confidence interval [%]		0,61	Positive								

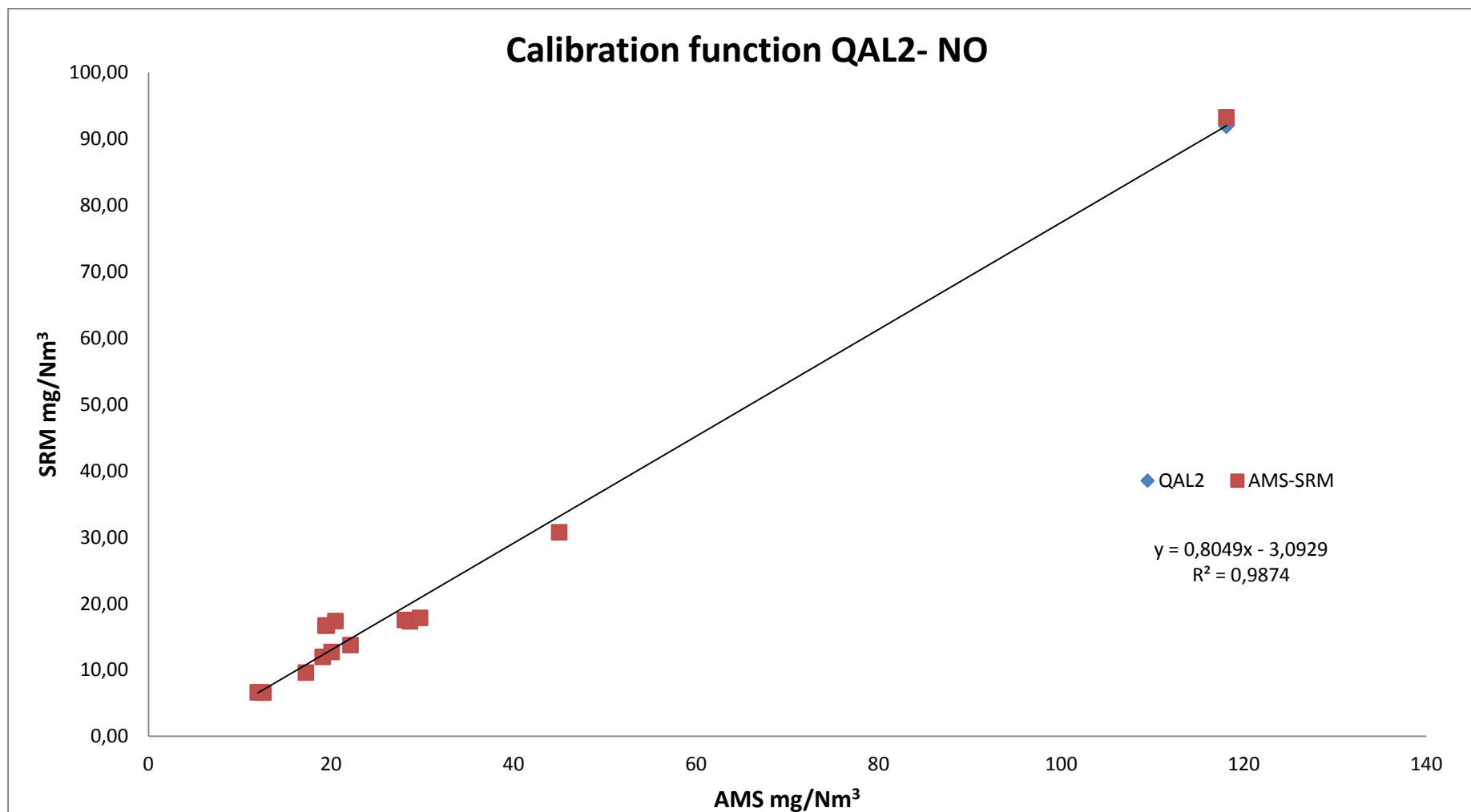




## 14.2 NITROGEN OXIDE - QAL2

Parameter				NO			Emission Point			6C					
O2 rif %	15	SRM				AMS							Calculations		
N. Test	DATE/TIME	Y <sub>i</sub>	Yi-Ym	O <sub>2</sub>	Y <sub>i,s</sub>	X <sub>i</sub>	O <sub>2</sub>	xi-xm	(xi-xm) <sup>2</sup>	(xi-xm)*(Yi-Ym)	ŷ <sub>i</sub>	ŷ <sub>i,s</sub>	D <sub>i</sub> = y <sub>i,s</sub> -ŷ <sub>i,s</sub>	D <sub>i</sub> -đ	(D <sub>i</sub> -đ) <sup>2</sup>
1	10/5/17 13:59	16,69	-3,00	12,01	11,15	19,40	11,24	-8,90	79,27	26,69	12,52	7,70	3,45	2,05	4,22
2	10/5/17 14:59	17,37	-2,32	12,00	11,58	20,49	11,13	-7,82	61,11	18,15	13,40	8,14	3,44	2,05	4,19
3	10/5/17 15:59	16,70	-2,99	12,07	11,22	19,55	11,11	-8,75	76,63	26,17	12,65	7,67	3,55	2,15	4,64
4	10/5/17 18:59	11,98	-7,71	12,23	8,19	19,10	11,16	-9,21	84,82	71,05	12,28	7,49	0,70	-0,69	0,48
5	10/5/17 19:59	9,61	-10,08	12,31	6,63	17,26	11,24	-11,05	122,12	111,37	10,80	6,63	0,00	-1,39	1,94
6	11/5/17 9:59	6,59	-13,10	12,39	4,59	12,61	11,13	-15,70	246,43	205,71	7,06	4,29	0,30	-1,09	1,19
7	11/5/17 10:59	6,62	-13,07	12,42	4,63	12,36	11,15	-15,95	254,43	208,55	6,85	4,17	0,46	-0,94	0,88
8	11/5/17 17:59	6,64	-13,05	12,93	4,94	11,99	11,53	-16,32	266,35	213,01	6,55	4,15	0,78	-0,61	0,38
9	11/5/17 18:59	13,75	-5,94	12,41	9,60	22,14	11,17	-6,16	37,99	36,59	14,73	8,99	0,61	-0,78	0,61
10	11/5/17 19:59	12,71	-6,98	12,33	8,80	20,07	11,06	-8,23	67,76	57,43	13,07	7,88	0,92	-0,48	0,23
11	17/5/17 12:59	93,24	73,55	13,38	73,44	118,10	12,70	89,79	8062,97	6604,22	91,97	66,48	6,95	5,56	30,90
12	17/5/17 14:59	30,74	11,05	12,71	22,25	45,01	11,75	16,70	279,03	184,56	33,14	21,49	0,75	-0,64	0,41
13	17/5/17 15:59	17,54	-2,15	12,51	12,40	28,11	11,63	-0,20	0,04	0,42	19,53	12,51	-0,11	-1,51	2,27
14	17/5/17 16:59	17,33	-2,36	12,51	12,25	28,65	11,60	0,34	0,12	-0,81	19,97	12,75	-0,50	-1,89	3,58
15	17/5/17 17:59	17,85	-1,84	12,52	12,63	29,76	11,39	1,45	2,11	-2,68	20,86	13,02	-0,40	-1,79	3,20
Average													1,39		
Sum									9641,2	7760,4					59,11
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		55	Yaverage	19,69	x average	28,31	Z	//	Procedure for the determination of the calibration fuction						
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		8,25	m	0,805	i	-3,093	r	0,994	Method A				Calibration Function		
Ys Max-Ys min		68,85	ŷs, max	66,48	Calibration Range				0 - 73,13 [mg/Nm3 rif O2]				Y= 0,805X -3,093		
Test of Variability															
Maximum permissible uncertainty (95% confidence interval)		20	Test value for variability (k <sub>v</sub> )		0,9761	σ0kv		5,478	Result of Variability Test (s <sub>0</sub> ≤σ <sub>0</sub> k <sub>v</sub> )						
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		2,054703	Standard Deviation (σ <sub>0</sub> )		5,61	Experimental Confidence interval [%]		7,32	Positive						

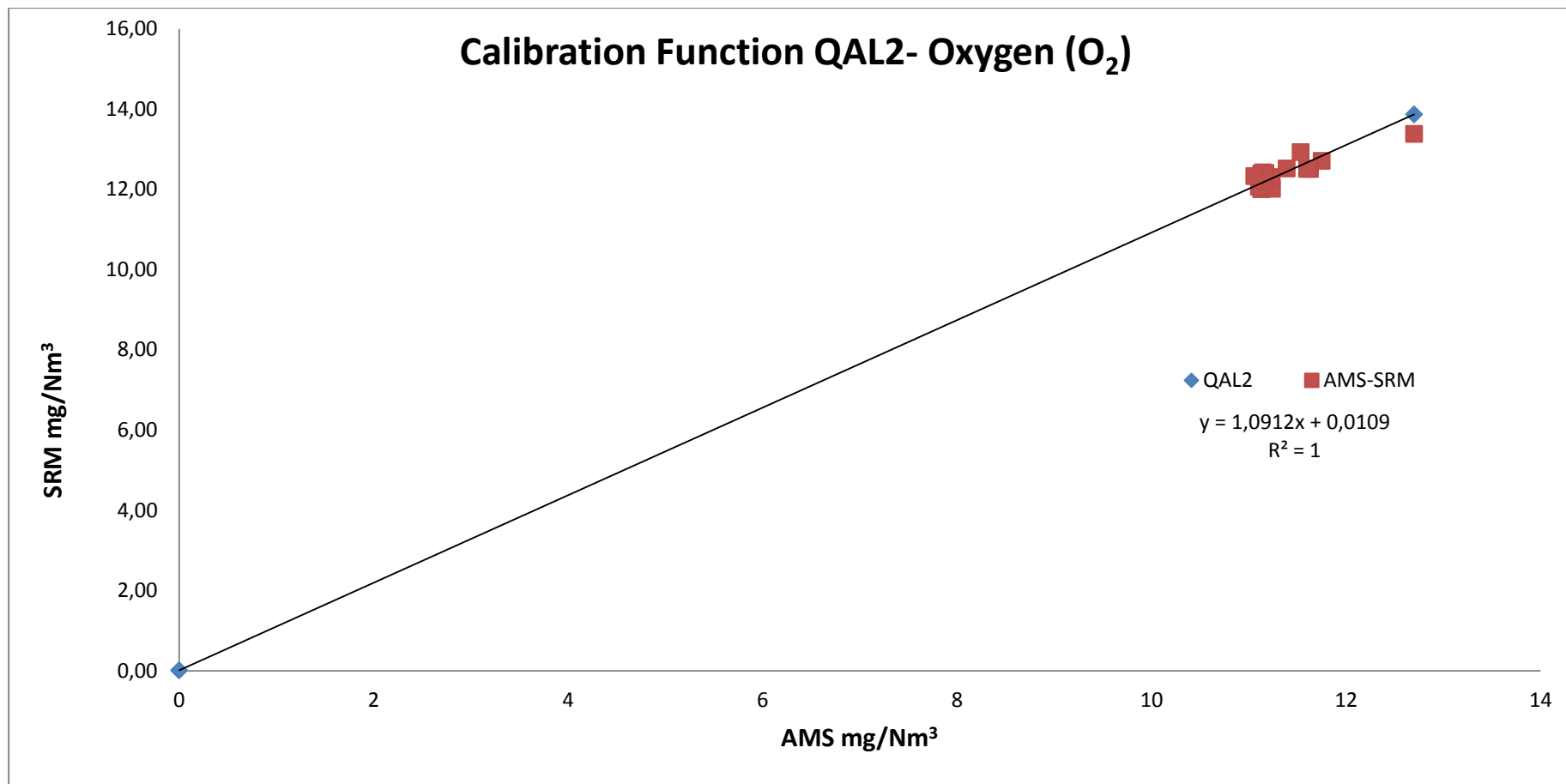






## 14.3 OXYGEN - QAL2

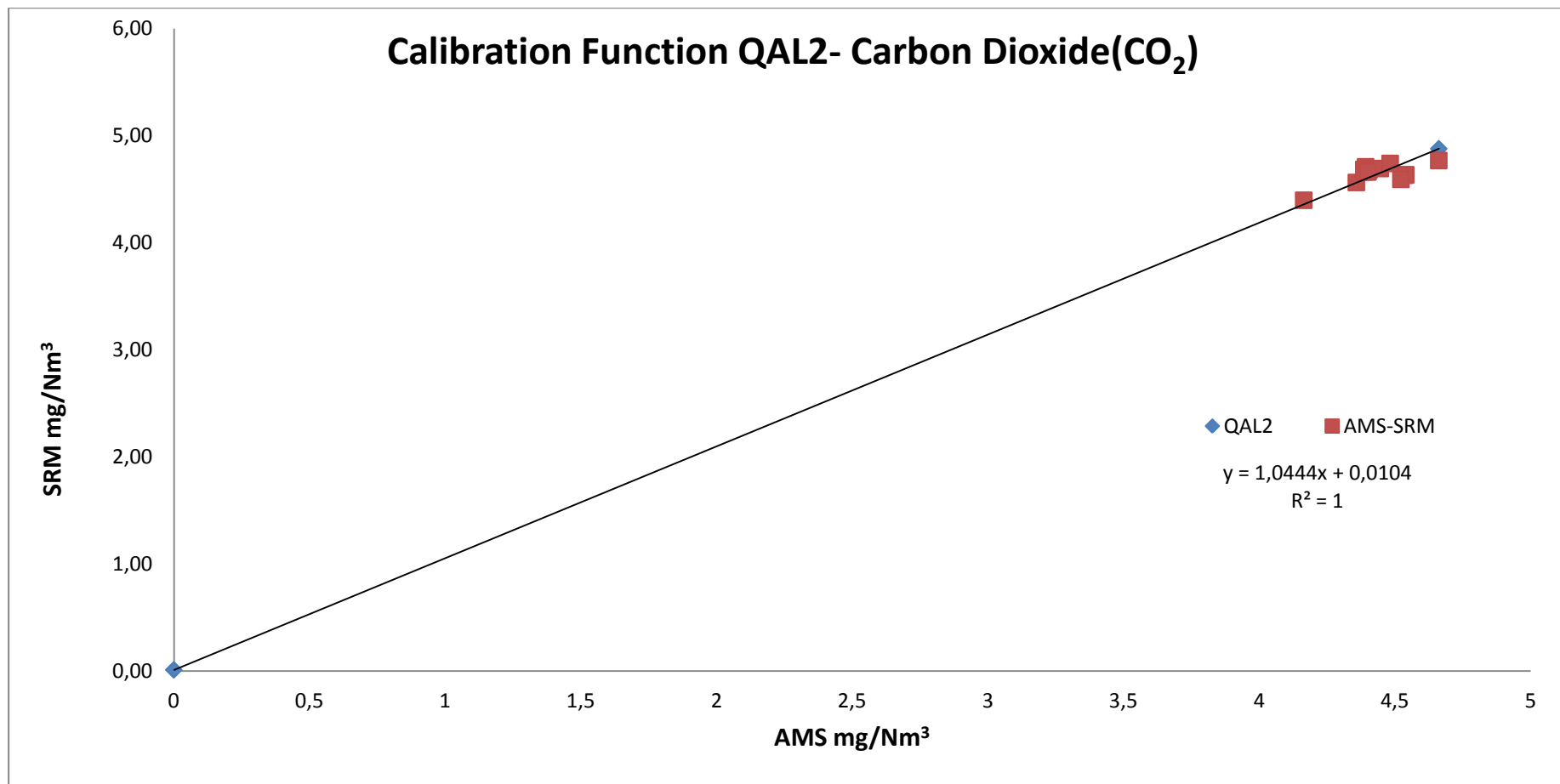
Parameter				O <sub>2</sub>		Emission Point			6C								
O2 rif %	15	SRM				AMS						Calculations					
N. Test	DATE/TIME	Y <sub>i</sub>	Yi-Ym	O <sub>2</sub>	Y <sub>i,s</sub>	x <sub>i</sub>	O <sub>2</sub>	xi-xm	(xi-xm) <sup>2</sup>	(xi-xm)*(Yi-Ym)	ŷ <sub>i</sub>		D <sub>i</sub> = y <sub>i,s</sub> -ŷ <sub>i,s</sub>	D <sub>i</sub> -đ	(D <sub>i</sub> -đ) <sup>2</sup>		
1	10/5/17 13:59	12,01	-0,43			11,24		-0,16	0,03	0,07	12,27		-0,26	-0,26	0,07		
2	10/5/17 14:59	12,00	-0,45			11,13		-0,27	0,07	0,12	12,15		-0,15	-0,15	0,02		
3	10/5/17 15:59	12,07	-0,38			11,11		-0,29	0,09	0,11	12,13		-0,06	-0,06	0,00		
4	10/5/17 18:59	12,23	-0,22			11,16		-0,24	0,06	0,05	12,19		0,04	0,04	0,00		
5	10/5/17 19:59	12,31	-0,14			11,24		-0,16	0,03	0,02	12,27		0,04	0,04	0,00		
6	11/5/17 9:59	12,39	-0,06			11,13		-0,27	0,07	0,02	12,15		0,24	0,24	0,06		
7	11/5/17 10:59	12,42	-0,03			11,15		-0,25	0,06	0,01	12,17		0,25	0,25	0,06		
8	11/5/17 17:59	12,93	0,48			11,53		0,14	0,02	0,07	12,60		0,33	0,33	0,11		
9	11/5/17 18:59	12,41	-0,04			11,17		-0,23	0,05	0,01	12,20		0,21	0,21	0,04		
10	11/5/17 19:59	12,33	-0,12			11,06		-0,34	0,12	0,04	12,08		0,25	0,25	0,06		
11	17/5/17 12:59	13,38	0,93			12,70		1,30	1,69	1,22	13,87		-0,49	-0,49	0,24		
12	17/5/17 14:59	12,71	0,26			11,75		0,35	0,12	0,09	12,83		-0,12	-0,12	0,01		
13	17/5/17 15:59	12,51	0,06			11,63		0,23	0,05	0,01	12,70		-0,19	-0,19	0,04		
14	17/5/17 16:59	12,51	0,06			11,60		0,20	0,04	0,01	12,67		-0,16	-0,16	0,03		
15	17/5/17 17:59	12,52	0,07			11,39		-0,01	0,00	0,00	12,44		0,08	0,08	0,01		
Average												0,00					
Sum									2,50		1,85				0,75		
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		21	Yaverage	12,45	x average	11,40	Z	-0,01	Procedure for the determination of the calibration fuction								
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		3,15	m	1,091	i	0,011	r	0,86913519	Method B				Calibration Function				
Ys Max-Ys min		1,38	ŷs, max	13,87	Calibration Range				0 - 15,26 [mg/Nm3 rif O2]				Y= 1,091X + 0,01				
Test of Variability																	
Maximum permissible uncertainty (95% confidence interval)		10	Test value for variability (k <sub>v</sub> )		0,9761	σ0kv		1,046	Result of Variability Test (s <sub>0</sub> ≤σ <sub>0</sub> k <sub>v</sub> )								
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,231994	Standard Deviation (σ <sub>0</sub> )		1,07	Experimental Confidence interval [%]		2,17	Positive								





## 14.4 CARBON DIOXIDE – QAL2

Parameter				CO <sub>2</sub>		Emission Point			6C								
O2 rif %	15	SRM				AMS						Calculations					
N. Test	DATE/TIME	Y <sub>i</sub>	Yi-Ym	O <sub>2</sub>	Y <sub>i,s</sub>	x <sub>i</sub>	O <sub>2</sub>	xi-xm	(xi-xm) <sup>2</sup>	(xi-xm)*(Yi-Ym)	ŷ <sub>i</sub>		D <sub>i</sub> = y <sub>i,s</sub> -ŷ <sub>i,s</sub>	D <sub>i</sub> -đ	(D <sub>i</sub> -đ) <sup>2</sup>		
1	10/5/17 13:59	4,64	-0,01			4,54		0,10	0,01	0,00	4,75		-0,11	-0,11	0,01		
2	10/5/17 14:59	4,64	-0,01			4,54		0,10	0,01	0,00	4,75		-0,12	-0,12	0,01		
3	10/5/17 15:59	4,63	-0,02			4,54		0,09	0,01	0,00	4,75		-0,12	-0,12	0,01		
4	10/5/17 18:59	4,59	-0,06			4,52		0,08	0,01	0,00	4,73		-0,14	-0,14	0,02		
5	10/5/17 19:59	4,56	-0,08			4,36		-0,08	0,01	0,01	4,56		0,00	0,00	0,00		
6	11/5/17 9:59	4,71	0,06			4,39		-0,05	0,00	0,00	4,60		0,11	0,11	0,01		
7	11/5/17 10:59	4,68	0,03			4,41		-0,04	0,00	0,00	4,61		0,07	0,07	0,01		
8	11/5/17 17:59	4,40	-0,25			4,16		-0,28	0,08	0,07	4,36		0,04	0,04	0,00		
9	11/5/17 18:59	4,69	0,05			4,45		0,01	0,00	0,00	4,65		0,04	0,04	0,00		
10	11/5/17 19:59	4,74	0,09			4,48		0,04	0,00	0,00	4,69		0,05	0,05	0,00		
11	17/5/17 12:59	4,77	0,12			4,66		0,22	0,05	0,03	4,88		-0,11	-0,11	0,01		
12	17/5/17 14:59	4,69	0,04			4,39		-0,06	0,00	0,00	4,59		0,10	0,10	0,01		
13	17/5/17 15:59	4,66	0,01			4,39		-0,05	0,00	0,00	4,59		0,07	0,07	0,01		
14	17/5/17 16:59	4,67	0,02			4,40		-0,04	0,00	0,00	4,60		0,06	0,06	0,00		
15	17/5/17 17:59	4,66	0,01			4,40		-0,04	0,00	0,00	4,61		0,06	0,06	0,00		
Average												0,00					
Sum									0,18	0,09		0,12					
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		25	Yaverage	4,65	x average	4,44	Z	-0,01	Procedure for the determination of the calibration fuction								
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		3,75	m	1,044	i	0,010	r	0,64762436	Method B			Calibration Function					
Ys Max-Ys min		0,37	ŷs, max	4,88	Calibration Range			0 - 5,37 [mg/Nm3 rif O <sub>2</sub> ]			Y= 1,044X + 0,01						
Test of Variability																	
Maximum permissible uncertainty (95% confidence interval)		10	Test value for variability (k <sub>v</sub> )		0,9761	σ0kv		1,245	Result of Variability Test (s <sub>p</sub> ≤σ <sub>0</sub> k <sub>v</sub> )								
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,09133	Standard Deviation (σ <sub>0</sub> )		1,28	Experimental Confidence interval [%]		0,72	Positive								



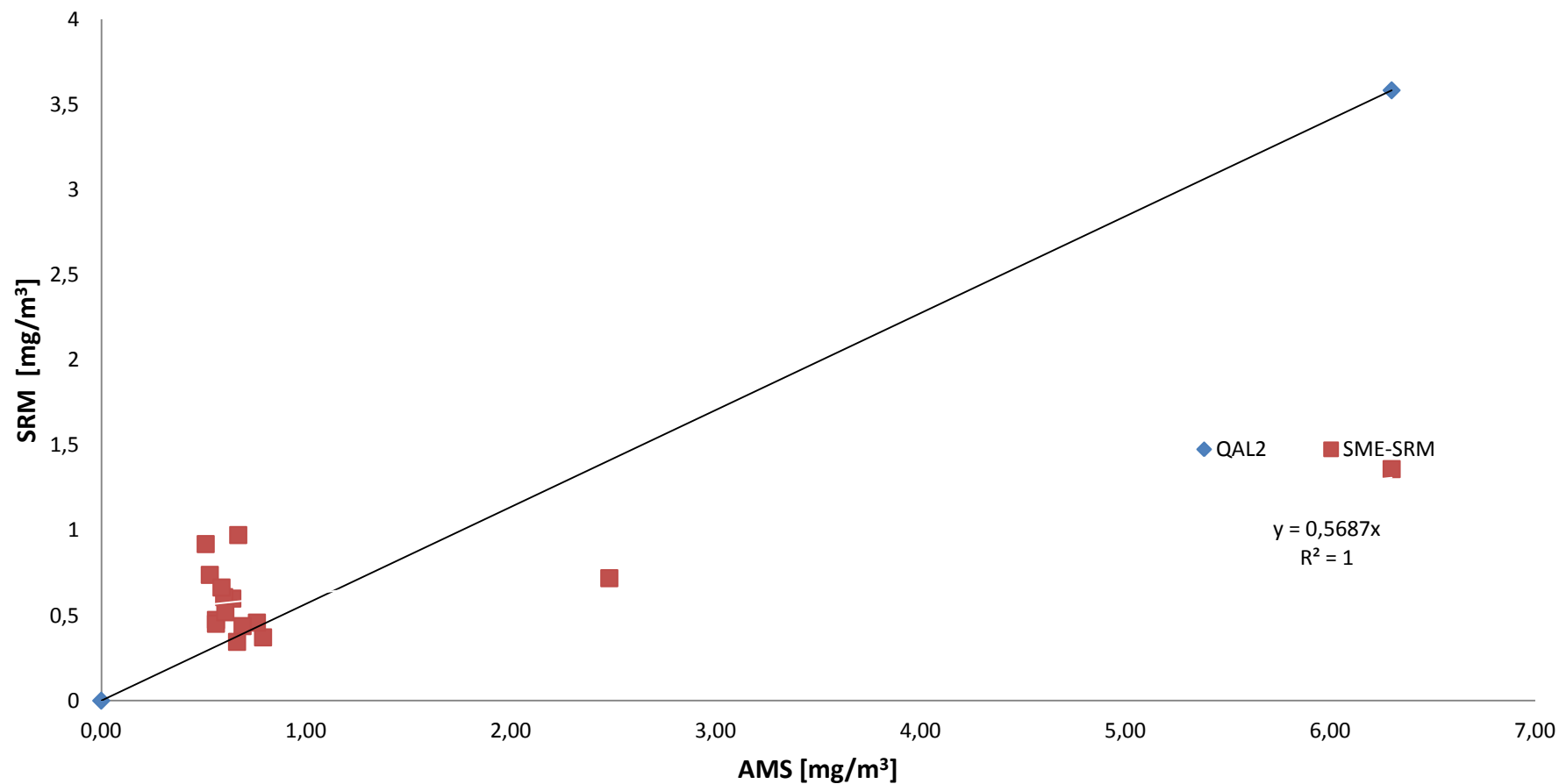


## 14.5 DUST – QAL2

Parameter								Dust		Emission Point					6C						
O <sub>2</sub> rif. %	15	SRM							AMS										Calculations		
N. Test	DATE/TIME	Y <sub>i</sub> [mg/m <sup>3</sup> ]	O <sub>2</sub> [%vol]	T [°C]	P [KPa]	U [%]	Y <sub>i</sub> -Y <sub>m</sub>	Y <sub>i,s</sub> [mg/Nm <sup>3</sup> ]	x <sub>i</sub> [mg/m3]	O <sub>2</sub> [%vol]	T [°C]	P [hPa]	U [%]	x <sub>i</sub> -x <sub>m</sub>	(x <sub>i</sub> -x <sub>m</sub> ) <sup>2</sup>	(x <sub>i</sub> -x <sub>m</sub> )* (Y <sub>i</sub> -Y <sub>m</sub> )	Ŷ <sub>i</sub> [mg/m <sup>3</sup> ]	Ŷ <sub>i,s</sub> [mg/Nm <sup>3</sup> ]	D <sub>i</sub> = Y <sub>i,s</sub> - Ŷ <sub>i,s</sub>	D <sub>i</sub> -d̄	(D <sub>i</sub> - d̄) <sup>2</sup>
1	10/05/2017 13:59	0,92	12,01	165,40	101,19	8,28	0,28	1,08	0,51	11,24	165,52	992,25	9,99	-0,62	0,38	-0,17	0,29	0,32	0,75	0,68	0,46
2	10/05/2017 14:59	0,74	12,00	164,40	101,05	9,21	0,10	0,87	0,53	11,13	165,32	992,12	10,03	-0,60	0,36	-0,06	0,30	0,33	0,54	0,47	0,22
3	10/05/2017 15:59	0,47	12,07	165,70	101,13	8,43	-0,17	0,56	0,56	11,11	165,14	991,97	10,05	-0,57	0,32	0,10	0,32	0,35	0,21	0,14	0,02
4	10/05/2017 17:59	0,60	12,16	165,60	100,86	10,92	-0,04	0,74	0,64	11,12	165,10	991,93	10,08	-0,49	0,24	0,02	0,36	0,40	0,33	0,26	0,07
5	10/05/2017 18:59	0,61	12,23	165,50	100,83	9,05	-0,03	0,74	0,60	11,16	165,19	991,87	10,08	-0,53	0,28	0,02	0,34	0,38	0,36	0,29	0,08
6	11/05/2017 09:59	0,37	12,39	163,10	100,63	9,97	-0,27	0,46	0,79	11,13	162,89	991,47	9,64	-0,34	0,12	0,09	0,45	0,49	-0,03	-0,10	0,01
7	11/05/2017 10:59	0,46	12,42	163,10	100,81	10,24	-0,18	0,57	0,76	11,15	162,79	991,61	9,62	-0,37	0,14	0,07	0,43	0,47	0,10	0,03	0,00
8	11/05/2017 11:59	0,44	12,33	161,80	100,83	8,10	-0,20	0,53	0,69	11,16	161,67	991,66	9,66	-0,44	0,19	0,09	0,39	0,43	0,10	0,03	0,00
9	11/05/2017 12:59	1,36	12,33	163,10	100,86	9,62	0,72	1,67	6,30	11,14	162,75	991,67	9,67	5,17	26,73	3,71	3,58	3,93	-2,26	-2,33	5,45
10	11/05/2017 13:59	0,45	12,34	162,70	100,70	10,50	-0,19	0,56	0,56	11,15	162,84	991,61	9,74	-0,57	0,32	0,11	0,32	0,35	0,21	0,14	0,02
11	17/05/2017 14:59	0,72	12,71	161,30	101,68	10,85	0,08	0,92	2,48	11,75	160,17	993,05	8,86	1,35	1,82	0,10	1,41	1,62	-0,70	-0,77	0,59
12	17/05/2017 15:59	0,97	12,51	164,20	101,53	8,70	0,33	1,20	0,67	11,63	158,88	993,03	9,43	-0,46	0,21	-0,15	0,38	0,43	0,77	0,70	0,49
13	17/05/2017 16:59	0,35	12,51	160,80	101,53	7,29	-0,30	0,42	0,66	11,60	158,35	992,95	9,39	-0,47	0,22	0,14	0,38	0,43	-0,01	-0,08	0,01
14	17/05/2017 17:59	0,52	12,52	159,40	101,54	8,36	-0,12	0,63	0,61	11,39	159,80	992,88	9,46	-0,52	0,27	0,06	0,34	0,38	0,25	0,18	0,03
15	17/05/2017 18:59	0,66	12,56	159,60	101,45	8,38	0,02	0,82	0,59	11,42	160,71	992,88	9,62	-0,54	0,29	-0,01	0,33	0,38	0,44	0,37	0,14
Average																			0,07		
Sum															31,91	4,11					7,59
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		5	Yaverage	0,64	x average	1,13	Z	/	Procedure for the determination of the calibration fuction								Calibration Function				
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		0,75	m	0,57	i	0,000	r	0,72	Method B								<b>Y= 0,568X + 0</b>				
Ys Max-Ys min		1,25	ŷs, max	3,93	Calibration Range				0 - 4,33 [mg/Nm3 rif O2]												
Test of Variability																					
Maximum permissible uncertainty (95% confidence interval)		30	Test value for variability (k <sub>v</sub> )			0,9761	σ0kv			0,747	Result of Variability Test (s <sub>p</sub> ≤σ <sub>0</sub> k <sub>v</sub> )										
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,736	Standard Deviation (σ <sub>0</sub> )			0,77	Experimental Confidence interval [%]			28,87	Positive										
Note: Method B was used to process the results in order to obtain a proper calibration function.																					



## Calibration function QAL2- Dust







## 15 ANNEX 5 – IAR REPORT

### 15.1 WATER VAPOUR - IAR

Parameter		Water Vapour		
N. Test	DATE/TIME	SRM [%]	AMS [%]	Absolute Differences ( $X_i$ )
1	10/5/17 13:59	8,3	10,0	2
2	10/5/17 14:59	9,2	10,0	1
3	10/5/17 15:59	8,4	10,1	2
4	10/5/17 17:59	10,9	10,1	1
5	10/5/17 18:59	9	10	1
Average		9,2	10,0	1,2
t student $0,95 (N-1)$		2,78		
Standard Deviation ( $S_D$ )		0,43		
Confidence Interval ( $I_c$ )		0,53		
I.A.R		81,1		

### 15.2 TEMPERATURE - IAR

Parameter		Temperature		
N. Test	DATE/TIME	SRM [°C]	AMS [°C]	Absolute Differences ( $X_i$ )
1	10/5/17 13:59	165	166	0
2	10/5/17 14:59	164	165	1
3	10/5/17 15:59	166	165	1
4	10/5/17 17:59	166	165	1
5	10/5/17 18:59	166	165	0
Average		165	165	0,5
t student $0,95 (N-1)$		2,78		
Standard Deviation ( $S_D$ )		0,30		
Confidence Interval ( $I_c$ )		0,37		
I.A.R		99,5		



### 15.3 PRESSURE - IAR

Parameter		Pressure		
N. Test	DATE/TIME	SRM [hPa]	SME [hPa]	Absolute Differences (X <sub>i</sub> )
1	10/5/17 13:59	1012	992	20
2	10/5/17 14:59	1011	992	18
3	10/5/17 15:59	1011	992	19
4	10/5/17 17:59	1009	992	17
5	10/5/17 18:59	1008	992	16
Average		1010	992	18
t student 0,95 (N-1)		2,78		
Standard Deviation (S <sub>D</sub> )		1,49		
Confidence Interval (I <sub>C</sub> )		1,84		
<b>I.A.R</b>		<b>98,0</b>		

### 15.4 FLOW - IAR

Parameter			Flow	
N. Test	DATE/TIME	SRM [Nm <sup>3</sup> /h]	AMS [Nm <sup>3</sup> /h]	Absolute Differences (X <sub>i</sub> )
1	11/5/17 9:59	142301	163071	20770
2	11/5/17 10:59	147627	162805	15179
3	11/5/17 11:59	147320	162865	15545
4	11/5/17 12:59	147277	162835	15558
5	11/5/17 13:59	147477	163212	15735
Average		146400,43	162957,66	16557
t student 0,95 (N-1)		2,78		
Standard Deviation (S <sub>D</sub> )		2363,57		
Confidence Interval (I <sub>C</sub> )		2934,76		
<b>I.A.R</b>		<b>86,7</b>		



## 16 ANNEX 6 – QAL1 CERTIFIED SRM ANALYZER

	
<h1>CERTIFICATE</h1> <p>on Product Conformity (QAL1)</p>	
Certificate No.: 0000032301	
<b>Certified AMS:</b>	PG-350E for NO <sub>x</sub> , SO <sub>2</sub> , CO, CO <sub>2</sub> and O <sub>2</sub>
<b>Manufacturer:</b>	HORIBA Europe GmbH Julius-Kronenberg-Str. 9 42799 Leichlingen Germany
<b>Test Institute:</b>	TÜV Rheinland Energie und Umwelt GmbH
<p><b>This is to certify that the AMS has been tested and found to comply with:</b></p> <p><b>EN 15267-1: 2009, EN 15267-2: 2009, EN 15267-3: 2007 and EN 14181: 2004</b></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"><li>• EN 15267-3 tested</li><li>• QAL1 certified</li><li>• TÜV approved</li><li>• Annual inspection</li></ul>	
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
<a href="http://www.umwelt-tuv.de">www.umwelt-tuv.de</a> / <a href="http://www.eco-tuv.com">www.eco-tuv.com</a> 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
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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<sub>x</sub>, SO<sub>2</sub>, CO, CO<sub>2</sub> and O<sub>2</sub>

**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 <sub>x</sub>	0 - 205 <sup>1)</sup>	0 - 2050 <sup>2)</sup>	mg/m <sup>3</sup>
SO <sub>2</sub>	0 - 143	0 - 1430	mg/m <sup>3</sup>
CO	0 - 75	0 - 1250	mg/m <sup>3</sup>
CO <sub>2</sub>	0 - 20	-	Vol.-%
O <sub>2</sub>	0 - 25	0 - 10	Vol.-%

<sup>1)</sup> as NO<sub>2</sub>, this corresponds to apx 0 - 134 mg/m<sup>3</sup> NO

<sup>2)</sup> as NO<sub>2</sub>, this corresponds to apx. 0 - 1340 mg/m<sup>3</sup> NO

**Software version:**

P2000788001D / 1.11

**Restrictions:**

None

**Notes:**

1. The maintenance interval is four weeks.
2. The certification range for the component SO<sub>2</sub> 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 SO<sub>2</sub> 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 <sub>x</sub>	Chemiluminescence
CO, SO <sub>2</sub> , CO <sub>2</sub>	Non-dispersive absorption (NDIR) Infrared
O <sub>2</sub>	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](http://qal1.de).

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

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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

SO<sub>2</sub>  
Certification range 0 - 143 mg/m<sup>3</sup>

Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point 0.54 mg/m<sup>3</sup>  
Sum of negative CS at zero point -0.69 mg/m<sup>3</sup>  
Sum of positive CS at reference point 0.70 mg/m<sup>3</sup>  
Sum of negative CS at reference point -2.60 mg/m<sup>3</sup>  
Maximum sum of cross sensitivities -2.60 mg/m<sup>3</sup>  
Uncertainty of cross sensitivity -1.503 mg/m<sup>3</sup>

Calculation of the combined standard uncertainty

Tested parameter

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

\* The larger value is used:

"Repeatability standard deviation at span" or

"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u<sub>c</sub>)  $u_c = \sqrt{\sum (u_{max,i})^2}$  4.23 mg/m<sup>3</sup>  
Total expanded uncertainty  $U = u_c \cdot k = u_c \cdot 1.96$  8.30 mg/m<sup>3</sup>

Relative total expanded uncertainty

U in % of the ELV 60 mg/m<sup>3</sup> 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/m<sup>3</sup>

15.0







			
<b>Certificate:</b> 0000032301 / 22 March 2013			
<b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b>			
<b>Measuring system</b>			
Manufacturer	Horiba Europe GmbH		
Name of measuring system	PG-350E		
Serial number of the candidates	VC4DFKB0 / XL7LTUL1		
Measuring principle	NDIR		
<b>Test report</b>			
Test laboratory	TÜV Rheinland		
Date of report	2012-10-08		
<b>Measured component</b>		CO	
Certification range	0 - 75 mg/m <sup>3</sup>		
<b>Evaluation of the cross sensitivity (CS)</b> (system with largest CS)			
Sum of positive CS at zero point	0.00 mg/m <sup>3</sup>		
Sum of negative CS at zero point	0.00 mg/m <sup>3</sup>		
Sum of positive CS at reference point	0.50 mg/m <sup>3</sup>		
Sum of negative CS at reference point	-0.65 mg/m <sup>3</sup>		
Maximum sum of cross sensitivities	-0.65 mg/m <sup>3</sup>		
Uncertainty of cross sensitivity	-0.377 mg/m <sup>3</sup>		
<b>Calculation of the combined standard uncertainty</b>			
<b>Tested parameter</b>			
Standard deviation from paired measurements under field conditions *	$u_D$	mg/m <sup>3</sup>	0.356 (mg/m <sup>3</sup> ) <sup>2</sup>
Lack of fit	$u_{of}$	mg/m <sup>3</sup>	0.070 (mg/m <sup>3</sup> ) <sup>2</sup>
Zero drift from field test	$u_{z,d}$	mg/m <sup>3</sup>	0.706 (mg/m <sup>3</sup> ) <sup>2</sup>
Span drift from field test	$u_{s,d}$	-0.675 mg/m <sup>3</sup>	0.456 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of ambient temperature at span	$u_t$	0.868 mg/m <sup>3</sup>	0.750 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of supply voltage	$u_v$	0.288 mg/m <sup>3</sup>	0.082 (mg/m <sup>3</sup> ) <sup>2</sup>
Cross sensitivity (interference)	$u_i$	mg/m <sup>3</sup>	0.142 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of sample gas flow	$u_p$	mg/m <sup>3</sup>	0.001 (mg/m <sup>3</sup> ) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	$u_{rm}$	mg/m <sup>3</sup>	0.368 (mg/m <sup>3</sup> ) <sup>2</sup>
* 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 <sup>3</sup>
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$		3.35 mg/m <sup>3</sup>
<b>Relative total expanded uncertainty</b>		<b>U in % of the ELV 50 mg/m<sup>3</sup></b>	
Requirement of 2000/76/EC and 2001/80/EC		10.0	
Requirement of EN 15267-3		7.5	

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	<p align="center"><b>Certificate:</b> 0000032301 / 22 March 2013</p>	
<p><b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b></p>		
<b>Measuring system</b>		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB9 / XL7LTUL1	
Measuring principle	NDIR	
<b>Test report</b>	21217617/A	
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
<b>Measured component</b>	CO <sub>2</sub>	
Certification range	0 - 20 Vol.-%	
<b>Evaluation of the cross sensitivity (CS)</b> (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.-%
<b>Calculation of the combined standard uncertainty</b>		
<b>Tested parameter</b>		<b>U<sup>2</sup></b>
Standard deviation from paired measurements under field conditions *	U <sub>D</sub>	Vol.-% 0.000 (Vol.-%) <sup>2</sup>
Lack of fit	U <sub>LOF</sub>	Vol.-% 0.013 (Vol.-%) <sup>2</sup>
Zero drift from field test	U <sub>ZD</sub>	Vol.-% 0.071 (Vol.-%) <sup>2</sup>
Span drift from field test	U <sub>SD</sub>	0.238 Vol.-% 0.057 (Vol.-%) <sup>2</sup>
Influence of ambient temperature at span	U <sub>t</sub>	0.115 Vol.-% 0.013 (Vol.-%) <sup>2</sup>
Influence of supply voltage	U <sub>v</sub>	0.051 Vol.-% 0.003 (Vol.-%) <sup>2</sup>
Cross sensitivity (interference)	U <sub>i</sub>	Vol.-% 0.004 (Vol.-%) <sup>2</sup>
Influence of sample gas flow	U <sub>g</sub>	Vol.-% 0.000 (Vol.-%) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	U <sub>rm</sub>	Vol.-% 0.026 (Vol.-%) <sup>2</sup>
* The larger value is used : "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"		
Combined standard uncertainty (u <sub>c</sub> )	$u_c = \sqrt{\sum (u_{max,i})^2}$	0.43 Vol.-%
Total expanded uncertainty	$U = u_c \cdot k = u_c \cdot 1.96$	0.85 Vol.-%
<b>Relative total expanded uncertainty</b>	<b>U in % of the range 20 Vol.-%</b>	<b>4.2</b>
Requirement of 2000/76/EC and 2001/80/EC	<b>U in % of the range 20 Vol.-%</b>	<b>10.0**</b>
Requirement of EN 15267-3	<b>U in % of the range 20 Vol.-%</b>	<b>7.5</b>
** 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.		
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Umwelt Bundes Amt For our Environment		Certificate: 0000032301 / 22 March 2013		TÜVRheinland® Precisely Right.	
<b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b>					
<b>Measuring system</b>					
Manufacturer	Horiba Europe GmbH				
Name of measuring system	PG-350E				
Serial number of the candidates	VC4DFKB9 / XL7LTUL1				
Measuring principle	Paramagnetism				
<b>Test report</b>		21217617/A			
Test laboratory	TÜV Rheinland				
Date of report	2012-10-08				
<b>Measured component</b>		O <sub>2</sub>			
Certification range	0 - 25 Vol.-%				
<b>Evaluation of the cross sensitivity (CS)</b> (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.-%				
<b>Calculation of the combined standard uncertainty</b>					
<b>Tested parameter</b>		<b>u<sup>2</sup></b>			
Standard deviation from paired measurements under field conditions *	u <sub>D</sub>	Vol.-%	0.004	(Vol.-%) <sup>2</sup>	
Lack of fit	u <sub>lof</sub>	Vol.-%	0.000	(Vol.-%) <sup>2</sup>	
Zero drift from field test	u <sub>dz</sub>	Vol.-%	0.006	(Vol.-%) <sup>2</sup>	
Span drift from field test	u <sub>ds</sub>	0.092 Vol.-%	0.008	(Vol.-%) <sup>2</sup>	
Influence of ambient temperature at span	u <sub>t</sub>	0.064 Vol.-%	0.007	(Vol.-%) <sup>2</sup>	
Influence of supply voltage	u <sub>v</sub>	0.018 Vol.-%	0.000	(Vol.-%) <sup>2</sup>	
Cross sensitivity (Interference)	u <sub>i</sub>	Vol.-%	0.000	(Vol.-%) <sup>2</sup>	
Influence of sample gas flow	u <sub>g</sub>	Vol.-%	0.000	(Vol.-%) <sup>2</sup>	
Uncertainty of reference material at 70% of certification range	u <sub>rm</sub>	Vol.-%	0.041	(Vol.-%) <sup>2</sup>	
* The larger value is used : "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"					
Combined standard uncertainty (u <sub>c</sub> )		$u_c = \sqrt{\sum (u_{max,i})^2}$		0.26	Vol.-%
Total expanded uncertainty		$U = u_c \cdot k = u_c \cdot 1.96$		0.51	Vol.-%
<b>Relative total expanded uncertainty</b>					
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.					
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## 17 ANNEX 7 – 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](http://www.tetratec.de) · [info@tetratec.de](mailto: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.





Calibration Laboratory of TetraTec Instruments GmbH

Seite 3 of 3  
Page english version

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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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Tel +497157/53870 · Fax +497157/538710 · [www.tetratec.de](http://www.tetratec.de) · [info@tetratec.de](mailto:info@tetratec.de)

File: CAL032528



## 18 ANNEX 8 - 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](http://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](http://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)



## 19 ANNEX 9 - 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: P69313YDEN  
Code reordering:

PER RIORDINO: [ordini@sapio.it](mailto: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/m<sup>3</sup>  
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](mailto: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 S-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, 20067, 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  
Order number

CODICE RIORDINO: P61LB2BDFN  
Code reordering:

PER RIORDINO: [ordini@sapio.it](mailto:ordini@sapio.it)  
Numero verde: 800416110

MATRICOLA: P33021  
Serial number:

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

SCADENZA  
PROVA IDRAULICA: 02/2024  
Expiration hydraulic test:

CONTENUTO: MISCELA DI GAS  
Content:

RECIPIENTE: BOMBOLA GRUPPO 2-UNITI1144  
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%)
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 (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 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](mailto: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  
Vessel:  
INOX

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 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:	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:





**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 6C**

performed on behalf of

**SUN LAB GROUP Ltd**

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

**July, 2017**



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# 1 INTRODUCTION

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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 6C emissions at the Delimara Power Station, Marsaxlokk, Malta .

In this technical report, we describe the AST test performed on AMS Stack 6C. 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 18<sup>th</sup> 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	6C	
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 <sup>3</sup>	55
Nitrogen Oxides	mg/Nm <sup>3</sup>	176
Sulfur Dioxide	mg/Nm <sup>3</sup>	132
Carbon Monoxide	mg/Nm <sup>3</sup>	264
Ammonia	mg/Nm <sup>3</sup>	2,6
<b>Note:</b> 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 “6C” 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 <sup>2</sup> ]	3,14
Number of Sampling Lines (Access Ports)	2
Conformance of the Sampling Platform	
Sampling platform area > 5 m <sup>2</sup> 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	
18/05/2017	08:00 - 22:00	Diesel Engine 45 (DE 46 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 <sub>3</sub>	EPA CTM 027:1997	Procedure for collection and analysis of ammonia in stationary sources.
NO <sub>x</sub>	UNI EN 14792:2006	Stationary source emissions. Determination of mass concentration of nitrogen oxides (NO <sub>x</sub> ). Reference method: Chemiluminescence.
SO <sub>2</sub>	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 <sub>2</sub>	ISO 11042-1:1996	Gas turbines - Exhaust gas emission - Part 1: Measurement and evaluation. Principle of Measurement: Non-dispersive infrared (NDIR).
O <sub>2</sub>	UNI EN 14789:2006	Determination of volume concentration of oxygen (O <sub>2</sub> ). Reference method - Paramagnetism.
H <sub>2</sub> 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 <sub>3</sub>	Dado Lab - ST5	Sampling	
NOx	Horiba / PG - 350 E	CLD chemiluminescence	0-25/50/100/250/ 500/1000/2500 ppm
SO <sub>2</sub>	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 <sub>2</sub>	Horiba / PG - 350 E	ND-IR	0-10/20/30 %
O <sub>2</sub>	Horiba / PG - 350 E	Paramagnetic	0-/10/25 %
H <sub>2</sub> 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 6C.

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 (SO<sub>2</sub>), nitrogen monoxide (NO), nitrogen dioxide (NO<sub>2</sub>), carbon dioxide (CO<sub>2</sub>), ammonia (NH<sub>3</sub>) and water vapor (H<sub>2</sub>O).

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 <sup>3</sup>
		MCS 100 E	ZrO <sub>2</sub>	O <sub>2</sub>	0 - 21 %
			IR Non-Dispersive (NDIR)	CO	0 - 300 mg/Nm <sup>3</sup>
				CO <sub>2</sub>	0 - 25 %
				NO	0 - 300 mg/Nm <sup>3</sup>
				NO <sub>2</sub>	0 - 100 mg/Nm <sup>3</sup>
				SO <sub>2</sub>	0 - 2000 mg/Nm <sup>3</sup>
				NH <sub>3</sub>	0 - 30 mg/Nm <sup>3</sup>



## 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 8<sup>th</sup> 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)

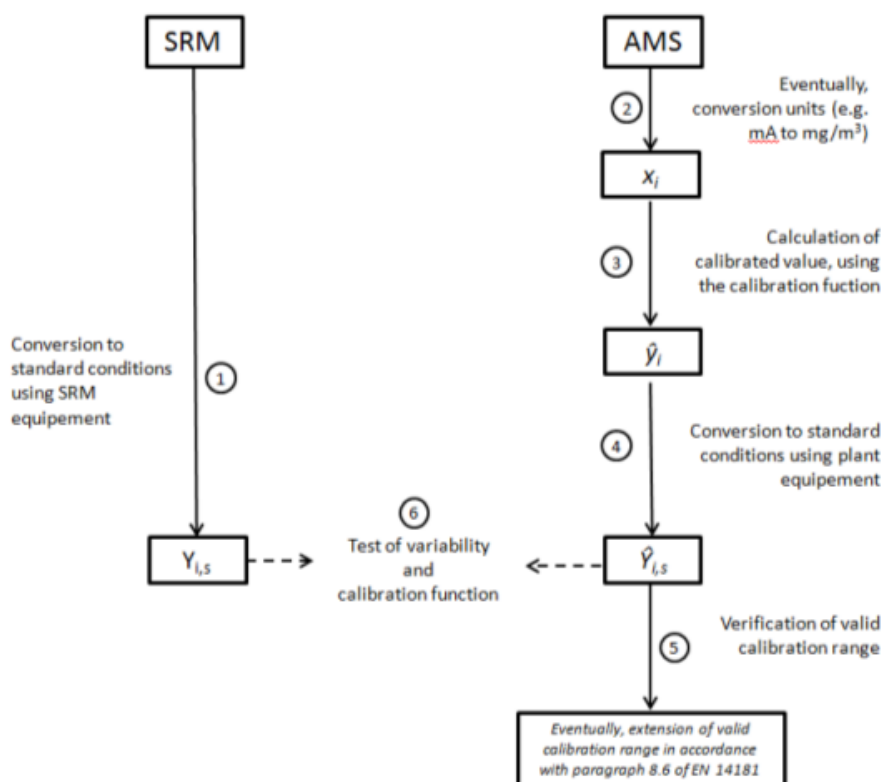
### 7.1 PARALLEL MEASUREMENTS WITH THE SRM

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 ( $\sigma_0$ ).

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

Where

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

$\hat{y}_{i,s}$  is the result  $i^{\text{th}}$  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



$\sigma_0$  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  $\chi^2$ -test with a  $\beta$ -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 6C.

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 <sub>2</sub>	Valid calibration range extension (AST)	Emission Limit Value (ELV)	Test of variability	Test of validity of the calibration function
Dust	1,002	-0,387	0 – 11.0 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	/	55	Positive	Positive
Nitrogen Oxide (NO)	1,162	0	0 – 123.4 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	/	176	Positive	Positive
Carbon Monoxide (CO)	0,958	0	0 – 129.6 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	/	132	Positive	Positive
Sulfur Dioxide (SO <sub>2</sub> )	0,976	0	0 – 113.7 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	/	264	Positive	Positive
Ammonia (NH <sub>3</sub> )	0,994	0,225	0 – 0.5 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	/	2,6	Positive	Positive





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## 9 CONCLUSIONS AND COMMENTS

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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.



## 10 ANNEX 1 – FUNCTIONAL TEST

1	ALIGNMENT AND CLEANLINESS (ONLY NON-EXTRACTIVE SYSTEM)	
	Type of Verification (visual)	Notes / Comments
a	Obstruction Optical path	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. The visual checks required by EN 14181 were positive.
b	Cleaning of Optical Components	
c	Alignment	
d	Presence of Air Purge	

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 )	
a	Description of the test		Result
	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 <sup>(1)</sup>					
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	288,57	292
				0,2		291
				0		292
NO	mg/Nm3	0	0	0,2	256,98	239
				0		244
				0		246
SO <sub>2</sub>	mg/Nm3	0	0	0	140,77	138
				0,3		137
				0,2		137
O <sub>2</sub>	% Vol	0	0	0	16,707	16,33
				0		16,45
				0		16,53
CO <sub>2</sub>	% Vol	0	0	0	16,78	16,7
				0,2		16,7
				0		16,7
NH <sub>3</sub>	mg/Nm3	0	0	0	17,93	17,46
				0,1		17,48
				0		17,54
NO <sub>2</sub>	mg/Nm3	0	0	0,1	83,73	82,5
				0		79,76
				0		79,8
Notes / Comments: (*) Values recorded by linearity tests.						



7	<i>Linearity (*)</i>				
Parameter	Full Scale set	Slope (B)	Intercept (A)	d <sub>c,rel</sub> [%]	Results
CO	0 - 300 mg/Nm3	1,001	-1,081	1,3	Positive
NO	0 - 300 mg/Nm3	0,950	0,011	4,1	Positive
SO <sub>2</sub>	0 - 2000 mg/Nm3	0,955	-1,574	0,2	Positive
O <sub>2</sub>	0 - 21 %vol	0,986	0,019	0,4	Positive
CO <sub>2</sub>	0 - 25 %vol	0,988	-0,162	1,2	Positive
NH <sub>3</sub>	0 - 30 mg/Nm3	0,942	0,180	1,5	Positive
NO <sub>2</sub>	0 - 100 mg/Nm3	0,969	-0,416	4,7	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

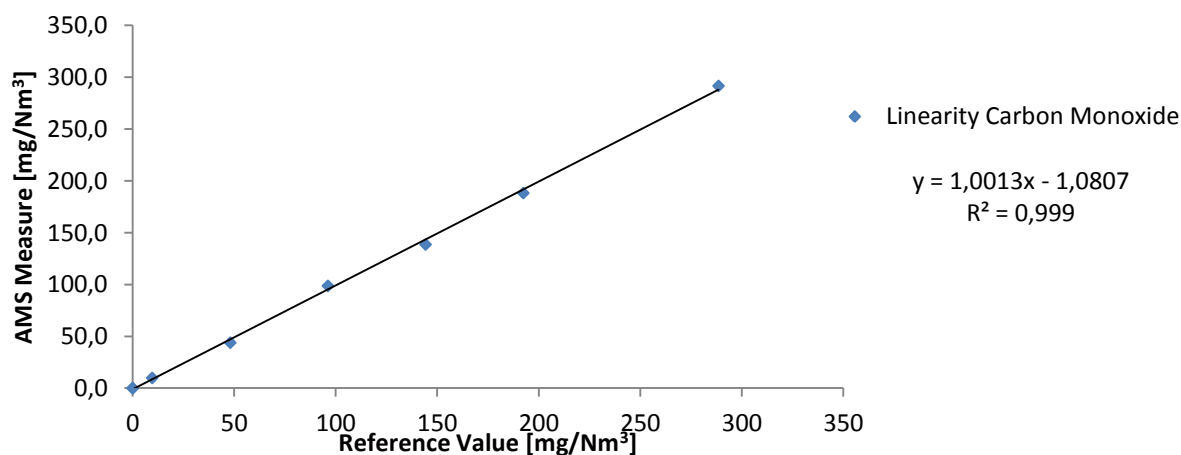


## 11 ANNEX 2 – TEST LINEARITY RESULTS

### 11.1 TEST LINEARITY OF CARBON MONOXIDE

Stack		6C		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		08/05/2017		Diluter		Beta CAP30RK			
Measurements and calculations									
CO mg/Nm3	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0	0,2	0	0,1	1,15	0,4	Positive
	1	9,62	10,2	9,9	9,8	10,0	1,41	0,5	Positive
	2	48,09	44	44	43,9	44,0	-3,10	-1,0	Positive
	3	96,18	98,5	98,8	99	98,8	3,54	1,2	Positive
	4	144,28	140	137	139	138,7	-4,72	-1,6	Positive
	5	192,4	188	189	188	188,3	-3,23	-1,1	Positive
	6	288,57	292	291	292	291,7	3,81	1,3	Positive
	0	0	0,1	0,1	0	0,1	1,15	0,4	Positive
		Y <sub>z</sub>	97,4	A'	96,4	B	1,001	A	-1,0807
Legend									
Y <sub>i</sub> : concentration of reference material; X <sub>i</sub> : AMS measure corresponding to the Reference Material Concentration Level; Y <sub>z</sub> : 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 monoxide





## 11.2 TEST LINEARITY OF NITROGEN OXIDE

Stack	6C		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/Nm <sup>3</sup>	Expiration	30/03/2019
Date measurements	08/05/2017		Diluter	Beta CAP30RK

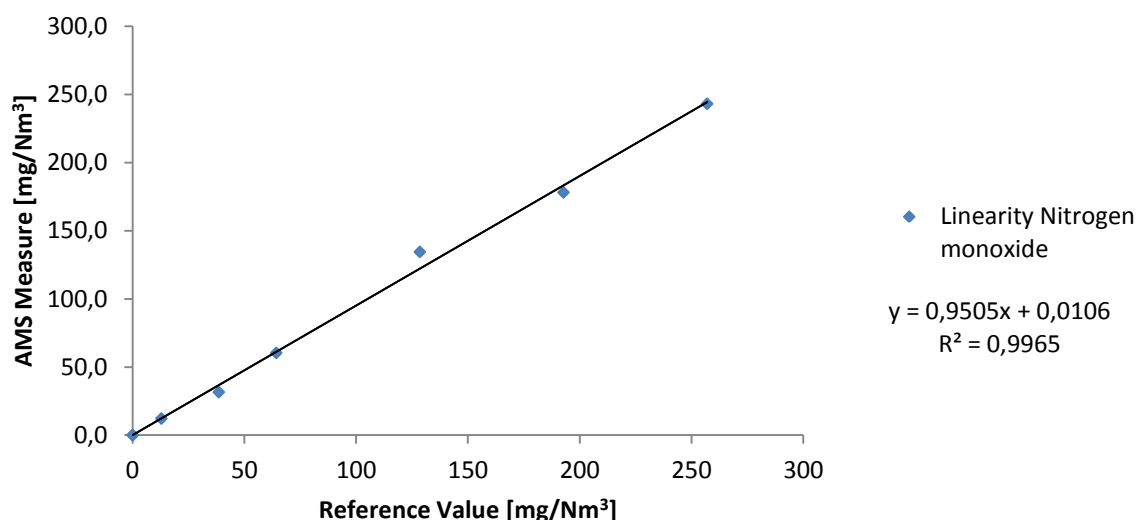
### Measurements and calculations

NO mg/Nm <sup>3</sup>	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0,2	0	0	0,1	0,06	0,0	Positive
	1	12,84	12,3	12,2	12,1	12,2	-0,01	0,0	Positive
	2	38,54	31,6	31,5	31,6	31,6	-5,08	-1,7	Positive
	3	64,24	63,7	59,8	57,4	60,3	-0,77	-0,3	Positive
	4	128,49	133,2	134,8	135,2	134,4	12,26	4,1	Positive
	5	192,74	180	175	179	178,0	-5,21	-1,7	Positive
	6	256,98	239	244	246	243,0	-1,27	-0,4	Positive
	0	0	0,1	0	0	0,0	0,02	0,0	Positive
		Y <sub>z</sub>	86,7	A'	82,4	B	0,950	A	0,0106

### Legend

Y<sub>i</sub>: concentration of reference material;  
X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  
Y<sub>z</sub>: 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	6C		Data materials used	
Customer	D3 POWER GENERATION LIMITED		Cylinder Producer	SAPIO
Parameter	NO <sub>2</sub>		Serial/Certificate	P61YZ3YDFN
Analyzer	SICK MCS 100 E		Concentration	81,6 ppm
Full Scale set	0- 100	mg/Nm <sup>3</sup>	Expiration	30/03/2018
Date measurements	08/05/2017		Diluter	Beta CAP30RK

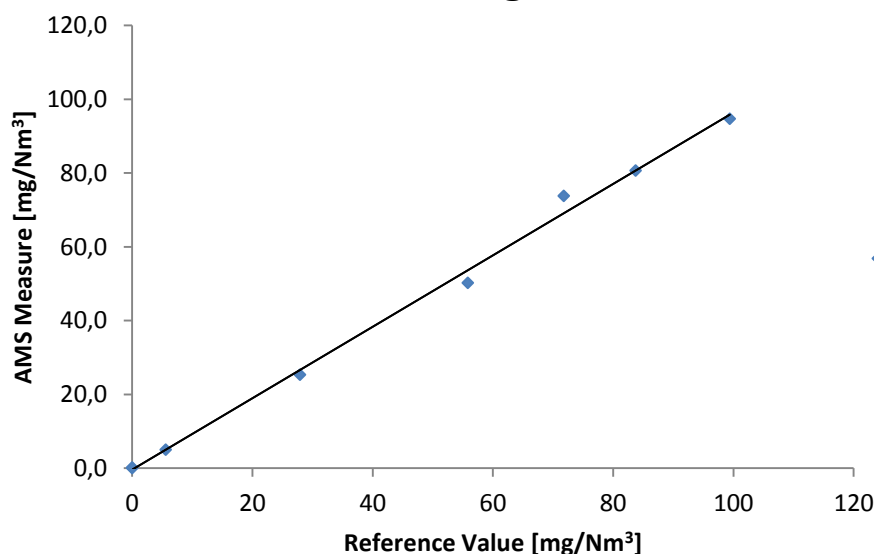
#### Measurements and calculations

NO <sub>2</sub> mg/Nm <sup>3</sup>	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0,1	0	0	0,0	0,45	0,4	Positive
	1	5,58	4,98	5,1	5	5,0	0,04	0,0	Positive
	2	27,91	24,99	25,02	26,04	25,4	-1,27	-1,3	Positive
	3	55,82	50,28	50,33	50,12	50,2	-3,41	-3,4	Positive
	4	71,78	73,28	74,12	74,06	73,8	4,71	4,7	Positive
	5	83,73	82,5	79,76	79,8	80,7	0,00	0,0	Positive
	6	99,39	96,56	93,81	93,81	94,7	-1,13	-1,1	Positive
	0	0	0,2	0,2	0,2	0,2	0,62	0,6	Positive
		Y <sub>z</sub>	43,0	A'	41,3	B	0,969	A	-0,4156

#### Legend

Y<sub>i</sub>: concentration of reference material;  
X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  
Y<sub>z</sub>: 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 Dioxide



$$y = 0,9686x - 0,4156$$
$$R^2 = 0,9965$$



## 11.4 TEST LINEARITY OF SULFUR DIOXIDE

Stack	6C		Data materials used	
Customer	D3 POWER GENERATION LIMITED		Cylinder Producer	SAPIO
Parameter	SO <sub>2</sub>		Serial/Certificate	P69313YDEN
Analyzer	SICK MCS 100 E		Concentration	49,3 ppm
Full Scale set	0- 2000	mg/Nm <sup>3</sup>	Expiration	30/03/2019
Date measurements	08/05/2017		Diluter	Beta CAP30RK

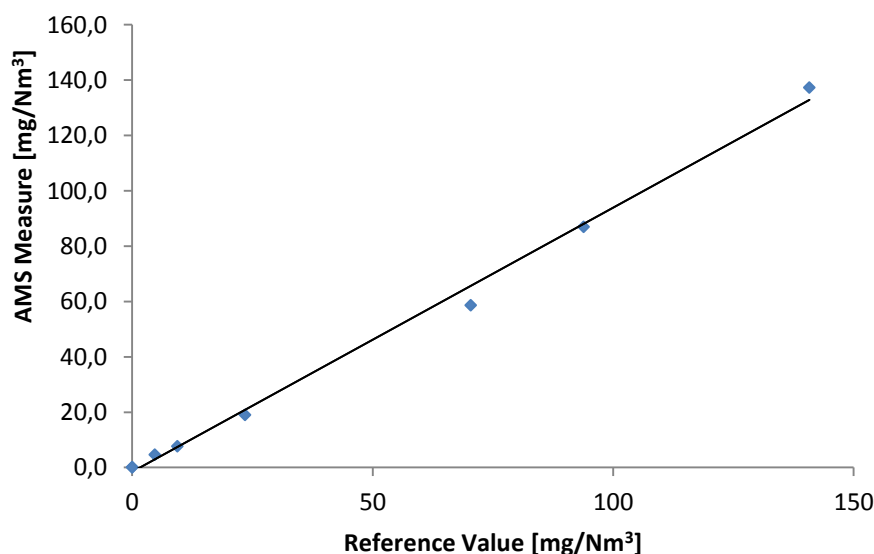
### Measurements and calculations

SO <sub>2</sub> mg/Nm <sup>3</sup>	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0	0,3	0,2	0,2	1,74	0,1	Positive
	1	4,7	5	4	5	4,7	1,75	0,1	Positive
	2	9,39	8	8,1	7	7,7	0,30	0,0	Positive
	3	23,46	19,2	19	18,9	19,0	-1,80	-0,1	Positive
	4	70,38	59	58	59	58,7	-6,99	-0,3	Positive
	5	93,85	87	88	86	87,0	-1,08	-0,1	Positive
	6	140,77	138	137	137	137,3	4,44	0,2	Positive
	0	0	0,1	0	0,1	0,1	1,64	0,1	Positive
		Y <sub>z</sub>	42,8	A'	39,3	B	0,955	A	-1,5739

### Legend

Y<sub>i</sub>: concentration of reference material;  
X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  
Y<sub>z</sub>: 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

$$y = 0,9553x - 1,5739$$
$$R^2 = 0,9954$$



## 11.5 TEST LINEARITY OF OXYGEN

Stack	6C		Data materials used	
Customer	D3 POWER GENERATION LIMITED		Cylinder Producer	SAPIO
Parameter	O <sub>2</sub>		Serial/Certificate	P61LB2BDFN
Analyzer	SICK MCS 100 E		Concentration	25,06 %vol
Full Scale set	0- 21	%vol	Expiration	30/03/2020
Date measurements	08/05/2017		Diluter	Beta CAP30RK

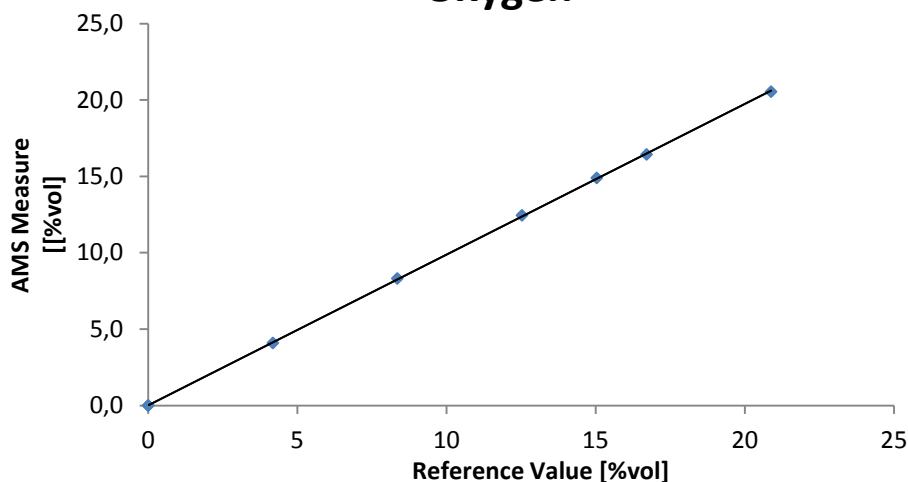
### Measurements and calculations

O <sub>2</sub> %vol	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0	0	0	0,0	-0,02	-0,1	Positive
	1	4,18	3,92	4,18	4,18	4,1	-0,05	-0,2	Positive
	2	8,35	8,13	8,33	8,49	8,3	0,07	0,3	Positive
	3	12,53	12,36	12,45	12,54	12,5	0,08	0,4	Positive
	4	15,036	14,89	14,9	14,9	14,9	0,05	0,3	Positive
	5	16,707	16,33	16,45	16,53	16,4	-0,05	-0,3	Positive
	6	20,88	20,49	20,55	20,59	20,5	-0,06	-0,3	Positive
	0	0	0	0	0	0,0	-0,02	-0,1	Positive
		Y <sub>z</sub>	9,7	A'	9,6	B	0,986	A	0,0190

### Legend

Y<sub>i</sub>: concentration of reference material;  
X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  
Y<sub>z</sub>: 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

### Oxygen





## 11.6 TEST LINEARITY OF CARBON DIOXIDE

Stack	6C		Data materials used	
Customer	D3 POWER GENERATION LIMITED		Cylinder Producer	SAPIO
Parameter	CO <sub>2</sub>		Serial/Certificate	P69313YDEN
Analyzer	SICK MCS 100 E		Concentration	25,17 %vol
Full Scale set	0- 25	%vol	Expiration	30/03/2019
Date measurements	08/05/2017		Diluter	Beta CAP30RK

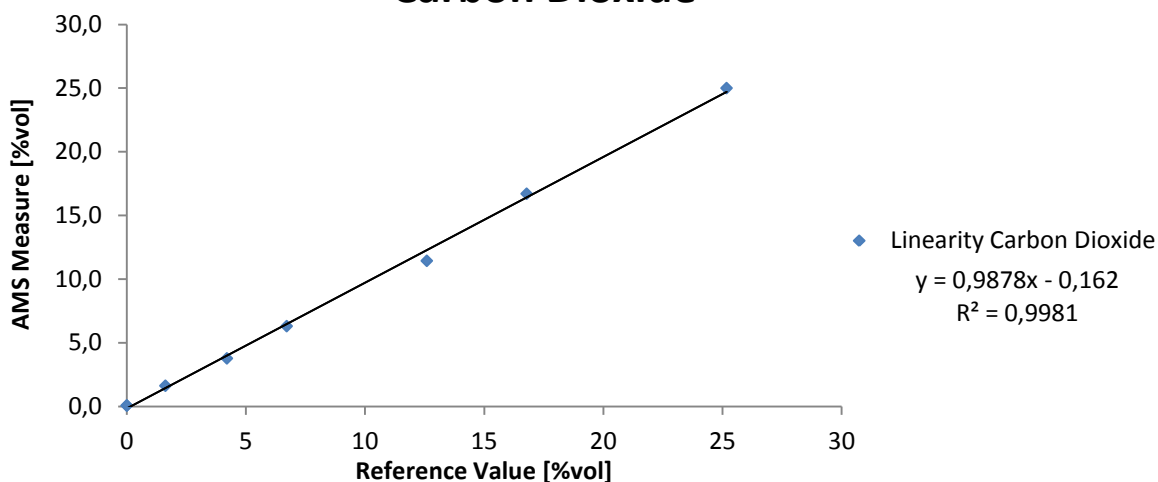
### Measurements and calculations

CO <sub>2</sub> %vol	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0	0,2	0	0,1	0,23	0,9	Positive
	1	1,62	1,62	1,62	1,62	1,6	0,18	0,7	Positive
	2	4,2	3,77	3,77	3,77	3,8	-0,22	-0,9	Positive
	3	6,71	6,3	6,3	6,3	6,3	-0,17	-0,7	Positive
	4	12,59	11,5	11,4	11,4	11,4	-0,84	-3,4	Positive
	5	16,78	16,7	16,7	16,7	16,7	0,29	1,1	Positive
	6	25,17	25	25	25	25,0	0,30	1,2	Positive
	0	0	0,1	0,1	0	0,1	0,23	0,9	Positive
		Y <sub>z</sub>	8,4	A'	8,1	B	0,988	A	-0,1620

### Legend

Y<sub>i</sub>: concentration of reference material;  
X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  
Y<sub>z</sub>: 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	6C		Data materials used	
Customer	D3 POWER GENERATION LIMITED		Cylinder Producer	SAPIO
Parameter	NH <sub>3</sub>		Serial/Certificate	P61AR3YDFN
Analyzer	SICK MCS 100 E		Concentration	47,3 ppm
Full Scale set	0- 30	mg/Nm <sup>3</sup>	Expiration	30/09/2017
Date measurements	08/05/2017		Diluter	Beta CAP30RK

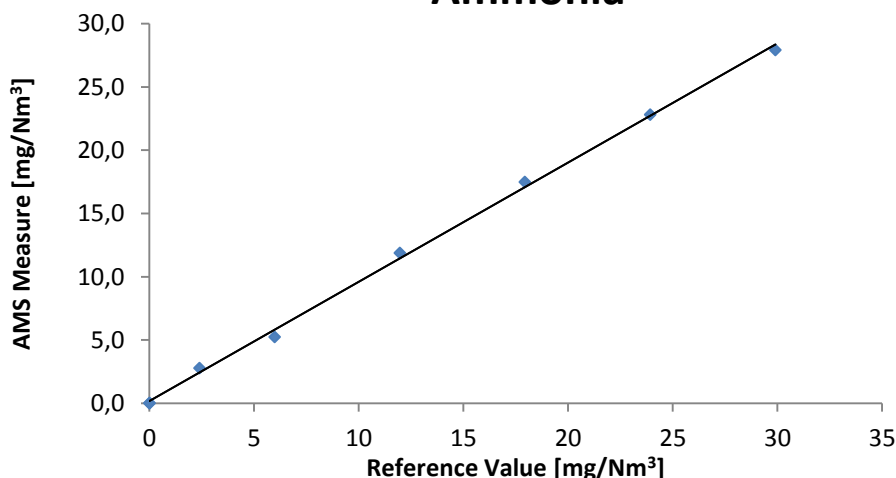
### Measurements and calculations

NH <sub>3</sub> mg/Nm <sup>3</sup>	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	0	0	0	0,1	0	0,0	-0,15	-0,5	Positive
	1	2,39	2,94	2,72	2,7	2,8	0,36	1,2	Positive
	2	5,98	5,29	5,2	5,25	5,2	-0,57	-1,9	Positive
	3	11,96	11,89	11,92	11,85	11,9	0,44	1,5	Positive
	4	17,93	17,46	17,48	17,54	17,5	0,42	1,4	Positive
	5	23,92	22,59	22,89	22,97	22,8	0,10	0,3	Positive
	6	29,9	27,82	27,95	28	27,9	-0,43	-1,4	Positive
	0	0	0	0	0	0,0	-0,18	-0,6	Positive
		Y <sub>z</sub>	11,5	A'	11,0	B	0,942	A	0,1798

### Legend

Y<sub>i</sub>: concentration of reference material;  
X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  
Y<sub>z</sub>: 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

### Ammonia





## 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 Parameter	
Oxygen (O <sub>2</sub> )	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 <sup>2</sup> ]		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							18/05/2017
Point	Diameter	Grid Sampling	Temperatura [°C]	Δpi [Pa]	Velocity [m/s]	Auxiliary Parameter	
1	1	9	161	107,6	13,6	Oxygen [% vol]	12,67
2	1	29	161	107,3	13,6		
3	1	59	162	107,5	13,6		
4	1	141	161	106,8	13,6	Carbon dioxide [%vol]	5,9
5	1	171	161	106,9	13,6		
6	1	191	162	106,2	13,5		
7						Water vapor [% vol]	7,54
8							
9							
10						Density - ρ (Kg/m <sup>3</sup> )	1,313
11	2	9	161	106,0	13,5		
12	2	29	162	105,5	13,5		
13	2	59	160	106,9	13,6	Pressione Emissione [kPa]	101
14	2	141	161	106,8	13,6		
15	2	171	161	106,4	13,5		
16	2	191	161	106,7	13,6	Ambient Temperature [°C]	29
17							
18							
19						Ambient Pressure [hPa]	1012
20							



## 12.2 DUST REPORT

Sampling and Analysis Report - Dust							
Dust				UNI EN 13284 - 1 : 2003			
<b>Auxiliary Parameter</b>							
Velocity and Flow				UNI EN ISO 16911-1:2013 Annex A			
Oxygen (O <sub>2</sub> )				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			
<b>Information on the instrumentation and materials used for sampling and analysis</b>							
<b>Instrumentation</b>							
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)			
<b>Sampling material</b>							
Filter Material		Glass Fiber Filter		Diameter [mm]		47	
Filtration Temperature		Stack Temperature		Conditioning Temperature [° C]		180	
<b>Technical personnel who performed the sampling</b>							
Dott. Giorgio Rocchia							
Ing. Calogero Romano							
<b>Dust - Sampling and analysis Data</b>							<b>1</b>
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 <sup>3</sup> ] <sup>(1)</sup>
Method Blank		18/05/2017	/	FF57	0,00	0,05	0,500
2123747-001	Reply 1	18/05/2017 09:59	30	FF58	2,98	0,04	0,540
2123747-002	Reply 2	18/05/2017 10:59	30	FF59	2,61	0,04	0,557
2123747-003	Reply 3	18/05/2017 11:59	30	FF60	2,68	0,05	0,555
2123747-004	Reply 4	18/05/2017 12:59	30	FF61	2,48	0,06	0,666
2123747-005	Reply 5	18/05/2017 13:59	30	FF62	2,88	0,06	0,672





Dust - Sampling and analysis Data							2
I.D. Sample	Stack Speed [m/s]	Temperature[°C]	Pressure [kPa]	H <sub>2</sub> O [%v/v]	O <sub>2</sub> [%v/v]	Dust Concentration [mg/Nm <sup>3</sup> ] <sup>(2)</sup>	Dust Concentration correct with O <sub>2</sub> [mg/Nm <sup>3</sup> ] <sup>(3)</sup>
Method Blank	/	163,00	101,2	7,74	12,63	0,10	0,07
2123747-001	13,61	160,57	101,3	7,47	12,63	5,60	4,02
2123747-002	14,02	160,97	101,3	7,59	12,61	4,76	3,41
2123747-003	13,84	160,70	101,4	7,96	12,63	4,93	3,53
2123747-004	13,76	161,89	101,5	7,78	12,64	3,81	2,74
2123747-005	13,68	160,28	101,5	7,89	12,65	4,37	3,14
<sup>(2)</sup> Dust Concentration (Wet).							
<sup>(3)</sup> 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 [%] <sup>(4)</sup>	Result	Dust Concentration correct with O <sub>2</sub> [mg/Nm <sup>3</sup> ] - Blank	Result <sup>(5)</sup>
Method Blank		18/05/2017	/			0,07	Positive
2123747-001	Reply 1	18/05/2017 09:59	30	0,1	Positive		
2123747-002	Reply 2	18/05/2017 10:59	30	0,1	Positive		
2123747-003	Reply 3	18/05/2017 11:59	30	0	Positive		
2123747-004	Reply 4	18/05/2017 12:59	30	0	Positive		
2123747-005	Reply 5	18/05/2017 13:59	30	0,1	Positive		
<sup>(4)</sup> Dust sampling must be done in isocinetics. The isocinet value must be within the Range -5% <G <+ 15%.							
<sup>(5)</sup> 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 <sub>2</sub> )					UNI EN 14789:2017
Nitrogen Oxide (NO)					UNI EN 14792:2017
Carbon Monoxide (CO)					UNI EN 15058:2017
Sulfur Dioxide (SO <sub>2</sub> )					ISO 11042-1:1996
Carbon Dioxide (CO <sub>2</sub> )					ISO 11042-1:1996
<b>Information on the instrumentation used for sampling and analysis</b>					
<b>Instrumentation</b>					
Analizzatore Gas		Horiba	MY25EG2X	Analizzatore Horiba PG-350E	
<b>Technical personnel who performed the sampling</b>					
Dott. Giorgio Rocchia					
Ing. Calogero Romano					
<b>Determination of Nitrogen Oxide (NO) - Sampling and analysis Data</b>					<b>1</b>
<b>I.D. Sample</b>	<b>Reply</b>	<b>Date and time of Start of the Sampling</b>	<b>Sampling duration [min]</b>	<b>Nitrogen Oxide (NO) - [mg/Nm<sup>3</sup>] (2)</b>	<b>Oxygen (O<sub>2</sub>) - [%vol] <sup>(1)</sup></b>
2123747-001	Reply 1	18/05/2017 09:59	30	43,12	12,63
2123747-002	Reply 2	18/05/2017 10:59	30	42,48	12,61
2123747-003	Reply 3	18/05/2017 11:59	30	42,03	12,63
2123747-004	Reply 4	18/05/2017 12:59	30	42,66	12,64
2123747-005	Reply 5	18/05/2017 13:59	30	41,79	12,65
<b>Notes:</b> (1) The oxygen value reported refers to the same measurement period of the parameter on which AST (NO <sub>x</sub> ) is performed. (2) The Nitric Oxide (NO <sub>x</sub> ) 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
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Carbon Monoxide (CO) - [mg/Nm <sup>3</sup> ]	Oxygen (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2123747-001	Reply 1	18/05/2017 09:59	30	0,87	12,63
2123747-002	Reply 2	18/05/2017 10:59	30	0,96	12,61
2123747-003	Reply 3	18/05/2017 11:59	30	1,03	12,63
2123747-004	Reply 4	18/05/2017 12:59	30	1,02	12,64
2123747-005	Reply 5	18/05/2017 13:59	30	1,05	12,65
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 (SO <sub>2</sub> ) - Sampling and analysis Data					3
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Sulfur Dioxide (SO <sub>2</sub> ) - [mg/Nm <sup>3</sup> ]	Oxygen (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2123747-001	Reply 1	18/05/2017 09:59	30	22,72	12,63
2123747-002	Reply 2	18/05/2017 10:59	30	22,59	12,61
2123747-003	Reply 3	18/05/2017 11:59	30	22,88	12,63
2123747-004	Reply 4	18/05/2017 12:59	30	21,63	12,64
2123747-005	Reply 5	18/05/2017 13:59	30	21,99	12,65
Notes: (1) The oxygen value reported refers to the same measurement period of the parameter on which AST (SO <sub>2</sub> ) is performed. (2) The sulfur dioxide (SO <sub>2</sub> ) 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			
<b>Auxiliary Parameter</b>							
Velocity and Flow				UNI EN ISO 16911-1:2013 Annex A			
Oxygen (O <sub>2</sub> )				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			
<b>Information on the instrumentation and materials used for sampling and analysis</b>							
<b>Instrumentation</b>							
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)			
<b>Sampling material</b>							
Filter Material		Glass Fiber Filter		Absorption solution		H <sub>2</sub> SO <sub>4</sub> - 0,1 N	
Filtration Temperature		Stack Temperature		Conditioning Temperature [° C]		180	
<b>Technical personnel who performed the sampling</b>							
Dott. Giorgio Rocchia							
Ing. Calogero Romano							
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Sampling Volume [Nm <sup>3</sup> ] <sup>(1)</sup>	Impinger G1 [mg]	Impinger G2 [mg]	Concentration [mg/Nm <sup>3</sup> ]
Method Blank		18/05/2017	/	/	0,000	0,000	/
2123747-001	Reply 1	18/05/2017 09:59	30	0,540	0,510	0,000	0,94
2123747-002	Reply 2	18/05/2017 10:59	30	0,557	0,440	0,000	0,79
2123747-003	Reply 3	18/05/2017 11:59	30	0,555	0,610	0,000	1,10
2123747-004	Reply 4	18/05/2017 12:59	30	0,666	0,570	0,000	0,86
2123747-005	Reply 5	18/05/2017 13:59	30	0,672	0,650	0,000	0,97
<sup>(1)</sup> For Blanks of the method is considered a volume of 1 m <sup>3</sup>							





## 13 ANNEX 4 – AST REPORT

### 13.1 CARBON MONOXIDE - AST

Parameter		CO		
N. Test	DATE/TIME	SRM (Y) [mg/Nm <sup>3</sup> Rep. O <sub>2</sub> ]	AMS (X) [mg/Nm <sup>3</sup> Rep. O <sub>2</sub> ]	Difference (Xi)
1	18/5/17 9:59	0,87	1,92	-1,05
2	18/5/17 10:59	0,96	1,99	-1,03
3	18/5/17 11:59	1,03	2,07	-1,04
4	18/5/17 12:59	1,02	2,05	-1,03
5	18/5/17 13:59	1,05	2,06	-1,01
Average		0,99	2,02	-1,03
Standard deviation(S <sub>D</sub> )		0,01		
Y max -Y min		0,18		
Emission Limit Value [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]		264		
Confidence Internal limit value 95%		10		
Test value for variability kv		0,916		
Uncertainty σ <sub>0</sub>		13,47		
t student 0,95 (N-1)		2,13		
Test of variability S <sub>D</sub> ≤ 1,5σ <sub>0</sub> kv		Positive		
<b>Test of Validity of the calibration function</b> $ \bar{D}  \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 <sup>3</sup> Rep. O <sub>2</sub> ]	AMS (X) [mg/Nm <sup>3</sup> Rep. O <sub>2</sub> ]	Difference (Xi)
1	18/5/17 9:59	43,12	56,86	-13,74
2	18/5/17 10:59	42,48	56,72	-14,24
3	18/5/17 11:59	42,03	56,89	-14,86
4	18/5/17 12:59	42,66	56,76	-14,10
5	18/5/17 13:59	41,79	55,90	-14,11
Average		42,42	56,63	-14,21
Standard deviation(S <sub>D</sub> )		0,41		
Y max -Y min		1,33		
Emission Limit Value [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]		176		
Confidence Internal limit value 95%		20		
Test value for variability kv		0,916		
Uncertainty σ <sub>0</sub>		17,96		
t student 0,95 (N-1)		2,13		
Test of variability S <sub>D</sub> ≤ 1,5σ <sub>0</sub> kv		Positive		
Test of Validity of the calibration function $ \bar{D}  \leq t_{0,95}(N-1) \frac{SD}{\sqrt{N}} + \sigma_0$		Positive		



### 13.3 SULFUR DIOXIDE - AST

Parameter		SO <sub>2</sub>		
N. Test	DATE/TIME	SRM (Y) [mg/Nm <sup>3</sup> Rep. O <sub>2</sub> ]	AMS (X) [mg/Nm <sup>3</sup> Rep. O <sub>2</sub> ]	Difference (Xi)
1	18/5/17 9:59	22,72	26,77	-4,05
2	18/5/17 10:59	22,59	24,75	-2,16
3	18/5/17 11:59	22,88	24,76	-1,88
4	18/5/17 12:59	21,63	24,10	-2,47
5	18/5/17 13:59	21,99	24,91	-2,92
Average		22,36	25,06	-2,70
Standard deviation(S <sub>D</sub> )		0,85		
Y max -Y min		1,25		
Emission Limit Value [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]		132		
Confidence Internal limit value 95%		20		
Test value for variability kv		0,916		
Uncertainty σ <sub>0</sub>		13,47		
t student 0,95 (N-1)		2,13		
Test of variability S <sub>D</sub> ≤ 1,5σ <sub>0</sub> 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		





## 13.4 DUST - AST

Parameter		Dust		
N. Test	DATE/TIME	SRM (Y) [mg/Nm <sup>3</sup> Dry gas, Rep. O <sub>2</sub> ]	AMS (X) [mg/Nm <sup>3</sup> Dry gas, Rep. O <sub>2</sub> ]	Difference (Xi)
1	18/5/17 9:59	4,02	5,67	-1,65
2	18/5/17 10:59	3,41	5,59	-2,18
3	18/5/17 11:59	3,53	5,60	-2,07
4	18/5/17 12:59	2,74	5,52	-2,78
5	18/5/17 13:59	3,14	5,30	-2,16
Average		3,37	5,54	-2,17
Standard deviation(S <sub>D</sub> )		0,40		
Y max -Y min		1,28		
Emission Limit Value [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]		55		
Confidence Internal limit value 95%		30		
Test value for variability kv		0,916		
Uncertainty σ <sub>0</sub>		8,42		
t student 0,95 (N-1)		2,13		
Test of variability S <sub>D</sub> ≤ 1,5σ <sub>0</sub> 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 <sub>3</sub>		
N. Test	DATE/TIME	SRM (Y) [mg/Nm <sup>3</sup> Rep. O <sub>2</sub> ]	AMS (X) [mg/Nm <sup>3</sup> Rep. O <sub>2</sub> ]	Difference (Xi)
1	18/5/17 9:59	0,68	0,15	0,53
2	18/5/17 10:59	0,56	0,15	0,41
3	18/5/17 11:59	0,79	0,15	0,64
4	18/5/17 12:59	0,61	0,15	0,46
5	18/5/17 13:59	0,70	0,15	0,55
Average		0,67	0,15	0,52
Standard deviation(S <sub>D</sub> )		0,08		
Y max -Y min		0,22		
Emission Limit Value [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]		2,6		
Confidence Internal limit value 95%		40		
Test value for variability kv		0,92		
Uncertainty σ <sub>0</sub>		0,53		
t student 0,95 (N-1)		2,13		
Test of variability S <sub>D</sub> ≤ 1,5σ <sub>0</sub> 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	
<b>Certified AMS:</b>	PG-350E for NO <sub>x</sub> , SO <sub>2</sub> , CO, CO <sub>2</sub> and O <sub>2</sub>
<b>Manufacturer:</b>	HORIBA Europe GmbH Julius-Kronenberg-Str. 9 42799 Leichlingen Germany
<b>Test Institute:</b>	TÜV Rheinland Energie und Umwelt GmbH
<p><b>This is to certify that the AMS has been tested and found to comply with:</b></p> <p><b>EN 15267-1: 2009, EN 15267-2: 2009, EN 15267-3: 2007 and EN 14181: 2004</b></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"><li>• EN 15267-3 tested</li><li>• QAL1 certified</li><li>• TÜV approved</li><li>• Annual inspection</li></ul>	
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
<a href="http://www.umwelt-tuv.de">www.umwelt-tuv.de</a> / <a href="http://www.eco-tuv.com">www.eco-tuv.com</a> 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<sub>x</sub>, SO<sub>2</sub>, CO, CO<sub>2</sub> and O<sub>2</sub>

**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 <sub>x</sub>	0 - 205 <sup>1)</sup>	0 - 2050 <sup>2)</sup>	mg/m <sup>3</sup>
SO <sub>2</sub>	0 - 143	0 - 1430	mg/m <sup>3</sup>
CO	0 - 75	0 - 1250	mg/m <sup>3</sup>
CO <sub>2</sub>	0 - 20	-	Vol.-%
O <sub>2</sub>	0 - 25	0 - 10	Vol.-%

<sup>1)</sup> as NO<sub>2</sub>, this corresponds to apx 0 - 134 mg/m<sup>3</sup> NO

<sup>2)</sup> as NO<sub>2</sub>, this corresponds to apx. 0 - 1340 mg/m<sup>3</sup> NO

**Software version:**

P2000788001D / 1.11

**Restrictions:**

None

**Notes:**

1. The maintenance interval is four weeks.
2. The certification range for the component SO<sub>2</sub> 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 SO<sub>2</sub> 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 <sub>x</sub>	Chemiluminescence
CO, SO <sub>2</sub> , CO <sub>2</sub>	Non-dispersive absorption (NDIR) Infrared
O <sub>2</sub>	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

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0000032301 / 22 March 2013



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**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](http://qal1.de).

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

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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

	SO <sub>2</sub>
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 <sub>i</sub>	u <sub>i</sub> <sup>2</sup>
Standard deviation from paired measurements under field conditions *	u <sub>0</sub>	mg/m³	1.672 (mg/m³)²
Lack of fit	u <sub>lof</sub>	mg/m³	0.334 (mg/m³)²
Zero drift from field test	u <sub>zdr</sub>	mg/m³	3.881 (mg/m³)²
Span drift from field test	u <sub>sdr</sub>	mg/m³	4.713 (mg/m³)²
Influence of ambient temperature at span	u <sub>t</sub>	1.752 mg/m³	3.070 (mg/m³)²
Influence of supply voltage	u <sub>v</sub>	0.790 mg/m³	0.624 (mg/m³)²
Cross sensitivity (interference)	u <sub>i</sub>	mg/m³	2.258 (mg/m³)²
Influence of sample gas flow	u <sub>p</sub>	mg/m³	0.067 (mg/m³)²
Uncertainty of reference material at 70% of certification range	u <sub>rm</sub>	mg/m³	1.336 (mg/m³)²

\* The larger value is used:

"Repeatability standard deviation at span" or

"Standard deviation from paired measurements under field conditions"



Combined standard uncertainty (u <sub>c</sub> )	$u_c = \sqrt{\sum (u_{max,i})^2}$	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

Requirement of 2000/76/EC and 2001/80/EC	U in % of the ELV 60 mg/m³	13.8
Requirement of EN 15267-3	U in % of the ELV 60 mg/m³	20.0
	U in % of the ELV 60 mg/m³	15.0







	<p align="center"><b>Certificate:</b> 0000032301 / 22 March 2013</p>	
<p align="center"><b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b></p>		
<b>Measuring system</b>		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB0 / XL7LTUL1	
Measuring principle	NDIR	
<b>Test report</b>	21217617/A	
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
<b>Measured component</b>	CO	
Certification range	0 - 75 mg/m³	
<b>Evaluation of the cross sensitivity (CS)</b> (system with largest CS)		
Sum of positive CS at zero point	0.00 mg/m³	
Sum of negative CS at zero point	0.00 mg/m³	
Sum of positive CS at reference point	0.50 mg/m³	
Sum of negative CS at reference point	-0.65 mg/m³	
Maximum sum of cross sensitivities	-0.65 mg/m³	
Uncertainty of cross sensitivity	-0.377 mg/m³	
<b>Calculation of the combined standard uncertainty</b>		
<b>Tested parameter</b>	<b>u<sub>i</sub></b>	<b>u<sup>2</sup></b>
Standard deviation from paired measurements under field conditions *	u <sub>D</sub> mg/m³	0.356 (mg/m³)²
Lack of fit	u <sub>of</sub> mg/m³	0.070 (mg/m³)²
Zero drift from field test	u <sub>z,d</sub> mg/m³	0.706 (mg/m³)²
Span drift from field test	u <sub>s,d</sub> -0.675 mg/m³	0.456 (mg/m³)²
Influence of ambient temperature at span	u <sub>t</sub> 0.868 mg/m³	0.750 (mg/m³)²
Influence of supply voltage	u <sub>v</sub> 0.288 mg/m³	0.082 (mg/m³)²
Cross sensitivity (interference)	u <sub>i</sub> mg/m³	0.142 (mg/m³)²
Influence of sample gas flow	u <sub>p</sub> mg/m³	0.001 (mg/m³)²
Uncertainty of reference material at 70% of certification range	u <sub>rm</sub> mg/m³	0.368 (mg/m³)²
* The larger value is used: * Repeatability standard deviation at span* or * Standard deviation from paired measurements under field conditions*		
Combined standard uncertainty (u <sub>c</sub> )	$u_c = \sqrt{\sum (u_{max,i})^2}$	1.71 mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	3.35 mg/m³
<b>Relative total expanded uncertainty</b>	<b>U in % of the ELV 50 mg/m³</b>	<b>6.7</b>
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

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	<p align="center"><b>Certificate:</b> 0000032301 / 22 March 2013</p>	
<p align="center"><b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b></p>		
<b>Measuring system</b>		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB9 / XL7LTUL1	
Measuring principle	NDIR	
<b>Test report</b>	21217617/A	
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
<b>Measured component</b>	CO <sub>2</sub>	
Certification range	0 - 20 Vol.-%	
<b>Evaluation of the cross sensitivity (CS)</b> (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.-%
<b>Calculation of the combined standard uncertainty</b>		
<b>Tested parameter</b>		<b>U<sup>2</sup></b>
Standard deviation from paired measurements under field conditions *	U <sub>D</sub>	Vol.-% 0.000 (Vol.-%) <sup>2</sup>
Lack of fit	U <sub>lof</sub>	Vol.-% 0.013 (Vol.-%) <sup>2</sup>
Zero drift from field test	U <sub>dz</sub>	Vol.-% 0.071 (Vol.-%) <sup>2</sup>
Span drift from field test	U <sub>sd</sub>	0.238 Vol.-% 0.057 (Vol.-%) <sup>2</sup>
Influence of ambient temperature at span	U <sub>t</sub>	0.115 Vol.-% 0.013 (Vol.-%) <sup>2</sup>
Influence of supply voltage	U <sub>v</sub>	0.051 Vol.-% 0.003 (Vol.-%) <sup>2</sup>
Cross sensitivity (interference)	U <sub>i</sub>	Vol.-% 0.004 (Vol.-%) <sup>2</sup>
Influence of sample gas flow	U <sub>g</sub>	Vol.-% 0.000 (Vol.-%) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	U <sub>rm</sub>	Vol.-% 0.026 (Vol.-%) <sup>2</sup>
* The larger value is used : "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"		
Combined standard uncertainty (u <sub>c</sub> )	$u_c = \sqrt{\sum (u_{max,i})^2}$	0.43 Vol.-%
Total expanded uncertainty	$U = u_c \cdot k = u_c \cdot 1.96$	0.85 Vol.-%
<b>Relative total expanded uncertainty</b>	<b>U in % of the range 20 Vol.-%</b>	<b>4.2</b>
Requirement of 2000/76/EC and 2001/80/EC	<b>U in % of the range 20 Vol.-%</b>	<b>10.0**</b>
Requirement of EN 15267-3	<b>U in % of the range 20 Vol.-%</b>	<b>7.5</b>
** 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.		
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Umwelt Bundes Amt For our Environment		Certificate: 0000032301 / 22 March 2013		TÜVRheinland® Precisely Right.	
<b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b>					
<b>Measuring system</b>					
Manufacturer	Horiba Europe GmbH				
Name of measuring system	PG-350E				
Serial number of the candidates	VC4DFKB9 / XL7LTUL1				
Measuring principle	Paramagnetism				
<b>Test report</b>		21217617/A			
Test laboratory	TÜV Rheinland				
Date of report	2012-10-08				
<b>Measured component</b>		O <sub>2</sub>			
Certification range	0 - 25 Vol.-%				
<b>Evaluation of the cross sensitivity (CS)</b> (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.-%				
<b>Calculation of the combined standard uncertainty</b>					
<b>Tested parameter</b>		<b>u<sup>2</sup></b>			
Standard deviation from paired measurements under field conditions *	u <sub>D</sub>	Vol.-%	0.004	(Vol.-%) <sup>2</sup>	
Lack of fit	u <sub>lof</sub>	Vol.-%	0.000	(Vol.-%) <sup>2</sup>	
Zero drift from field test	u <sub>dz</sub>	Vol.-%	0.006	(Vol.-%) <sup>2</sup>	
Span drift from field test	u <sub>ds</sub>	0.092 Vol.-%	0.008	(Vol.-%) <sup>2</sup>	
Influence of ambient temperature at span	u <sub>t</sub>	0.064 Vol.-%	0.007	(Vol.-%) <sup>2</sup>	
Influence of supply voltage	u <sub>v</sub>	0.018 Vol.-%	0.000	(Vol.-%) <sup>2</sup>	
Cross sensitivity (Interference)	u <sub>i</sub>	Vol.-%	0.000	(Vol.-%) <sup>2</sup>	
Influence of sample gas flow	u <sub>g</sub>	Vol.-%	0.000	(Vol.-%) <sup>2</sup>	
Uncertainty of reference material at 70% of certification range	u <sub>rm</sub>	Vol.-%	0.041	(Vol.-%) <sup>2</sup>	
* The larger value is used : "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"					
Combined standard uncertainty (u <sub>c</sub> )		$u_c = \sqrt{\sum (u_{max,i})^2}$		0.26	Vol.-%
Total expanded uncertainty		$U = u_c \cdot k = u_c \cdot 1.96$		0.51	Vol.-%
<b>Relative total expanded uncertainty</b>					
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.					
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## 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  
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File: CAL032528  
DA0999 VQ300 R00





## Calibration Laboratory of TetraTec Instruments GmbH

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Page english version

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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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Tel +497157/53870 · Fax +497157/538710 · [www.tetratec.de](http://www.tetratec.de) · [info@tetratec.de](mailto:info@tetratec.de)

File: CAL032528



Calibration Laboratory of TetraTec Instruments GmbH

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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"),  $Q_{N,TG0} = Q_{OUT} - Q_{N,TG1}$   
 $c_S$  : 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

TetraTec Instruments GmbH · Gewerbestrasse 8 · 71144 Steinbronn · Germany  
Tel +497157/53870 · Fax +497157/538710 · [www.tetratec.de](http://www.tetratec.de) · [info@tetratec.de](mailto:info@tetratec.de)

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](http://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](http://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](mailto: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/m<sup>3</sup>  
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 PT53;  
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  
LIVELLO 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](mailto: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](mailto: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 (ΔC%) Relative Uncertainty (ΔC%)
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 (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 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 RIPIEMIMENTO (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](mailto: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:



**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

### **QAL 2 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

**June, 2017**



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# 1 INTRODUCTION

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SUNLAB Ltd commissioned to CADA snc di F.Giglio & C. the calibration activities (QAL2) 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 linearity test performed on AMS Stack 6D after change over to the methane conversion of the plant.

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),
- ⇒ Calibration function created on 15 parallel measurements.

The technical activity has been performed on 12<sup>th</sup>, 15<sup>th</sup> and 16<sup>th</sup> 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°47 & 48	
Majority fuel	Natural Gas	
GPS Coordinates (N - E)	35°49'57.12"	14°33'27.87"
Pollution abatement system	SCR/Denox + DeSOx + Filter	
Authorization decree	IPPC IP 0002/07/Fii	
Reference Oxygen for Correction of Results	15 % Vol.	

The emission limits with Natural Gas 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 <sup>3</sup>	5
Nitrogen Oxides	mg/Nm <sup>3</sup>	55
Sulfur Dioxide	mg/Nm <sup>3</sup>	100
Carbon Monoxide	mg/Nm <sup>3</sup>	110
Ammonia	mg/Nm <sup>3</sup>	2,6
<b>Note:</b> 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 <sup>2</sup> ]	3,14
Number of Sampling Lines (Access Ports)	2
Conformance of the Sampling Platform	
Sampling platform area > 5 m <sup>2</sup> 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 have been changed, this operation represents the normal plant conditions and increase the variability of data to implement the calibration.

**Table 4 - Plant Load during the measurements**

Plant Load during the measurements				
Fuel	Natural Gas	Other Fuel	/	
Day	Time	Source of emission	Load	
12/05/2017	08:00 - 24:00	DE47 & DE48 shut down	16 MW	50%
15/05/2017	08:00 - 24:00	DE47 & 48	32 MW	100%
16/05/2017	08:00 - 24:00	DE47 & 48	26 MW	80%



## 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 <sub>3</sub>	EPA CTM 027:1997	Procedure for collection and analysis of ammonia in stationary sources.
NO <sub>x</sub>	UNI EN 14792:2006	Stationary source emissions. Determination of mass concentration of nitrogen oxides (NO <sub>x</sub> ). Reference method: Chemiluminescence.
SO <sub>2</sub>	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 <sub>2</sub>	ISO 11042-1:1996	Gas turbines - Exhaust gas emission - Part 1: Measurement and evaluation. Principle of Measurement: Non-dispersive infrared (NDIR).
O <sub>2</sub>	UNI EN 14789:2006	Determination of volume concentration of oxygen (O <sub>2</sub> ). Reference method - Paramagnetism.
H <sub>2</sub> 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 <sub>3</sub>	Dado Lab - ST5	Sampling	
NOx	Horiba / PG - 350 E	CLD chemiluminescence	0-25/50/100/250/ 500/1000/2500 ppm
SO <sub>2</sub>	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 <sub>2</sub>	Horiba / PG - 350 E	ND-IR	0-10/20/30 %
O <sub>2</sub>	Horiba / PG - 350 E	Paramagnetic	0-/10/25 %
H <sub>2</sub> O	Tecora - Ayrton	Sampling	Only Sampling

In Annex 6 and 7, 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 (SO<sub>2</sub>), nitrogen monoxide (NO), nitrogen dioxide (NO<sub>2</sub>), carbon dioxide (CO<sub>2</sub>), ammonia (NH<sub>3</sub>) and water vapor (H<sub>2</sub>O).

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 <sup>3</sup>
		MCS 100 E	ZrO <sub>2</sub>	O <sub>2</sub>	0 - 21 %
			IR Non-Dispersive (NDIR)	CO	0 - 300 mg/Nm <sup>3</sup>
				CO <sub>2</sub>	0 - 25 %
				NO	0 - 300 mg/Nm <sup>3</sup>
				NO <sub>2</sub>	0 - 100 mg/Nm <sup>3</sup>
				SO <sub>2</sub>	0 - 2000 mg/Nm <sup>3</sup>
				NH <sub>3</sub>	0 - 30 mg/Nm <sup>3</sup>



## 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 9<sup>th</sup> 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.

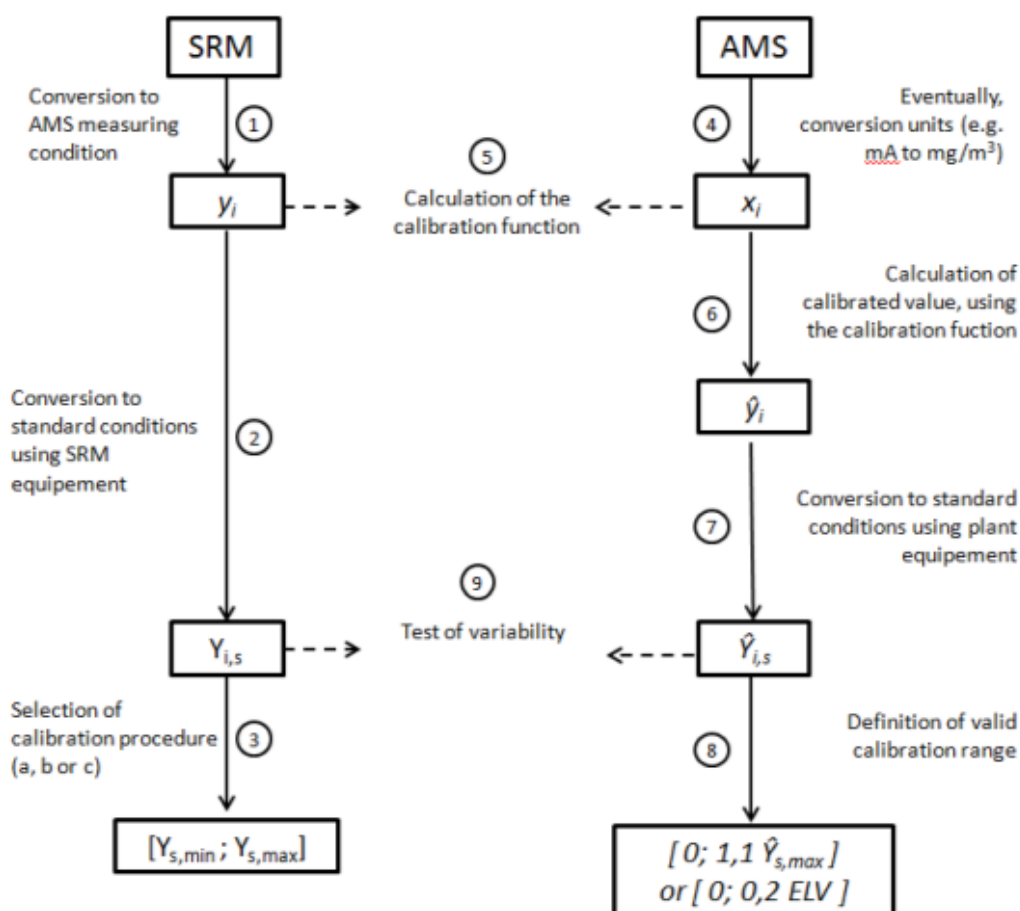
## 7 CALIBRATION and VALIDATION OF THE AMS (QAL2)

### 7.1 DETERMINATION OF THE CALIBRATION FUNCTION

The calibration of the AMS measurement should be performed on at least fifteen parallel measurements with an SRM distributed in a period of 6-8 hours for three days. The object of the parallel measurements was to calibrate and validate the AMS through an independent method (SRM). The tests were carried out over a period of three days in order to take measurements during different states of the system (for example changes of load).

Below it is shown flowchart that describes the steps of the calibration process.

Figure 1 - Flowchart of calibration process



The standard assumes that the calibration function is linear with a constant residual standard deviation. The calibration function is described by the following model.(See ISO 11095):



$$y_i = a + bx_i + \varepsilon_i \quad (9)$$

Where

- $x_i$  is the result  $i^{\text{th}}$  of the AMS;  $i$ =from 1 to N;  $N \geq 15$ ;  
 $y_i$  is the result  $i^{\text{th}}$  of the SRM;  $i$ =from 1 to N;  $N \geq 15$ ;  
 $\varepsilon_i$  is the deviation between  $y_i$  and the expected value;  
 $a$  is the intercept of calibration function;  
 $b$  is the slope of the calibration function.

The following quantities shall be calculated, average value of the AMS ( $\bar{x}$ ) and SRM ( $\bar{y}$ ):

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

$$\bar{y} = \frac{1}{N} \sum_{i=1}^N y_i \quad (11)$$

Following, the difference between the highest and lowest measured SRM concentration at standard condition shall be calculated ( $y_{s,max} - y_{s,min}$ ). Depending on the range of concentrations ( $y_{s,max} - y_{s,min}$ ) reported during the measurement one has to choose the method of calculation of the calibration function.

**Method a:** if ( $y_{s,max} - y_{s,min}$ )  $\geq$  maximum permissible uncertainty.

The parameters of the calibration function shall be calculated according to Formula (12) and Formula (13):

$$\hat{b} = \frac{\sum_{i=1}^N (x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^N (x_i - \bar{x})^2} \quad (12)$$

$$\hat{a} = \bar{y} - \hat{b}\bar{x} \quad (13)$$

**Method b:** if ( $y_{s,max} - y_{s,min}$ )  $<$  maximum permissible uncertainty and  $y_{s,min} \geq 15\%$  of Limit Emission Value (ELV). The parameters of the calibration function shall be calculated according to Formula (14) and Formula (15):



$$\hat{b} = \frac{\bar{y}}{\bar{x} - Z} \quad (14)$$

$$\hat{a} = -\hat{b}Z \quad (15)$$

Where

Z is the difference between the zero reading of the AMS and the zero.

**Method c:** if  $(y_{s,max} - y_{s,min}) < \text{maximum permissible uncertainty}$  and  $y_{s,min} < 15\%$  of Limit Emission Value (ELV). The function is constructed with the same formulas of *Method a* (12 - 13). In addition, two points "surrogate" of Zero and Span (*near the ELV*) are used using gaseous standards.

The calibration function is valid when the plant is operated within the valid calibration range. This valid calibration range is either the calibration range from zero to the maximum value  $y_{s,max}$  of calibrated AMS measured value at standard conditions, determined the QAL2 procedure, plus an extension of 10% of  $y_{s,max}$ , or to 20% of ELV, whichever is greater.

## 7.2 TEST OF VARIABILITY

In order to validate the calibration function obtained in this way, will be executed the test of variability.

The data pairs (SRM and AMS calibrated) thus obtained are normalized and reported to the standard conditions of the plant using auxiliary measures supplied with measurement systems.

For the series of data are calculated:

$$D_i = y_{i,s} - \hat{y}_{i,s} \quad (16)$$

Where

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

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

Mean differences, Formula 17:





$$\bar{D} = \frac{1}{N} \sum_{i=1}^N D_i \quad (17)$$

Standard deviation of differences, Formula 18:

$$S_D = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (D_i - \bar{D})^2} \quad (18)$$

The AMS passes the variability test when:

$$S_D \leq \sigma_0 k_v \quad (16)$$

where

$\sigma_0$  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 factors is:

$$\sigma_0 = \frac{P \times ELV}{1,96} \quad (17)$$

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

$k_v$  is a value from  $\chi^2$ -test with a  $\beta$ -value of 50%. The  $k_v$  value depending on the number of tests conducted.

Table 9-  $k_v$  values

Number of parallel measurement	$k_v(N)$
15	0,9761
16	0,9777
17	0,9791
18	0,9803



## 8 ACCURACY INDEX ACCORDING TO LEGISLATIVE DECREE. 152/06 (IAR)

To verify that the analyzer correctly measures the auxiliary parameters, it has been used Accuracy Index (IAR). This index is reported on Italian Legislative Decree N. 152/2006 - Part V, Annex VI "Criteria for conformity assessment of the measured values to the emission limit values".

In this law the calculation of the IAR (accuracy relative index) was calculated according to the following formula:

$$IAR = 100 \times \left(1 - \frac{M + I_c}{M_r}\right) \quad (18)$$

where

- $M$  It is the arithmetic average of  $N$  values  $X_i$ .
- $X_i$  It represents the absolute value of the difference of the concentrations measured by the two measuring systems (stationary analyzer "AMS" and reference analyzer "SRM").
- $M_r$  It represents the average of the values of the concentrations measured by the reference system (SRM).
- $I_c$  It represents the absolute value of the confidence range calculated for the average of  $N$  values  $X_i$  namely.

$$I_c = t_n \frac{S}{\sqrt{N}} \quad (19)$$

where

- $N$  number of measurements performed.
- $S$  It represents the standard deviation of values  $X_i$ .
- $t_n$  Represents the t Student calculated for the level of confidence of 95% and for (n) degrees of freedom equal to (N-1);



Table 10 - t Student values

N	t <sub>n</sub>
3	4,303
4	3,182
5	2,776
6	2,571
7	2,447
8	2,365
9	2,306
10	2,262
11	2,229
12	2,201
13	2,179
14	2,16
15	2,145
16	2,131

The AMS system is considered verified if the value of the **IAR** is above **80%**. The result of IAR test are in Annex 5.

## 8.1 DETERMINATION OF HOMOGENEITY OF THE SAMPLING POINT

During the Accuracy test (IAR), the homogeneity testing of the sampling point is performed in according to Technical standard UNI EN 15259:2006, *paragraph 8.3 - Determination of homogeneity*. The procedure involves measuring one parameter, such as Oxygen (O<sub>2</sub>) and its spatial and temporal variations shall be applied to determine the homogeneity. Below, the procedure:

- ⇒ determine the sampling points for the grid measurement;
- ⇒ install the probe of the measuring system for the grid measurement;
- ⇒ install the probe of an independent measuring system (reference measurement) at a fixed point in the measurement section;
- ⇒ adjust the sample flow in both systems in order to obtain equal response times;
- ⇒ perform a grid measurement and in parallel measurements at a fixed point in the measurement section, with a sampling time of at least four times the response time of the measuring system but not less than three minutes for each sampling point;



- ⇒ Record for each sampling point  $i$  the actual value  $y_{i,grid}$  of the measurand in the grid and the value  $y_{i,ref}$  of the reference measurement;
- ⇒ For each sample point  $i$ , determines the ratio  $r_i$  defined as follows:

$$r_i = \frac{y_{i,grid}}{y_{i,ref}} \quad (20)$$

- ⇒ average  $\bar{r}$  of the ratios  $r_i$  according to Equation (21):

$$\bar{r} = \frac{1}{N} \sum_{i=1}^N r_i \quad (21)$$

- ⇒ standard deviation  $s_{grid}$  of the grid measurements according to Equation (22):

$$s_{grid} = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (y_{i,grid} - \bar{y}_{grid})^2} \quad (22)$$

- ⇒ standard deviation  $s_{ref}$  of the reference measurements according to Equation (23):

$$s_{ref} = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (y_{i,ref} - \bar{y}_{ref})^2} \quad (23)$$

If  $s_{grid} < s_{ref}$ , the distribution of the gas in the measuring section can be considered homogeneous and sampling can therefore be performed in any point of the section occurred.

The result of Homogeneity of sampling point are in Annex 1.



## 9 RESULTS

Below a summary of the results obtained from the QAL2 test performed on the analyzer (AMS) installed on the stack 6D. Note that for ammonia and sulfur dioxide the QAL2 procedure is not applicable because the parameters concentration are below the detection limit (LOD).

In Annex 4, there are reports for single parameter.

Table 11 - Results of QAL2

Summary Report of QAL2							
Parameter	Slope	Intercept	Range of Validity	Procedure for the determination of the calibration function	Maximum permissible uncertainty (95% confidence interval)	Experimental Confidence interval [%]	Emission Limit Value (ELV)
Dust	0,567	0,000	0 - 2,95 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	Metodo B	30	23,34	5
Nitrogen Oxide (NO)	0,724	-0,185	0 - 26,67 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	Metodo A	20	10,32	55
Carbon Monoxide (CO)	1,085	-1,711	0 - 22 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	Metodo C	10	0,48	110
Oxygen (O <sub>2</sub> )	1,068	0,000	0 - 13,98 [% Vol.]	Metodo B	10	1,36	/
Carbon Dioxide (CO <sub>2</sub> )	1,043	0,010	0 - 5,53 [% Vol.]	Metodo B	10	1,25	/

As regards carbon monoxide and nitrogen monoxide, the range of validity is lower than the emission limit value, carbon monoxide ELV is 110 mg/Nm<sup>3</sup> and nitrogen monoxide ELV is 55 mg/Nm<sup>3</sup>, then the consideration of Chapter 6.5 "Calibration Function of the AMS and its validity" of the technical standard EN 14181 : 2015 are applied.

Table 12 - Zero Verify

Zero verify for single parameter (Rif. 6.5 - Calibration Function of the AMS and its validity EN 14181 : 2015)						
Parameter	Emission Limit Value (ELV)	Range of Validity	Reference Concentration (ZERO)	AMS Response	Deviation of the AMS calibrated value compared to the reference concentration	Result (Deviation < 10 % ELV)
Nitrogen Oxide (NO)	55	0 - 26,62 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	0	0,1	2,33	Positive
Carbon Monoxide (CO)	110	0 - 22 [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]	0	0	1,71	Positive



Table 13 - Span/ELV Verify

Span/ELV Verify (Rif. 6.5 - Calibration Function of the AMS and its validity EN 14181 : 2015)								
Parameter	Emission Limit Value (ELV)	Range of Validity	Reference Concentration (ELV - SPAN)	AMS Response	Deviation of the AMS calibrated value compared to the reference concentration	Maximum permissible uncertainty (95% confidence interval)	Maximum permissible uncertainty (95% confidence interval) at ELV	Result (Deviation < I.C. 95% - ELV)
Nitrogen Oxide (NO)	55	0 - 26,67 [mg/Nm3 rif O2]	51,4	57	10,34	20	11	Positive
Carbon Monoxide (CO)	110	0 - 22 [mg/Nm3 rif O2]	115,4	112,2	4,57	10	11	Positive

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

Table 14 - IAR Values

I <sub>AR</sub> Water Vapour	I <sub>AR</sub> Temperature	I <sub>AR</sub> Pressure	I <sub>AR</sub> Flow Rate
94,2	99,5	96,2	80,5





## 10 CONCLUSIONS AND COMMENTS

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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 QAL2. 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.

The Ammonia and Sulfur Dioxide parameters are in concentrations below instrumental detection limits, so it has not been possible to construct the QAL2 calibration. However, the analyzer can still correctly record the two parameters, this is noted by the linearity test.

Auxiliary parameter analyzers respond positively to the accuracy test, this shows that they work properly.



## 11 ANNEX 1 – FUNCTIONAL TEST

1	ALIGNMENT AND CLEANLINESS (ONLY NON-EXTRACTIVE SYSTEM)	
	Type of Verification (visual)	Notes / Comments
a	Obstruction Optical path	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. The visual checks required by EN 14181 were positive.
b	Cleaning of Optical Components	
c	Alignment	
d	Presence of Air Purge	

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 28/03/2017 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 <sup>(1)</sup>					
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 <sub>2</sub>	mg/Nm3	0	0	0	140,77	139
				0,3		138
				0,2		139
O <sub>2</sub>	% Vol	0	0	0	16,707	16,38
				0,1		16,4
				0		16,4
CO <sub>2</sub>	% Vol	0	0	0,1	16,78	16,3
				0		16,3
				0		16,3
NH <sub>3</sub>	mg/Nm3	0	0	0	17,93	18
				0,1		17,7
				0		17,6
NO <sub>2</sub>	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 <sub>c,rel</sub> [%]	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 <sub>2</sub>	0 - 2000 mg/Nm3	0,996	0,662	0,2	Positive
O <sub>2</sub>	0 - 21 %vol	0,985	0,012	0,4	Positive
CO <sub>2</sub>	0 - 25 %vol	0,991	-0,297	1,3	Positive
NH <sub>3</sub>	0 - 30 mg/Nm3	0,944	0,234	2,0	Positive
NO <sub>2</sub>	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

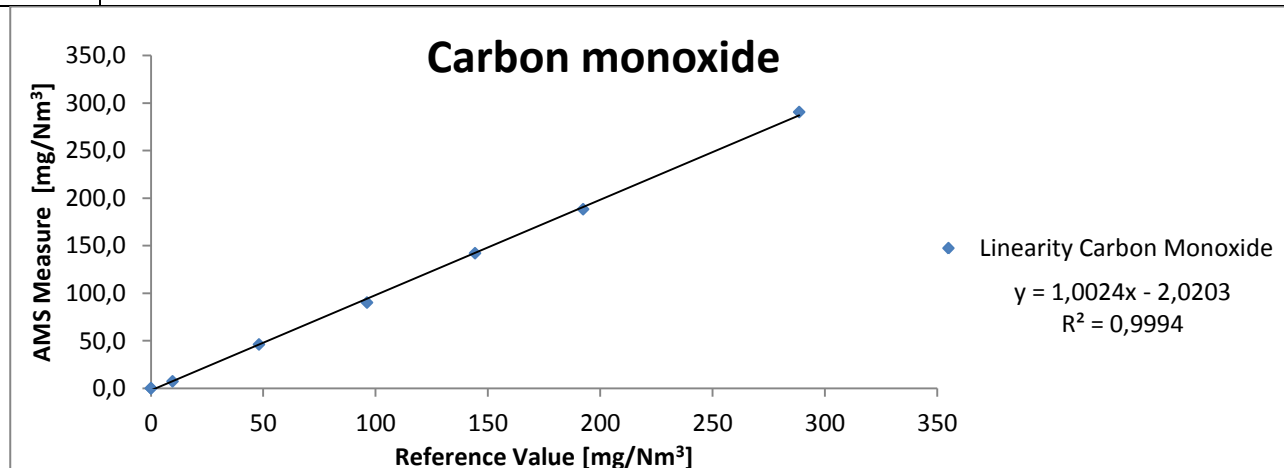
<b>Determination of homogeneity of the Sampling Point (Rif. 8.3 Determination of homogeneity - UNI EN 15259:2006)</b>							
Point	Grid Sampling	Diameter	O <sub>2</sub> [% vol] SRM	S <sub>grid</sub> O <sub>2</sub> SRM	O <sub>2</sub> [% vol] AMS	S <sub>grid</sub> O <sub>2</sub> AMS	Result
1	9	1	12,50	0,12	11,80	0,14	Positive
2	29	1	12,20		11,90		
3	59	1	12,40		11,90		
4	141	1	12,30		12,00		
5	171	1	12,50		12,20		
6	191	1	12,50		11,90		
7							
8							
9							
10							
11	9	2	12,50		11,90		
12	29	2	12,20		12,20		
13	59	2	12,40		11,90		
14	141	2	12,50		11,80		
15	171	2	12,50		11,80		
16	191	2	12,30		11,80		
17							
18							
19							
20							



## 12 ANNEX 2 – TEST LINEARITY RESULTS

### 12.1 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 <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	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 <sub>z</sub>	97,4	A'	95,6	B	1,002	A	-2,0203
Legend									
Yi: concentration of reference material; Xi: AMS measure corresponding to the Reference Material Concentration Level; Yz: 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									





## 12.2 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/Nm <sup>3</sup>	Expiration	30/03/2019
Date measurements	09/05/2017		Diluter	Beta CAP30RK

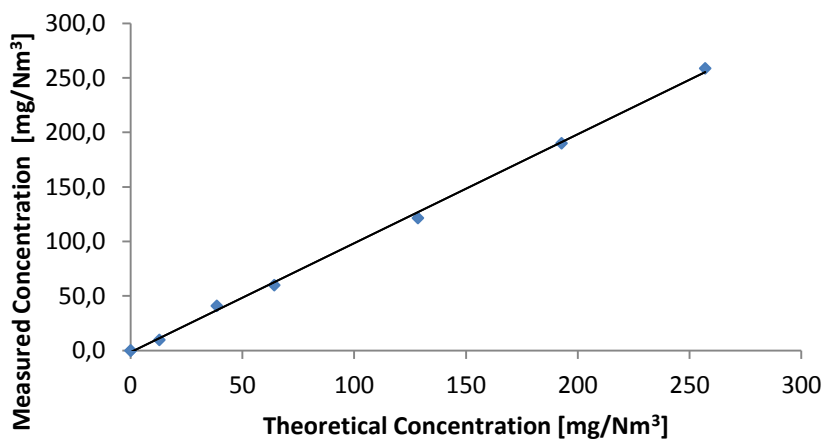
### Measurements and calculations

NO mg/Nm <sup>3</sup>	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	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 <sub>z</sub>			86,7	A'	85,2	B	0,999	A	-1,4117

### Legend

Y<sub>i</sub>: concentration of reference material;  
X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  
Y<sub>z</sub>: 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

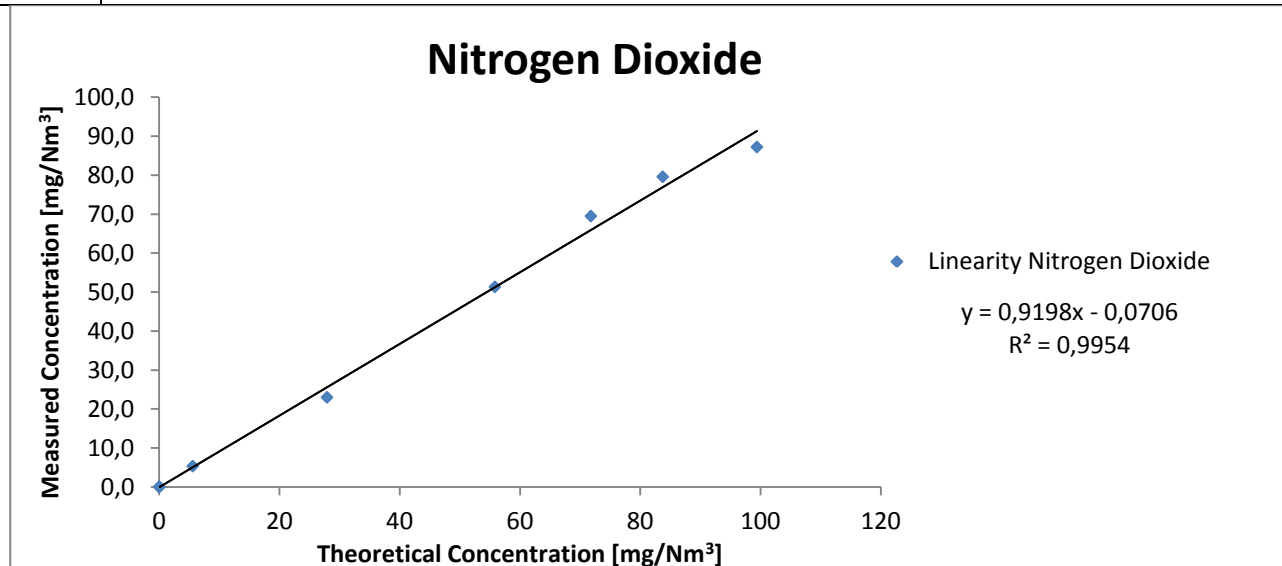
### Nitrogen monoxide





### 12.3 TEST LINEARITY OF NITROGEN DIOXIDE

Stack		6D			Data materials used				
Customer		D3 POWER GENERATION LIMITED			Cylinder Producer		SAPIO		
Parameter		NO <sub>2</sub>			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 <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	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 <sub>z</sub>	43,0	A'	39,5	B	0,920	A	-0,0706
Legend									
Y <sub>i</sub> : concentration of reference material; Xi: AMS measure corresponding to the Reference Material Concentration Level; Y <sub>z</sub> : 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									





## 12.4 TEST LINEARITY OF SULFUR DIOXIDE

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

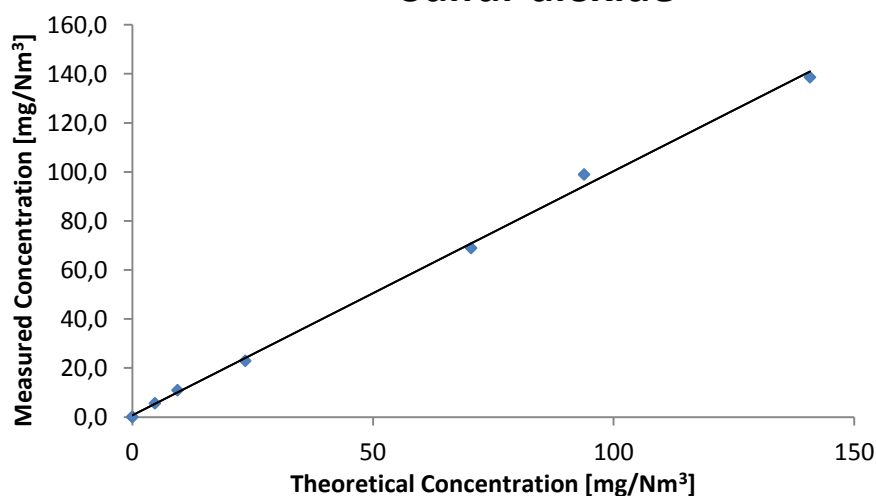
### Measurements and calculations

SO <sub>2</sub> mg/Nm <sup>3</sup>	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	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 <sub>z</sub>	42,8	A'	43,3	B	0,996	A	0,6618

### Legend

Y<sub>i</sub>: concentration of reference material;  
X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  
Y<sub>z</sub>: 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  
 $y = 0,9963x + 0,6618$   
 $R^2 = 0,9982$



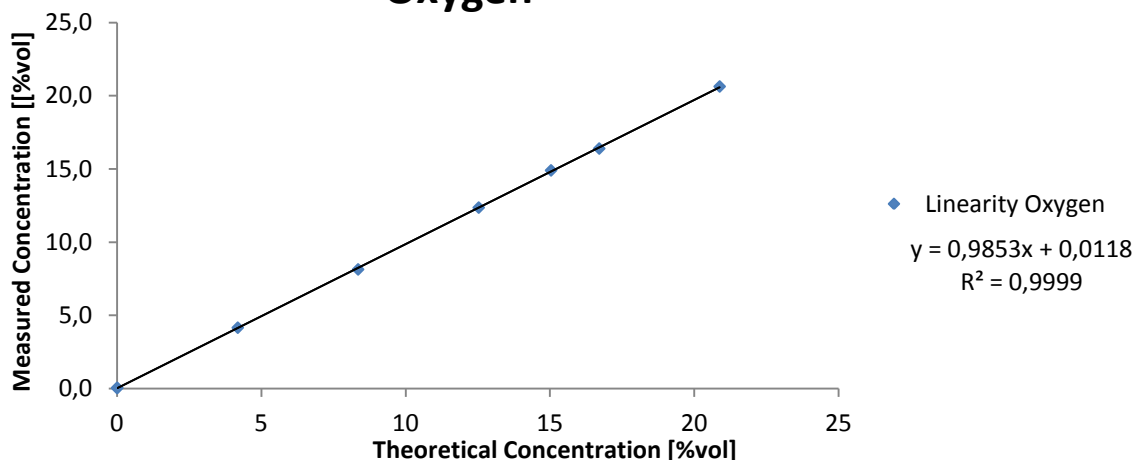
## 12.5 TEST LINEARITY OF OXYGEN

Stack	6D		Data materials used	
Customer	D3 POWER GENERATION LIMITED		Cylinder Producer	SAPIO
Parameter	O <sub>2</sub>		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 <sub>2</sub> %vol	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	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 <sub>z</sub>	9,7	A'	9,6	B	0,985	A	0,0118
Legend									
<p>Y<sub>i</sub>: concentration of reference material;  X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  Y<sub>z</sub>: 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

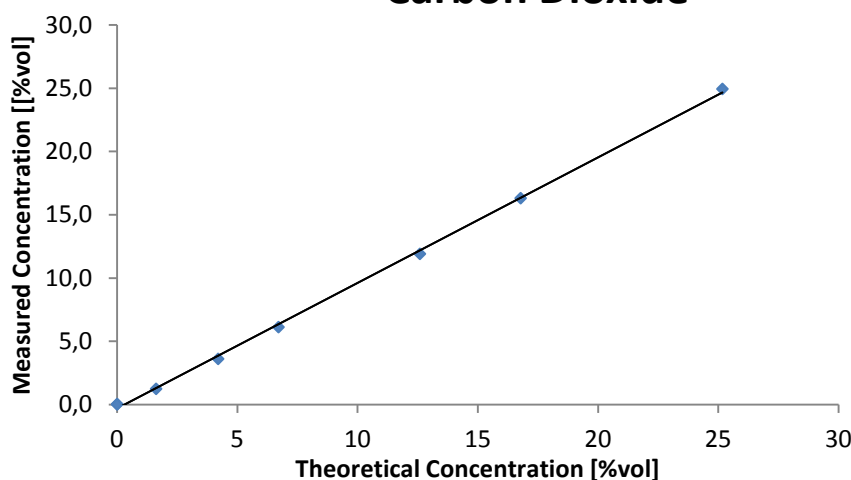




## 12.6 TEST LINEARITY OF CARBON DIOXIDE

Stack			6D			Data materials used			
Customer			D3 POWER GENERATION LIMITED			Cylinder Producer		SAPIO	
Parameter			CO <sub>2</sub>			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 <sub>2</sub> %vol	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	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 <sub>z</sub>	8,4	A'	8,0	B	0,991	A	-0,2965
	Legend								
Y <sub>i</sub> : concentration of reference material; Xi: AMS measure corresponding to the Reference Material Concentration Level; Y <sub>z</sub> : 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									

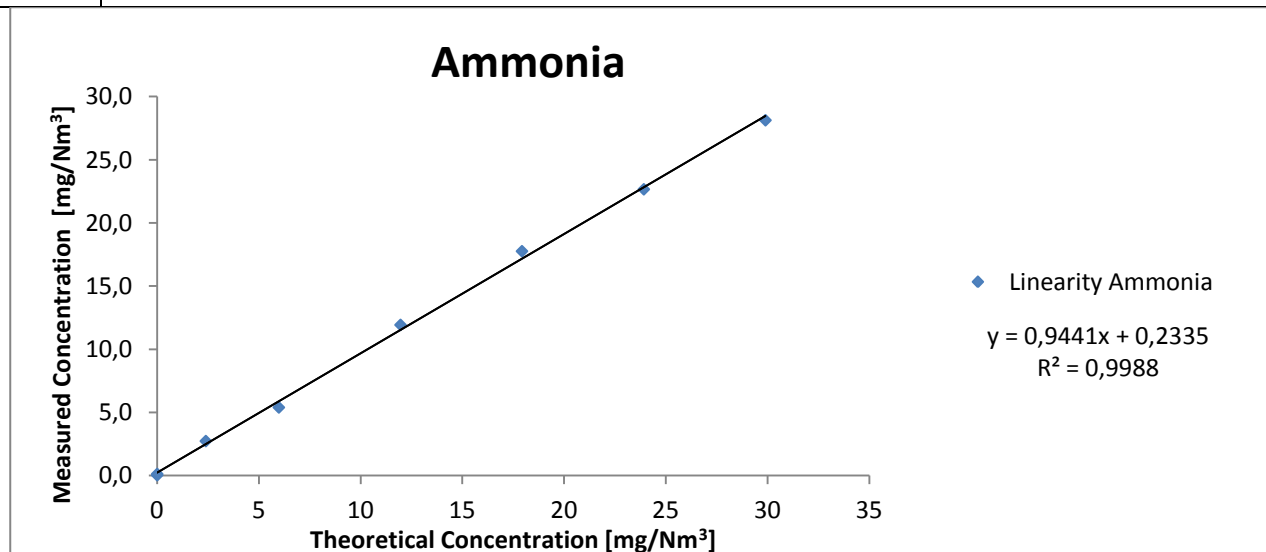
### Carbon Dioxide





## 12.7 TEST LINEARITY OF AMMONIA

Stack		6D		Data materials used					
Customer		D3 POWER GENERATION LIMITED		Cylinder Producer		SAPIO			
Parameter		NH <sub>3</sub>		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 <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	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 <sub>z</sub>	11,5	A'	11,1	B	0,944	A	0,2335
Legend									
<p>Y<sub>i</sub>: concentration of reference material; X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level; Y<sub>z</sub>: 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>									





## 13 ANNEX 3 - TEST REPORT

### 13.1 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 <sub>2</sub> )				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 <sup>2</sup> ]		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							12/05/2017
Point	Diameter	Grid Sampling	Temperatura [°C]	Δpi [Pa]	Velocity [m/s]	Auxiliary Parameter	
1	1	9	160	88,5	12,5	Oxygen [% vol]	12,5
2	1	29	160,2	92,4	12,7		
3	1	59	160,45	91,5	12,7		
4	1	141	161	90,2	12,6	Carbon dioxide [%vol]	4,6
5	1	171	161	91,3	12,7		
6	1	191	161,2	90,8	12,6		
7						Water vapor [% vol]	9,51
8							
9							
10						Density - ρ (Kg/m <sup>3</sup> )	1,304
11	2	9	160	91,3	12,6		
12	2	29	161	91,5	12,7		
13	2	59	161,5	91,6	12,7	Pressione Emissione [kPa]	101
14	2	141	160,2	92,0	12,7		
15	2	171	160,2	91,3	12,7		
16	2	191	161,2	91,6	12,7	Ambient Temperature [°C]	28
17							
18							
19						Ambient Pressure [hPa]	1011
20							





Determination of the velocity profile							15/05/2017	
Point	Diameter	Grid Sampling	Temperatura [°C]	Δpi [Pa]	Velocity [m/s]	Auxiliary Parameter		
1	1	9	164	383,3	25,9	Oxygen [% vol]	12,2	
2	1	29	164,82	389,4	26,1			
3	1	59	165,35	390,4	26,2			
4	1	141	166	391,0	26,2	Carbon dioxide [%vol]	5	
5	1	171	166	389,2	26,2			
6	1	191	165,2	389,0	26,1			
7						Water vapor [% vol]	9,97	
8								
9								
10						Density - ρ (Kg/m³)	1,306	
11	2	9	165,17	360,0	25,1			
12	2	29	165,49	355,0	25,0			
13	2	59	165	365,0	25,3	Pressione Emissione [kPa]	102	
14	2	141	165,4	363,0	25,2			
15	2	171	165,3	358,0	25,1			
16	2	191	165,4	355,4	25,0	Ambient Temperature [°C]	29	
17								
18								
19						Ambient Pressure [hPa]	1011	
20								
Determination of the velocity profile							16/05/2017	
Point	Diameter	Grid Sampling	Temperatura [°C]	Δpi [Pa]	Velocity [m/s]	Auxiliary Parameter		
1	1	9	158,38	246,7	20,6	Oxygen [% vol]	12,2	
2	1	29	160	244,8	20,6			
3	1	59	162	245,0	20,7			
4	1	141	163	250,3	20,9	Carbon dioxide [%vol]	4,9	
5	1	171	165	254,2	21,1			
6	1	191	165	255,0	21,1			
7						Water vapor [% vol]	10,44	
8								
9								
10						Density - ρ (Kg/m³)	1,305	
11	2	9	165,4	252,6	21,1			
12	2	29	165,3	252,9	21,1			
13	2	59	164	254,0	21,1	Pressione Emissione [kPa]	102	
14	2	141	165,5	253,8	21,1			
15	2	171	164,4	253,6	21,1			
16	2	191	163,8	252,3	21,0	Ambient Temperature [°C]	31	
17								
18								
19						Ambient Pressure [hPa]	102	
20								



## 13.2 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 <sub>2</sub> )				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 <sup>3</sup> ] <sup>(1)</sup>
Method Blank		12/05/2017	/	FF04	0,00	0,05	1,000
2123748-001	Reply 1	12/05/2017 09:59	60	FF05	0,77	0,06	0,992
2123748-002	Reply 2	12/05/2017 10:59	60	FF06	0,26	0,06	0,995
2123748-003	Reply 3	12/05/2017 14:59	60	FF07	0,86	0,04	0,972
2123748-004	Reply 4	12/05/2017 16:59	60	FF08	2,02	0,04	0,962
2123748-005	Reply 5	12/05/2017 18:59	60	FF09	0,77	0,04	0,982
Method Blank		15/05/2017	/	FF10	0,00	0,05	1,000
2123748-006	Reply 6	15/05/2017 09:59	60	FF11	1,71	0,05	2,032
2123748-007	Reply 7	15/05/2017 10:59	60	FF12	0,56	0,06	1,044
2123748-008	Reply 8	15/05/2017 13:59	60	FF13	0,73	0,06	0,959
2123748-009	Reply 9	15/05/2017 15:59	60	FF14	0,85	0,05	0,935
2123748-010	Reply 10	15/05/2017 16:59	60	FF15	1,87	0,04	0,934
Method Blank		16/05/2017	/	FF16	0,00	0,04	1,000
2123748-011	Reply 11	16/05/2017 09:59	60	FF17	1,02	0,04	0,833
2123748-012	Reply 12	16/05/2017 10:59	60	FF18	0,76	0,04	0,813
2123748-013	Reply 13	16/05/2017 12:59	60	FF19	0,79	0,04	0,840
2123748-014	Reply 14	16/05/2017 13:59	60	FF20	1,14	0,04	0,827
2123748-015	Reply 15	16/05/2017 14:59	60	FF21	1,51	0,04	0,833

<sup>(1)</sup> For Blanks of the method is considered a volume of 1 m<sup>3</sup>



Dust - Sampling and analysis Data							2
I.D. Sample	Stack Speed [m/s]	Temperature [°C]	Pressure [kPa]	H <sub>2</sub> O [%v/v]	O <sub>2</sub> [%v/v]	Dust Concentration [mg/Nm <sup>3</sup> ] <sup>(2)</sup>	Dust Concentration correct with O <sub>2</sub> [mg/Nm <sup>3</sup> ] <sup>(3)</sup>
Method Blank	/	/	/	10,34	15,00	0,05	0,05
2123748-001	12,75	159,88	100,6	9,86	12,63	0,83	0,60
2123748-002	12,68	160,45	100,7	10,71	12,55	0,32	0,23
2123748-003	12,38	160,06	100,7	10,09	12,50	0,93	0,66
2123748-004	12,25	160,14	100,7	10,77	12,46	2,15	1,51
2123748-005	12,43	159,79	100,7	10,29	12,48	0,83	0,58
Method Blank	/	/	/	9,97	15,00	0,05	0,05
2123748-006	26,11	164,82	102,0	9,41	12,17	0,87	0,59
2123748-007	26,16	165,35	102,1	10,43	12,15	0,59	0,40
2123748-008	23,96	165,49	102,0	9,88	12,13	0,82	0,56
2123748-009	23,25	165,51	102,1	9,90	12,05	0,97	0,65
2123748-010	23,16	165,11	95,2	10,24	12,06	2,05	1,38
Method Blank	/	/	/	9,96	15,00	0,04	0,04
2123748-011	21,05	163,95	101,7	10,56	12,27	1,28	0,88
2123748-012	20,17	162,46	96,0	9,57	12,64	0,98	0,70
2123748-013	20,66	158,38	101,7	10,07	12,18	0,99	0,67
2123748-014	20,46	161,23	95,8	10,24	12,13	1,43	0,96
2123748-015	20,40	162,46	95,7	9,38	12,14	1,86	1,26
<sup>(2)</sup> Dust Concentration (Wet).							
<sup>(3)</sup> 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 [%] <sup>(4)</sup>	Result	Dust Concentration correct with O <sub>2</sub> [mg/Nm <sup>3</sup> ] - Blank	Result <sup>(5)</sup>
Method Blank		12/05/2017	/			0,05	Positive
2123748-001	Reply 1	12/05/2017 09:59	60	-0,1	Positive		
2123748-002	Reply 2	12/05/2017 10:59	60	-0,1	Positive		
2123748-003	Reply 3	12/05/2017 14:59	60	0	Positive		
2123748-004	Reply 4	12/05/2017 16:59	60	0	Positive		
2123748-005	Reply 5	12/05/2017 18:59	60	0	Positive		
Method Blank		15/05/2017	/			0,05	Positive
2123748-006	Reply 6	15/05/2017 09:59	60	-0,1	Positive		
2123748-007	Reply 7	15/05/2017 10:59	60	0	Positive		
2123748-008	Reply 8	15/05/2017 13:59	60	0	Positive		
2123748-009	Reply 9	15/05/2017 15:59	60	0	Positive		
2123748-010	Reply 10	15/05/2017 16:59	60	0	Positive		
Method Blank		16/05/2017	/			0,04	Positive
2123748-011	Reply 11	16/05/2017 09:59	60	0	Positive		
2123748-012	Reply 12	16/05/2017 10:59	60	0	Positive		
2123748-013	Reply 13	16/05/2017 12:59	60	0	Positive		
2123748-014	Reply 14	16/05/2017 13:59	60	0	Positive		
2123748-015	Reply 15	16/05/2017 14:59	60	0	Positive		
<sup>(4)</sup> Dust sampling must be done in isocinetics. The isocinetic value must be within the Range -5% <G <+ 15%.							
<sup>(5)</sup> 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).							



### 13.3 COMBUSTION GAS REPORT

Nitrogen Oxides, Carbon Monoxide, Sulfur Dioxide, Oxygen and Carbon Dioxide - Sampling and Analysis Report					
Oxygen (O <sub>2</sub> )				UNI EN 14789:2017	
Nitrogen Oxide (NO)				UNI EN 14792:2017	
Carbon Monoxide (CO)				UNI EN 15058:2017	
Sulfur Dioxide (SO <sub>2</sub> )				ISO 11042-1:1996	
Carbon Dioxide (CO <sub>2</sub> )				ISO 11042-1:1996	
Information on the instrumentatio 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 (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2123748-001	Reply 1	12/05/2017 09:59	60	14,11	12,63
2123748-002	Reply 2	12/05/2017 10:59	60	13,53	12,55
2123748-003	Reply 3	12/05/2017 14:59	60	13,62	12,52
2123748-004	Reply 4	12/05/2017 16:59	60	13,70	12,52
2123748-005	Reply 5	12/05/2017 18:59	60	13,59	12,63
2123748-006	Reply 6	15/05/2017 09:59	60	14,32	12,17
2123748-007	Reply 7	15/05/2017 10:59	60	13,89	12,15
2123748-008	Reply 8	15/05/2017 13:59	60	14,56	12,06
2123748-009	Reply 9	15/05/2017 15:59	60	14,81	12,17
2123748-010	Reply 10	15/05/2017 16:59	60	13,65	12,23
2123748-011	Reply 11	16/05/2017 10:59	60	36,96	12,64
2123748-012	Reply 12	16/05/2017 12:59	60	14,33	12,13
2123748-013	Reply 13	16/05/2017 13:59	60	14,85	12,14
2123748-014	Reply 14	16/05/2017 14:59	60	14,53	12,16
2123748-015	Reply 15	16/05/2017 15:59	60	32,42	11,60
Notes:					
(1) The oxygen value reported refers to the same measurement period of the parameter on which QAL2 (NO) is performed.					
(2) The Nitrogen Oxide (NO) value is not 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
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Carbon Monoxide (CO) - [mg/Nm <sup>3</sup> ]	Oxygen (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2123748-001	Reply 1	12/05/2017 09:59	60	1,55	12,63
2123748-002	Reply 2	12/05/2017 10:59	60	1,56	12,55
2123748-003	Reply 3	12/05/2017 14:59	60	1,53	12,52
2123748-004	Reply 4	12/05/2017 16:59	60	1,89	12,52
2123748-005	Reply 5	12/05/2017 18:59	60	2,09	12,63
2123748-006	Reply 6	15/05/2017 09:59	60	2,20	12,17
2123748-007	Reply 7	15/05/2017 10:59	60	2,53	12,15
2123748-008	Reply 8	15/05/2017 13:59	60	2,48	12,06
2123748-009	Reply 9	15/05/2017 15:59	60	2,92	12,17
2123748-010	Reply 10	15/05/2017 16:59	60	3,18	12,23
2123748-011	Reply 11	16/05/2017 09:59	60	3,41	12,27
2123748-012	Reply 12	16/05/2017 10:59	60	3,30	12,64
2123748-013	Reply 13	16/05/2017 12:59	60	2,95	12,13
2123748-014	Reply 14	16/05/2017 13:59	60	3,11	12,14
2123748-015	Reply 15	16/05/2017 14:59	60	3,21	12,16
Notes: (1) The oxygen value reported refers to the same measurement period of the parameter on which QAL2 (CO) is performed. (2) The carbon monoxide (CO) value is not corrected for the reference oxygen, is normalized by temperature and pressure and is expressed on a dry basis.					

Determination of Sulfur Dioxide (SO <sub>2</sub> ) - Sampling and analysis Data					3
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Sulfur Dioxide (SO <sub>2</sub> ) - [mg/Nm <sup>3</sup> ]	Oxygen (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2123748-001	Reply 1	12/05/2017 09:59	60	< 0,1	12,63
2123748-002	Reply 2	12/05/2017 10:59	60	< 0,1	12,55
2123748-003	Reply 3	12/05/2017 14:59	60	< 0,1	12,52
2123748-004	Reply 4	12/05/2017 16:59	60	< 0,1	12,52
2123748-005	Reply 5	12/05/2017 18:59	60	< 0,1	12,63
2123748-006	Reply 6	15/05/2017 09:59	60	< 0,1	12,17
2123748-007	Reply 7	15/05/2017 10:59	60	< 0,1	12,15
2123748-008	Reply 8	15/05/2017 13:59	60	< 0,1	12,06
2123748-009	Reply 9	15/05/2017 15:59	60	< 0,1	12,17
2123748-010	Reply 10	15/05/2017 16:59	60	< 0,1	12,23
2123748-011	Reply 11	16/05/2017 10:59	60	< 0,1	12,64
2123748-012	Reply 12	16/05/2017 12:59	60	< 0,1	12,13
2123748-013	Reply 13	16/05/2017 13:59	60	< 0,1	12,14
2123748-014	Reply 14	16/05/2017 14:59	60	< 0,1	12,16
2123748-015	Reply 15	16/05/2017 15:59	60	< 0,1	11,6
Notes: (1) The oxygen value reported refers to the same measurement period of the parameter on which QAL2 (SO <sub>2</sub> ) is performed. (2) The sulfur dioxide (SO <sub>2</sub> ) value is not corrected for the reference oxygen, is normalized by temperature and pressure and is expressed on a dry basis.					



Determination of Oxygen (O <sub>2</sub> ) - Sampling and analysis Data				3
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Oxygen (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2123748-001	Reply 1	12/05/2017 09:59	60	12,63
2123748-002	Reply 2	12/05/2017 10:59	60	12,55
2123748-003	Reply 3	12/05/2017 14:59	60	12,52
2123748-004	Reply 4	12/05/2017 16:59	60	12,52
2123748-005	Reply 5	12/05/2017 18:59	60	12,63
2123748-006	Reply 6	15/05/2017 09:59	60	12,17
2123748-007	Reply 7	15/05/2017 10:59	60	12,15
2123748-008	Reply 8	15/05/2017 13:59	60	12,06
2123748-009	Reply 9	15/05/2017 15:59	60	12,17
2123748-010	Reply 10	15/05/2017 16:59	60	12,23
2123748-011	Reply 11	16/05/2017 09:59	60	12,27
2123748-012	Reply 12	16/05/2017 10:59	60	12,64
2123748-013	Reply 13	16/05/2017 12:59	60	12,13
2123748-014	Reply 14	16/05/2017 13:59	60	12,14
2123748-015	Reply 15	16/05/2017 14:59	60	12,16
Notes: (1) The Oxygen value reported refers to the values used to construct the QAL2 calibration function.				

Determination of Carbon Dioxide (CO <sub>2</sub> ) - Sampling and analysis Data				4
I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Carbon Dioxide (CO <sub>2</sub> ) - [%vol] <sup>(1)</sup>
2123748-001	Reply 1	12/05/2017 09:59	60	4,56
2123748-002	Reply 2	12/05/2017 10:59	60	4,57
2123748-003	Reply 3	12/05/2017 14:59	60	4,59
2123748-004	Reply 4	12/05/2017 16:59	60	4,59
2123748-005	Reply 5	12/05/2017 18:59	60	4,57
2123748-006	Reply 6	15/05/2017 09:59	60	5,01
2123748-007	Reply 7	15/05/2017 10:59	60	5,01
2123748-008	Reply 8	15/05/2017 13:59	60	5,05
2123748-009	Reply 9	15/05/2017 15:59	60	5,02
2123748-010	Reply 10	15/05/2017 16:59	60	5,00
2123748-011	Reply 11	16/05/2017 09:59	60	4,95
2123748-012	Reply 12	16/05/2017 10:59	60	4,79
2123748-013	Reply 13	16/05/2017 12:59	60	4,99
2123748-014	Reply 14	16/05/2017 13:59	60	5,00
2123748-015	Reply 15	16/05/2017 14:59	60	4,99
Notes: (1) The value of Carbon Dioxide reported refers to the values used to construct the QAL2 calibration function.				





## 13.4 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 <sub>2</sub> )				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 <sub>2</sub> SO <sub>4</sub> - 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 <sup>3</sup> ] <sup>(1)</sup>	Impinger G1 [mg]	Impinger G2 [mg]	Concentration [mg/Nm <sup>3</sup> ]
Method Blank		12/05/2017	60	0,000	0,000	0,000	/
2123748-001	Reply 1	12/05/2017 09:59	60	0,992	0,000	0,000	< 0,1
2123748-002	Reply 2	12/05/2017 10:59	60	0,995	0,000	0,000	< 0,1
2123748-003	Reply 3	12/05/2017 14:59	60	0,972	0,000	0,000	< 0,1
2123748-004	Reply 4	12/05/2017 16:59	60	0,962	0,000	0,000	< 0,1
2123748-005	Reply 5	12/05/2017 18:59	60	0,982	0,000	0,000	< 0,1
Method Blank		15/05/2017	60	0,000	0,000	0,000	/
2123748-006	Reply 6	15/05/2017 09:59	60	2,032	0,000	0,000	< 0,1
2123748-007	Reply 7	15/05/2017 10:59	60	1,044	0,000	0,000	< 0,1
2123748-008	Reply 8	15/05/2017 13:59	60	0,959	0,000	0,000	< 0,1
2123748-009	Reply 9	15/05/2017 15:59	60	0,935	0,000	0,000	< 0,1
2123748-010	Reply 10	15/05/2017 16:59	60	0,934	0,000	0,000	< 0,1
Method Blank		16/05/2017	60	0,000	0,000	0,000	/
2123748-011	Reply 11	16/05/2017 09:59	60	0,833	0,000	0,000	< 0,1
2123748-012	Reply 12	16/05/2017 10:59	60	0,813	0,000	0,000	< 0,1
2123748-013	Reply 13	16/05/2017 12:59	60	0,840	0,000	0,000	< 0,1
2123748-014	Reply 14	16/05/2017 13:59	60	0,827	0,000	0,000	< 0,1
2123748-015	Reply 15	16/05/2017 14:59	60	0,833	0,000	0,000	< 0,1

<sup>(1)</sup> For Blanks of the method is considered a volume of 1 m<sup>3</sup>





## 14 ANNEX 4 - QAL2 REPORT

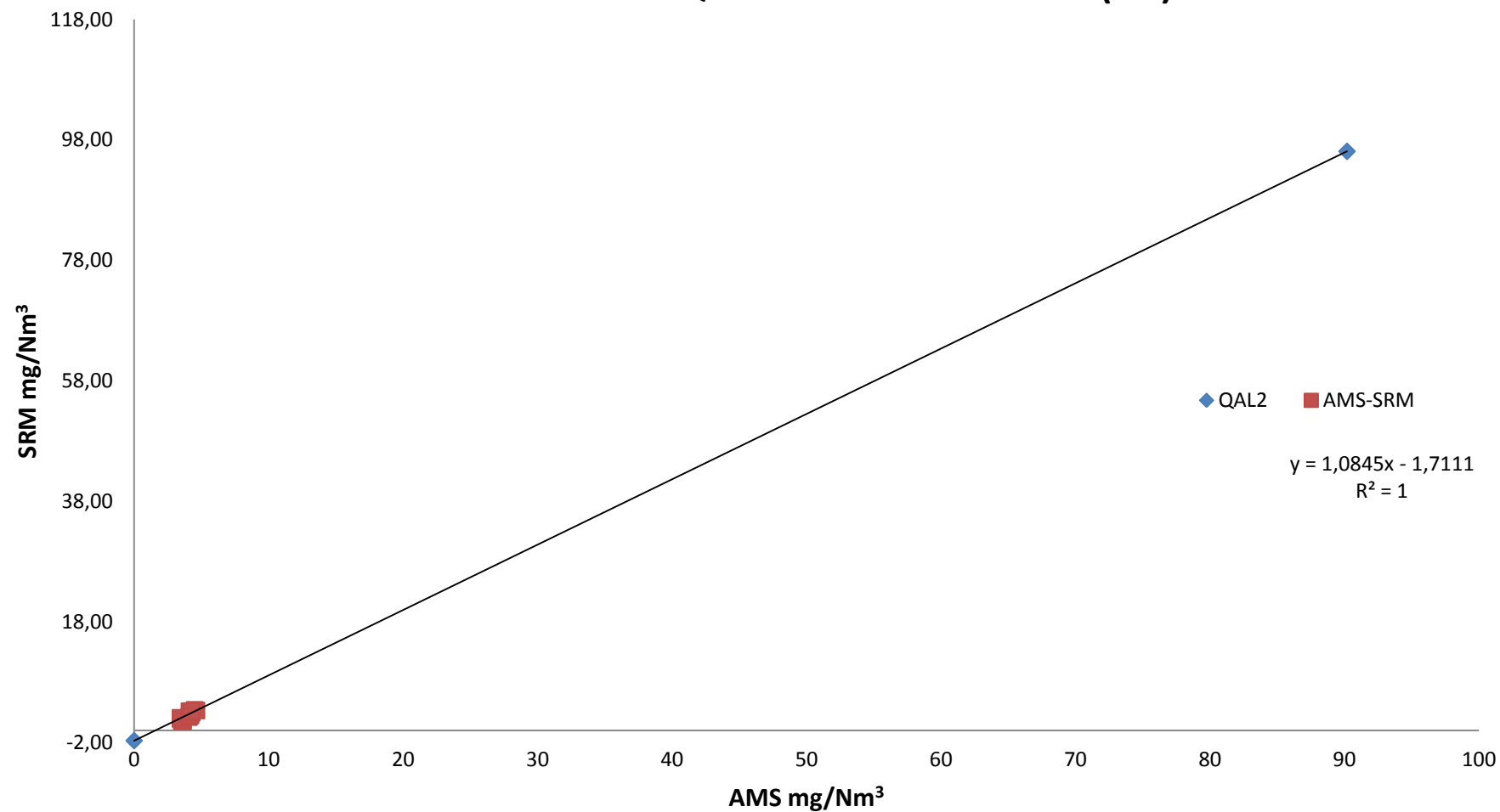
### 14.1 CARBON MONOXIDE - QAL2

Parameter				CO			Emission Point			6D							
O <sub>2</sub> rif %	15	SRM				AMS							Calculations				
N. Test	DATE/TIME	Y <sub>i</sub>	Yi-Ym	O <sub>2</sub>	Y <sub>i,s</sub>	x <sub>i</sub>	O <sub>2</sub>	xi-xm	(xi-xm) <sup>2</sup>	(xi-xm)*(Yi-Ym)	Ŷ <sub>i</sub>	Ŷ <sub>i,s</sub>	D <sub>i</sub> = Y <sub>i,s</sub> -Ŷ <sub>i,s</sub>	D <sub>i</sub> -đ	(D <sub>i</sub> -đ) <sup>2</sup>		
1	12/5/17 9:59	1,55	-6,34	12,63	1,11	3,55	11,76	-5,30	28,14	33,61	2,13	1,39	-0,27	-0,34	0,12		
2	12/5/17 10:59	1,56	-6,33	12,55	1,11	3,56	11,78	-5,29	28,01	33,50	2,15	1,40	-0,29	-0,36	0,13		
3	12/5/17 14:59	1,53	-6,35	12,52	1,09	3,64	11,77	-5,21	27,10	33,07	2,24	1,46	-0,37	-0,44	0,19		
4	12/5/17 16:59	1,89	-6,00	12,52	1,34	3,44	11,52	-5,41	29,24	32,44	2,02	1,28	0,06	-0,01	0,00		
5	12/5/17 18:59	2,09	-5,80	12,63	1,50	3,44	11,52	-5,41	29,23	31,35	2,02	1,28	0,22	0,15	0,02		
6	15/5/17 9:59	2,20	-5,69	12,17	1,49	4,07	11,47	-4,78	22,83	27,18	2,70	1,70	-0,21	-0,27	0,08		
7	15/5/17 10:59	2,53	-5,36	12,15	1,71	4,17	11,49	-4,68	21,92	25,09	2,81	1,77	-0,06	-0,13	0,02		
8	15/5/17 13:59	2,48	-5,41	12,06	1,66	4,19	11,43	-4,66	21,75	25,23	2,83	1,77	-0,11	-0,18	0,03		
9	15/5/17 15:59	2,92	-4,97	12,17	1,98	4,28	11,33	-4,57	20,88	22,72	2,93	1,82	0,16	0,10	0,01		
10	15/5/17 16:59	3,18	-4,71	12,23	2,17	4,11	11,28	-4,74	22,46	22,32	2,75	1,70	0,48	0,41	0,17		
11	16/5/17 9:59	3,41	-4,48	12,27	2,34	4,50	11,47	-4,35	18,92	19,48	3,17	2,00	0,35	0,28	0,08		
12	16/5/17 10:59	3,30	-4,59	12,64	2,36	4,63	11,90	-4,22	17,79	19,36	3,31	2,18	0,18	0,12	0,01		
13	16/5/17 12:59	2,95	-4,93	12,13	2,00	4,23	11,50	-4,62	21,38	22,82	2,87	1,81	0,18	0,12	0,01		
14	16/5/17 13:59	3,11	-4,78	12,14	2,11	4,21	11,49	-4,64	21,55	22,18	2,85	1,80	0,31	0,24	0,06		
15	16/5/17 14:59	3,21	-4,67	12,16	2,18	4,23	11,47	-4,62	21,32	21,58	2,88	1,81	0,37	0,30	0,09		
16	zero	0,00	-7,89	15,00	0,00	0,00	15,00	-8,85	78,31	69,79	-1,71	-1,71					
17	span	96,18	88,29	15,00	96,18	90,20	15,00	81,35	6617,91	7182,74	96,11	96,11					
Average												0,07					
Sum									7048,75	7644,45				1,01			
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		110	Yaverage	7,89	x average	8,85	Z	/	Procedure for the determination of the calibration fuction								
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		16,5	m	1,085	i	-1,711	r	0,99970	Method C				Calibration Function				
Ys Max-Ys min		1,28	ŷs, max	2,18	Calibration Range				0 - 22 [mg/Nm3 rif O2]				Y= 1,085X - 1,711				
Test of Variability																	
Maximum permissible uncertainty (95% confidence interval)		10	Test value for variability (k <sub>v</sub> )		0,9761	σ0kv		5,478	Result of Variability Test (s <sub>0</sub> ≤σ <sub>0</sub> k <sub>v</sub> )								
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,269123	Standard Deviation (σ <sub>0</sub> )		5,61	Experimental Confidence interval [%]		0,48	Positive								

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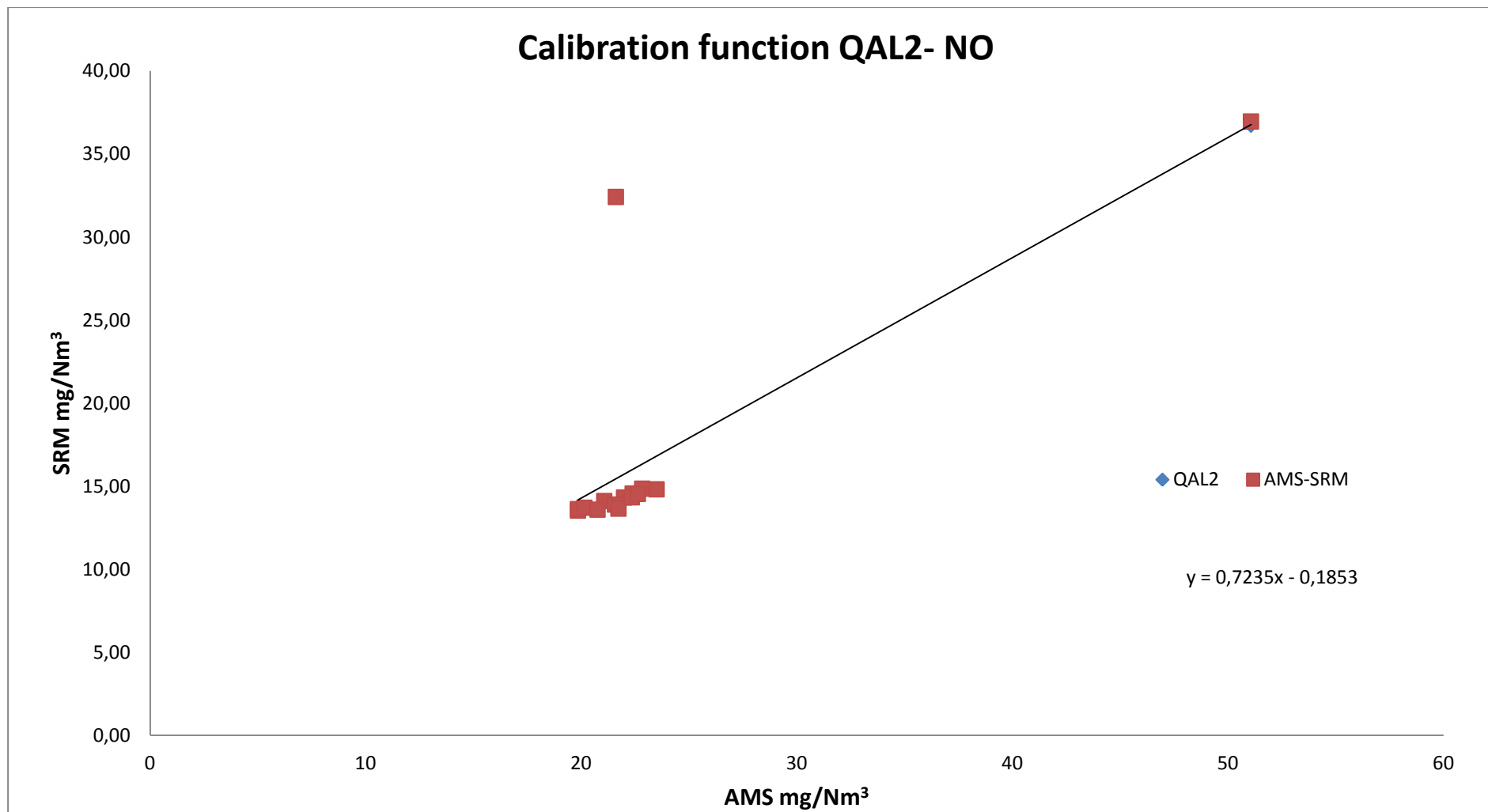
## Calibration function QAL2- Carbon monoxide (CO)





## 14.2 NITROGEN OXIDE - QAL2

Parameter			NO			Emission Point			6D								
O2 rif %	15	SRM				AMS							Calculations				
N. Test	DATE/TIME	Y <sub>i</sub>	Yi-Ym	O <sub>2</sub>	Y <sub>i,s</sub>	x <sub>i</sub>	O <sub>2</sub>	xi-xm	(xi-xm) <sup>2</sup>	(xi-xm)*(Yi-Ym)	ŷ <sub>i</sub>	ŷ <sub>i,s</sub>	D <sub>i</sub> = y <sub>i,s</sub> -ŷ <sub>i,s</sub>	D <sub>i</sub> -đ	(D <sub>i</sub> -đ) <sup>2</sup>		
1	12/5/17 9:59	14,11	-2,75	12,63	10,11	21,07	11,76	-2,49	6,18	6,84	15,06	9,78	0,33	-0,54	0,29		
2	12/5/17 10:59	13,53	-3,33	12,55	9,61	19,85	11,78	-3,71	13,74	12,34	14,18	9,23	0,38	-0,49	0,24		
3	12/5/17 14:59	13,62	-3,24	12,52	9,64	19,85	11,77	-3,71	13,74	12,00	14,18	9,22	0,42	-0,45	0,20		
4	12/5/17 16:59	13,70	-3,15	12,52	9,70	20,15	11,52	-3,41	11,61	10,75	14,39	9,11	0,59	-0,28	0,08		
5	12/5/17 18:59	13,59	-3,27	12,63	9,74	20,76	11,52	-2,80	7,82	9,14	14,84	9,39	0,35	-0,52	0,27		
6	15/5/17 9:59	14,32	-2,54	12,17	9,73	21,99	11,47	-1,57	2,45	3,98	15,73	9,90	-0,17	-1,04	1,08		
7	15/5/17 10:59	13,89	-2,97	12,15	9,42	21,57	11,49	-1,99	3,95	5,89	15,42	9,73	-0,31	-1,18	1,40		
8	15/5/17 13:59	14,56	-2,30	12,06	9,77	22,39	11,43	-1,17	1,36	2,68	16,01	10,04	-0,27	-1,14	1,29		
9	15/5/17 15:59	14,81	-2,05	12,17	10,06	23,50	11,33	-0,06	0,00	0,12	16,82	10,44	-0,37	-1,24	1,55		
10	15/5/17 16:59	13,65	-3,21	12,23	9,34	21,73	11,28	-1,83	3,34	5,86	15,54	9,59	-0,25	-1,12	1,25		
11	16/5/17 10:59	36,96	20,10	12,64	26,52	51,07	11,90	27,51	756,98	552,98	36,77	24,24	2,28	1,41	1,98		
12	16/5/17 12:59	14,33	-2,53	12,13	9,69	22,35	11,50	-1,21	1,46	3,05	15,99	10,10	-0,40	-1,27	1,62		
13	16/5/17 13:59	14,85	-2,01	12,14	10,06	22,83	11,49	-0,73	0,53	1,46	16,33	10,30	-0,24	-1,11	1,24		
14	16/5/17 14:59	14,53	-2,33	12,16	9,86	22,63	11,47	-0,93	0,86	2,16	16,19	10,19	-0,33	-1,20	1,44		
15	16/5/17 15:59	32,42	15,56	11,60	20,70	21,61	11,40	-1,95	3,79	-30,29	15,45	9,66	11,04	10,17	103,49		
Average													0,87				
Sum									827,8	599,0					117,41		
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		55	Yaverage	16,86	x average	23,56	Z	//	Procedure for the determination of the calibration fuction								
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		8,25	m	0,724	i	-0,185	r	0,762	Method A					Calibration Function			
Ys Max-Ys min		17,17	ŷs, max	24,24	Calibration Range				0 - 26,67 [mg/Nm3 rif O2]					Y= 0,723X -0,185			
Test of Variability																	
Maximum permissible uncertainty (95% confidence interval)		20	Test value for variability (k <sub>v</sub> )		0,9761	σ0kv		5,478	Result of Variability Test (s <sub>0</sub> ≤σ <sub>0</sub> k <sub>v</sub> )								
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		2,895905	Standard Deviation (σ <sub>0</sub> )		5,61	Experimental Confidence interval [%]		10,32	Positive								

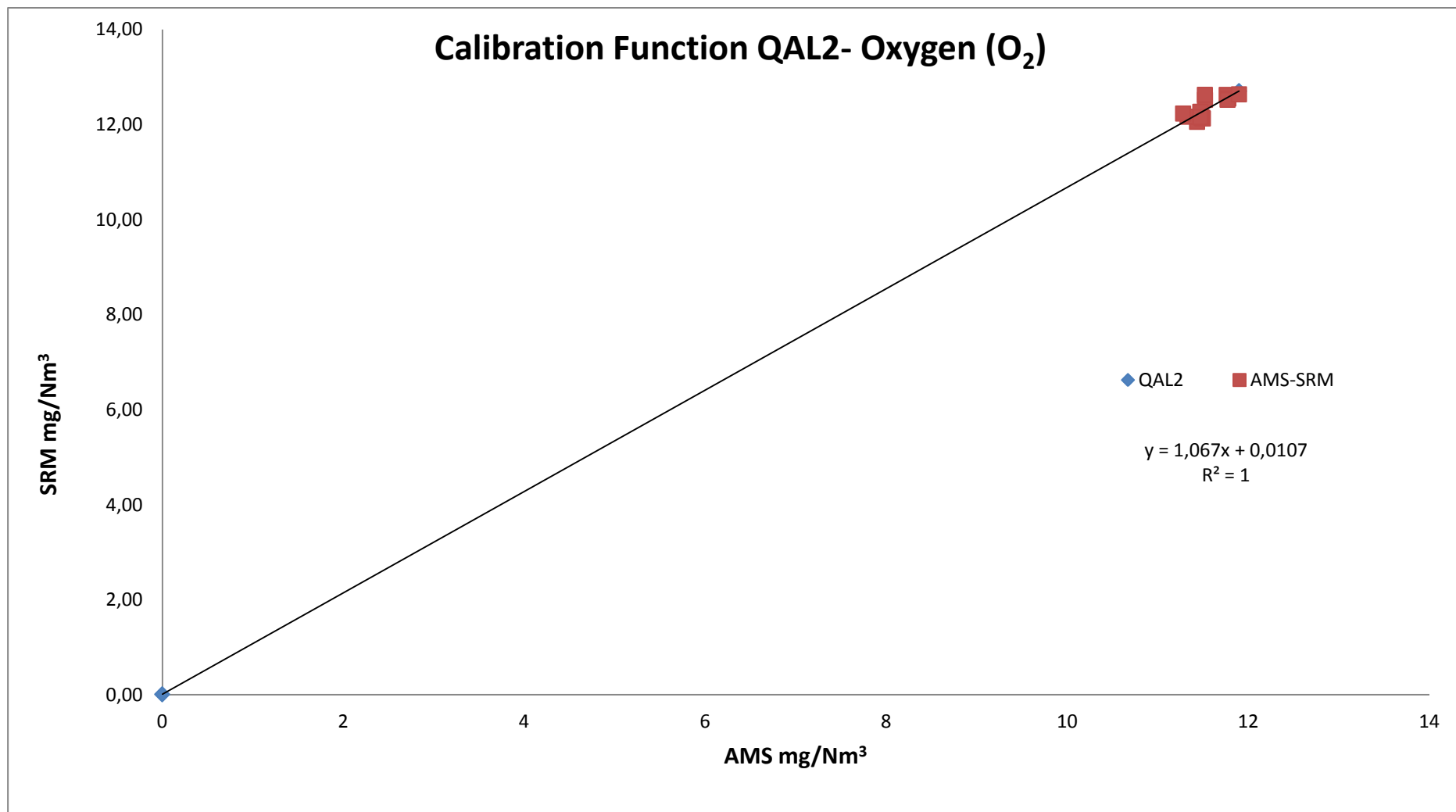




## 14.3 OXYGEN - QAL2

Parameter				O <sub>2</sub>		Emission Point			6D							
O2 rif %	15	SRM				AMS						Calculations				
N. Test	DATE/TIME	Y <sub>i</sub>	Yi-Ym	O <sub>2</sub>	Y <sub>i,s</sub>	x <sub>i</sub>	O <sub>2</sub>	xi-xm	(xi-xm) <sup>2</sup>	(xi-xm)*(Yi-Ym)	ŷ <sub>i</sub>		D <sub>i</sub> = y <sub>i,s</sub> -ŷ <sub>i,s</sub>	D <sub>i</sub> -đ	(D <sub>i</sub> -đ) <sup>2</sup>	
1	12/5/17 9:59	12,63	0,29			11,76		0,22	0,05	0,06	12,56		0,06	0,06	0,00	
2	12/5/17 10:59	12,55	0,22			11,78		0,23	0,05	0,05	12,58		-0,03	-0,03	0,00	
3	12/5/17 14:59	12,52	0,19			11,77		0,23	0,05	0,04	12,57		-0,05	-0,05	0,00	
4	12/5/17 16:59	12,52	0,19			11,52		-0,02	0,00	0,00	12,30		0,22	0,22	0,05	
5	12/5/17 18:59	12,63	0,30			11,52		-0,03	0,00	-0,01	12,30		0,32	0,32	0,10	
6	15/5/17 9:59	12,17	-0,16			11,47		-0,07	0,01	0,01	12,25		-0,08	-0,08	0,01	
7	15/5/17 10:59	12,15	-0,18			11,49		-0,05	0,00	0,01	12,27		-0,13	-0,13	0,02	
8	15/5/17 13:59	12,06	-0,27			11,43		-0,11	0,01	0,03	12,21		-0,15	-0,15	0,02	
9	15/5/17 15:59	12,17	-0,16			11,33		-0,22	0,05	0,04	12,10		0,07	0,07	0,00	
10	15/5/17 16:59	12,23	-0,10			11,28		-0,27	0,07	0,03	12,05		0,19	0,19	0,03	
11	16/5/17 9:59	12,27	-0,06			11,47		-0,08	0,01	0,00	12,25		0,02	0,02	0,00	
12	16/5/17 10:59	12,64	0,31			11,90		0,35	0,12	0,11	12,71		-0,07	-0,07	0,00	
13	16/5/17 12:59	12,13	-0,20			11,50		-0,05	0,00	0,01	12,28		-0,15	-0,15	0,02	
14	16/5/17 13:59	12,14	-0,19			11,49		-0,06	0,00	0,01	12,27		-0,13	-0,13	0,02	
15	16/5/17 14:59	12,16	-0,17			11,47		-0,07	0,01	0,01	12,25		-0,09	-0,09	0,01	
Average													0,00			
Sum									0,43	0,41						0,30
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		21	Yaverage	12,33	x average	11,55	Z	-0,01	Procedure for the determination of the calibration fuction							
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		3,15	m	1,067	i	0,011	r	0,75362193	Method B				Calibration Function			
Ys Max-Ys min		0,58	ŷs, max	12,71	Calibration Range				0 - 13,98 [% Vol.]				Y= 1,067X + 0,01			
Test of Variability																
Maximum permissible uncertainty (95% confidence interval)		10	Test value for variability (k <sub>v</sub> )		0,9761	σ0kv		1,046	Result of Variability Test (s <sub>0</sub> ≤σ <sub>0</sub> k <sub>v</sub> )							
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,145524	Standard Deviation (σ <sub>0</sub> )		1,07	Experimental Confidence interval [%]		1,36	Positive							

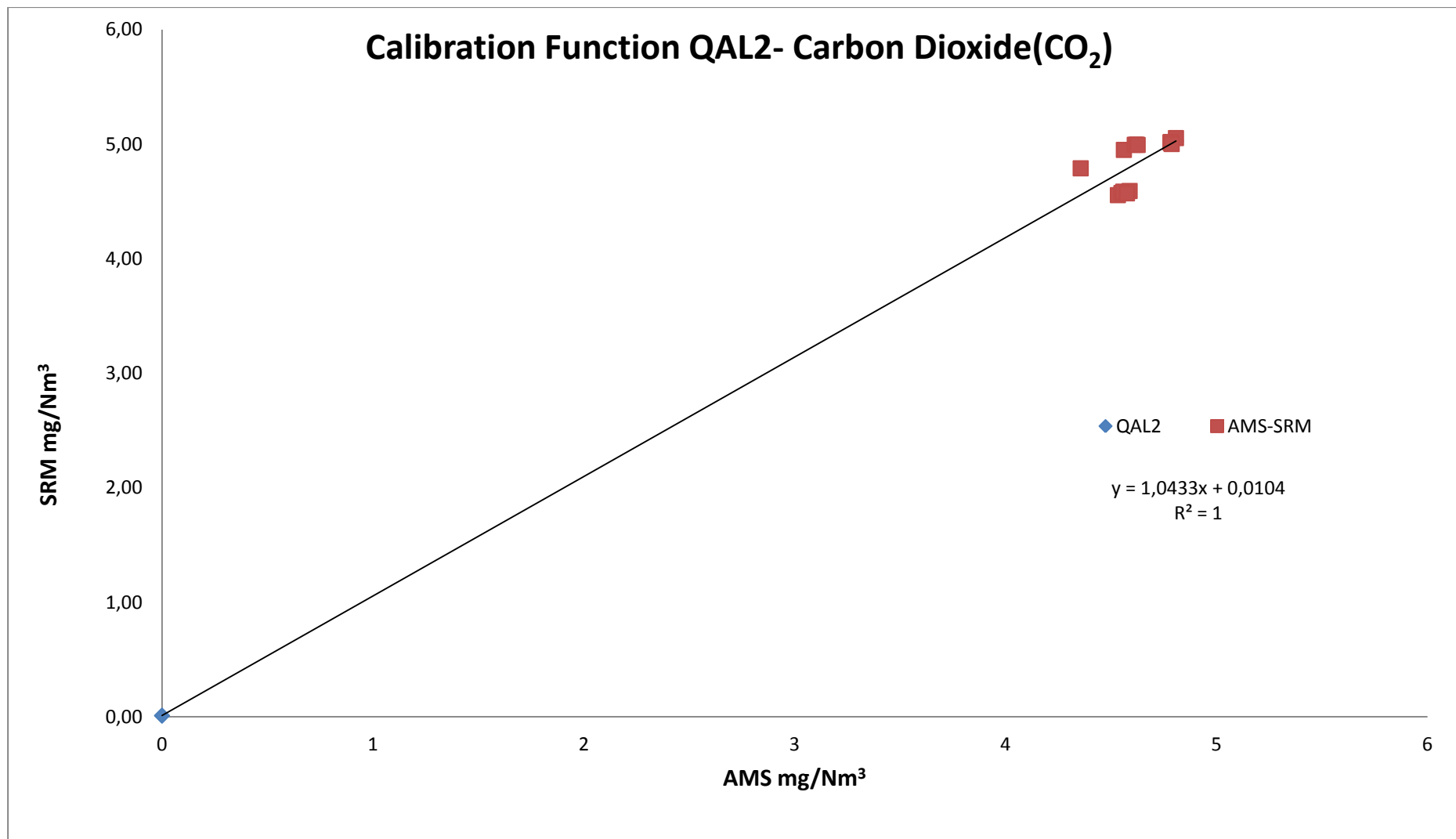






## 14.4 CARBON DIOXIDE – QAL2

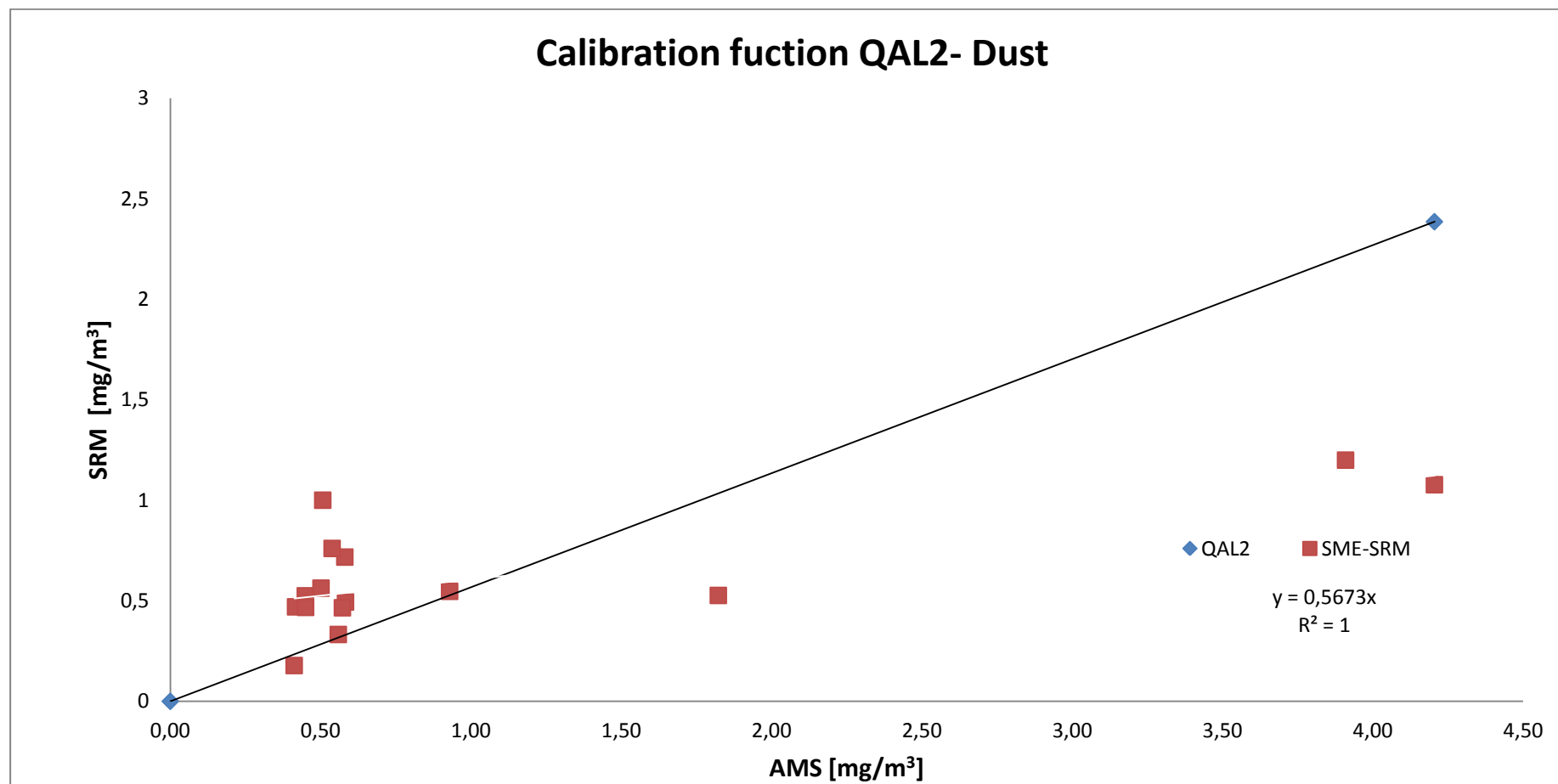
Parameter				CO <sub>2</sub>		Emission Point			6D								
O <sub>2</sub> rif %	15	SRM				AMS						Calculations					
N. Test	DATE/TIME	Y <sub>i</sub>	Yi-Ym	O <sub>2</sub>	Y <sub>i,s</sub>	x <sub>i</sub>	O <sub>2</sub>	xi-xm	(xi-xm) <sup>2</sup>	(xi-xm)*(Yi-Ym)	ŷ <sub>i</sub>		D <sub>i</sub> = y <sub>i,s</sub> -ŷ <sub>i,s</sub>	D <sub>i</sub> -đ	(D <sub>i</sub> -đ) <sup>2</sup>		
1	12/5/17 9:59	4,56	-0,29			4,53		-0,10	0,01	0,03	4,74		-0,18	-0,18	0,03		
2	12/5/17 10:59	4,57	-0,27			4,55		-0,09	0,01	0,02	4,76		-0,18	-0,18	0,03		
3	12/5/17 14:59	4,59	-0,26			4,56		-0,08	0,01	0,02	4,77		-0,18	-0,18	0,03		
4	12/5/17 16:59	4,59	-0,26			4,59		-0,05	0,00	0,01	4,80		-0,21	-0,21	0,04		
5	12/5/17 18:59	4,57	-0,28			4,58		-0,06	0,00	0,02	4,78		-0,21	-0,21	0,05		
6	15/5/17 9:59	5,01	0,16			4,79		0,15	0,02	0,02	5,00		0,00	0,00	0,00		
7	15/5/17 10:59	5,01	0,17			4,78		0,15	0,02	0,02	5,00		0,02	0,02	0,00		
8	15/5/17 13:59	5,05	0,21			4,81		0,17	0,03	0,04	5,03		0,03	0,03	0,00		
9	15/5/17 15:59	5,02	0,17			4,78		0,15	0,02	0,03	5,00		0,02	0,02	0,00		
10	15/5/17 16:59	5,00	0,16			4,79		0,15	0,02	0,02	5,01		0,00	0,00	0,00		
11	16/5/17 9:59	4,95	0,10			4,56		-0,07	0,01	-0,01	4,77		0,18	0,18	0,03		
12	16/5/17 10:59	4,79	-0,06			4,36		-0,28	0,08	0,02	4,56		0,23	0,23	0,05		
13	16/5/17 12:59	4,99	0,15			4,61		-0,02	0,00	0,00	4,82		0,17	0,17	0,03		
14	16/5/17 13:59	5,00	0,15			4,62		-0,01	0,00	0,00	4,83		0,16	0,16	0,03		
15	16/5/17 14:59	4,99	0,15			4,63		-0,01	0,00	0,00	4,84		0,16	0,16	0,02		
Average													0,00				
Sum									0,23	0,24						0,36	
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		25	Yaverage	4,85	x average	4,64	Z	-0,01	Procedure for the determination of the calibration fuction								
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		3,75	m	1,043	i	0,010	r	0,63444704	Method B				Calibration Function				
Ys Max-Ys min		0,50	ŷs, max	5,03	Calibration Range				0 - 5,53 [% Vol.]				Y= 1,043X + 0,01				
Test of Variability																	
Maximum permissible uncertainty (95% confidence interval)		10	Test value for variability (k <sub>v</sub> )		0,9761	σ0kv		1,245	Result of Variability Test (s <sub>0</sub> ≤σ0k <sub>v</sub> )								
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,159946	Standard Deviation (σ <sub>0</sub> )		1,28	Experimental Confidence interval [%]		1,25	Positive								





## 14.5 DUST – QAL2

Parameter									Dust		Emission Point					6D									
O <sub>2</sub> rif. %	15	SRM							AMS											Calculations					
N. Test	DATE/TIME	Y <sub>i</sub> [mg/m <sup>3</sup> ]	O <sub>2</sub> [%vol]	T [°C]	P [KPa]	U [%]	Y <sub>i</sub> -Y <sub>m</sub>	Y <sub>i,s</sub> [mg/Nm <sup>3</sup> ]	x <sub>i</sub> [mg/m3]	O <sub>2</sub> [%vol]	T [°C]	P [hPa]	U [%]	x <sub>i</sub> -x <sub>m</sub>	(x <sub>i</sub> -x <sub>m</sub> ) <sup>2</sup>	(x <sub>i</sub> -x <sub>m</sub> )* (Y <sub>i</sub> -Y <sub>m</sub> )	ŷ <sub>i</sub> [mg/m <sup>3</sup> ]	ŷ <sub>i,s</sub> [mg/Nm <sup>3</sup> ]	D <sub>i</sub> = y <sub>i,s</sub> - ŷ <sub>i,s</sub>	D <sub>i</sub> -d̄	(D <sub>i</sub> - d̄) <sup>2</sup>				
1	12/05/2017 09:59	0,47	12,63	159,88	100,59	9,86	-0,15	0,60	0,42	11,76	160,29	990,99	9,77	-0,68	0,46	0,10	0,24	0,28	0,32	0,26	0,07				
2	12/05/2017 10:59	0,18	12,55	160,45	100,68	10,71	-0,44	0,23	0,41	11,78	160,27	991,08	9,69	-0,68	0,47	0,30	0,23	0,27	-0,05	-0,11	0,01				
3	12/05/2017 14:59	0,52	12,50	160,06	100,70	10,09	-0,10	0,66	0,45	11,77	160,35	991,00	9,73	-0,65	0,42	0,06	0,25	0,30	0,36	0,29	0,09				
4	12/05/2017 16:59	1,20	12,46	160,14	100,66	10,77	0,58	1,51	3,91	11,52	160,18	990,86	9,62	2,81	7,92	1,63	2,22	2,52	-1,01	-1,08	1,16				
5	12/05/2017 18:59	0,47	12,48	159,79	100,70	10,29	-0,15	0,58	0,45	11,52	160,50	990,84	9,65	-0,65	0,42	0,10	0,26	0,29	0,29	0,23	0,05				
6	15/05/2017 09:59	0,49	12,17	164,82	101,99	9,41	-0,13	0,59	0,58	11,47	165,44	993,66	9,97	-0,51	0,26	0,07	0,33	0,38	0,21	0,15	0,02				
7	15/05/2017 10:59	0,33	12,15	165,35	102,06	10,43	-0,29	0,40	0,56	11,49	165,98	993,69	10,00	-0,54	0,29	0,16	0,32	0,36	0,04	-0,03	0,00				
8	15/05/2017 13:59	0,47	12,13	165,49	102,01	9,88	-0,16	0,56	0,57	11,43	165,86	993,67	9,88	-0,52	0,27	0,08	0,32	0,37	0,19	0,12	0,01				
9	15/05/2017 15:59	0,55	12,05	165,51	102,10	9,90	-0,07	0,65	0,93	11,33	165,98	993,58	10,03	-0,17	0,03	0,01	0,53	0,60	0,05	-0,01	0,00				
10	15/05/2017 16:59	1,08	12,06	165,11	95,18	10,24	0,46	1,38	4,21	11,28	166,07	993,49	9,89	3,11	9,67	1,42	2,39	2,68	-1,30	-1,37	1,88				
11	16/05/2017 09:59	0,72	12,27	163,95	101,67	10,56	0,10	0,88	0,58	11,47	163,45	993,04	9,97	-0,52	0,27	-0,05	0,33	0,38	0,50	0,44	0,19				
12	16/05/2017 10:59	0,53	12,64	162,46	95,95	9,57	-0,09	0,70	1,82	11,90	163,16	993,06	9,37	0,73	0,53	-0,07	1,03	1,23	-0,52	-0,59	0,35				
13	16/05/2017 12:59	0,56	12,18	158,38	101,71	10,07	-0,06	0,67	0,50	11,50	158,32	993,06	9,97	-0,59	0,35	0,03	0,28	0,32	0,35	0,28	0,08				
14	16/05/2017 13:59	0,76	12,13	161,23	95,78	10,24	0,14	0,96	0,54	11,49	162,81	993,06	9,91	-0,56	0,31	-0,08	0,31	0,35	0,62	0,55	0,30				
15	16/05/2017 14:59	1,00	12,14	162,46	95,69	9,38	0,38	1,26	0,51	11,47	163,42	993,02	9,92	-0,59	0,35	-0,22	0,29	0,33	0,93	0,87	0,76				
Average																			0,07						
Sum															22,01	3,54					4,96				
Emission Limit Value - ELV [mg/Nm3 rif O <sub>2</sub> ]		5	Yaverag e	0,62	x average	1,10	Z	Procedure for the determination of the calibration fuction					Calibration Function												
15% ELV [mg/Nm3 rif O <sub>2</sub> ]		0,75	m	0,57	i	0,000 0	r	0,72	Method B					Y= 0,567X + 0											
Ys Max-Ys min		1,28	ŷs, max	2,68	Calibration Range				0 - 2,95 [mg/Nm3 rif O <sub>2</sub> ]																
Test of Variability																									
Maximum permissible uncertainty (95% confidence interval)		30	Test value for variability (k <sub>v</sub> )				0,976 1	σ0k <sub>v</sub>			0,747	Result of Variability Test (s <sub>0</sub> ≤σ <sub>0</sub> k <sub>v</sub> )													
Standard Deviation of the difference D <sub>i</sub> - (S <sub>0</sub> )		0,595	Standard Deviation (σ <sub>0</sub> )			0,77	Experimental Confidence interval [%]			23,34	Positive										Note: Method B was used to process the results in order to obtain a proper calibration function.				





## 15 ANNEX 5 – IAR REPORT

### 15.1 WATER VAPOUR - IAR

Parameter		Water Vapour		
N. Test	DATE/TIME	SRM [%]	AMS [%]	Absolute Differences (X <sub>i</sub> )
1	15/5/17 9:59	9,4	10,0	1
2	15/5/17 10:59	10,4	10,0	0
3	15/5/17 13:59	9,9	9,9	0
4	15/5/17 15:59	9,9	10,0	0
5	15/5/17 16:59	10	10	0
Average		10,0	10,0	0,3
t student 0,95 (N-1)		2,78		
Standard Deviation (S <sub>D</sub> )		0,23		
Confidence Interval (I <sub>c</sub> )		0,28		
<b>I.A.R</b>		<b>94,2</b>		

### 15.2 TEMPERATURE - IAR

Parameter		Temperature		
N. Test	DATE/TIME	SRM [°C]	AMS [°C]	Absolute Differences (X <sub>i</sub> )
1	15/5/17 9:59	165	165	1
2	15/5/17 10:59	165	166	1
3	15/5/17 13:59	165	166	0
4	15/5/17 15:59	166	166	0
5	15/5/17 16:59	165	166	1
Average		165	166	0,6
t student 0,95 (N-1)		2,78		
Dev. Standard (S <sub>D</sub> )		0,22		
Intervallo di Confidenza (I <sub>c</sub> )		0,28		
<b>I.A.R</b>		<b>99,5</b>		





### 15.3 PRESSURE - IAR

Parameter		Pressure		
N. Test	DATE/TIME	SRM [hPa]	SME [hPa]	Absolute Differences (X <sub>i</sub> )
1	15/5/17 9:59	1020	994	26
2	15/5/17 10:59	1021	994	27
3	15/5/17 13:59	1020	994	26
4	15/5/17 15:59	1021	994	27
5	15/5/17 16:59	952	993	42
Average		1007	994	30
t student 0,95 (N-1)		2,78		
Standard Deviation (S <sub>D</sub> )		6,70		
Confidence Interval (I <sub>C</sub> )		8,32		

### 15.4 FLOW - IAR

Parameter			Flow	
N. Test	DATE/TIME	SRM [Nm <sup>3</sup> /h]	AMS [Nm <sup>3</sup> /h]	Absolute Differences (X <sub>i</sub> )
1	15/5/17 9:59	185321	188625	3304
2	15/5/17 10:59	185579	188862	3283
3	15/5/17 13:59	169835	187101	17266
4	15/5/17 15:59	164940	188847	23907
5	15/5/17 16:59	153306	188390	35084
Average		171796,24	188365,00	16569
t student 0,95 (N-1)		2,78		
Standard Deviation (S <sub>D</sub> )		13689,83		
Confidence Interval (I <sub>C</sub> )		16998,17		
<b>I.A.R</b>		<b>80,5</b>		



## 16 ANNEX 6 – QAL1 CERTIFIED SRM ANALYZER

	
<h1>CERTIFICATE</h1> <p>on Product Conformity (QAL1)</p>	
Certificate No.: 0000032301	
<b>Certified AMS:</b>	PG-350E for NO <sub>x</sub> , SO <sub>2</sub> , CO, CO <sub>2</sub> and O <sub>2</sub>
<b>Manufacturer:</b>	HORIBA Europe GmbH Julius-Kronenberg-Str. 9 42799 Leichlingen Germany
<b>Test Institute:</b>	TÜV Rheinland Energie und Umwelt GmbH
<p><b>This is to certify that the AMS has been tested and found to comply with:</b></p> <p><b>EN 15267-1: 2009, EN 15267-2: 2009, EN 15267-3: 2007 and EN 14181: 2004</b></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"><li>• EN 15267-3 tested</li><li>• QAL1 certified</li><li>• TÜV approved</li><li>• Annual inspection</li></ul>	
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
<a href="http://www.umwelt-tuv.de">www.umwelt-tuv.de</a> / <a href="http://www.eco-tuv.com">www.eco-tuv.com</a> 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<sub>x</sub>, SO<sub>2</sub>, CO, CO<sub>2</sub> and O<sub>2</sub>

**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 <sub>x</sub>	0 - 205 <sup>1)</sup>	0 - 2050 <sup>2)</sup>	mg/m <sup>3</sup>
SO <sub>2</sub>	0 - 143	0 - 1430	mg/m <sup>3</sup>
CO	0 - 75	0 - 1250	mg/m <sup>3</sup>
CO <sub>2</sub>	0 - 20	-	Vol.-%
O <sub>2</sub>	0 - 25	0 - 10	Vol.-%

<sup>1)</sup> as NO<sub>2</sub>, this corresponds to apx 0 - 134 mg/m<sup>3</sup> NO

<sup>2)</sup> as NO<sub>2</sub>, this corresponds to apx. 0 - 1340 mg/m<sup>3</sup> NO

**Software version:**

P2000788001D / 1.11

**Restrictions:**

None

**Notes:**

1. The maintenance interval is four weeks.
2. The certification range for the component SO<sub>2</sub> 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 SO<sub>2</sub> 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 <sub>x</sub>	Chemiluminescence
CO, SO <sub>2</sub> , CO <sub>2</sub>	Non-dispersive absorption (NDIR) Infrared
O <sub>2</sub>	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](http://qal1.de).

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

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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

SO<sub>2</sub>  
Certification range 0 - 143 mg/m<sup>3</sup>

Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point 0.54 mg/m<sup>3</sup>  
Sum of negative CS at zero point -0.69 mg/m<sup>3</sup>  
Sum of positive CS at reference point 0.70 mg/m<sup>3</sup>  
Sum of negative CS at reference point -2.60 mg/m<sup>3</sup>  
Maximum sum of cross sensitivities -2.60 mg/m<sup>3</sup>  
Uncertainty of cross sensitivity -1.503 mg/m<sup>3</sup>

Calculation of the combined standard uncertainty

Tested parameter

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

\* The larger value is used:

"Repeatability standard deviation at span" or

"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u<sub>c</sub>)  $u_c = \sqrt{\sum (u_{max,i})^2}$  4.23 mg/m<sup>3</sup>  
Total expanded uncertainty  $U = u_c \cdot k = u_c \cdot 1.96$  8.30 mg/m<sup>3</sup>

Relative total expanded uncertainty



U in % of the ELV 60 mg/m<sup>3</sup> 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/m<sup>3</sup>

15.0





	<p align="center"><b>Certificate:</b> 0000032301 / 22 March 2013</p>	
<p><b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b></p>		
<b>Measuring system</b>		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB0 / XL7LTUL1	
Measuring principle	NDIR	
<b>Test report</b>	21217617/A	
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
<b>Measured component</b>	CO	
Certification range	0 - 75 mg/m <sup>3</sup>	
<b>Evaluation of the cross sensitivity (CS)</b> (system with largest CS)		
Sum of positive CS at zero point	0.00 mg/m <sup>3</sup>	
Sum of negative CS at zero point	0.00 mg/m <sup>3</sup>	
Sum of positive CS at reference point	0.50 mg/m <sup>3</sup>	
Sum of negative CS at reference point	-0.65 mg/m <sup>3</sup>	
Maximum sum of cross sensitivities	-0.65 mg/m <sup>3</sup>	
Uncertainty of cross sensitivity	-0.377 mg/m <sup>3</sup>	
<b>Calculation of the combined standard uncertainty</b>		
<b>Tested parameter</b>	<b>u<sub>i</sub></b>	<b>u<sup>2</sup></b>
Standard deviation from paired measurements under field conditions *	u <sub>D</sub> mg/m <sup>3</sup>	0.356 (mg/m <sup>3</sup> ) <sup>2</sup>
Lack of fit	u <sub>of</sub> mg/m <sup>3</sup>	0.070 (mg/m <sup>3</sup> ) <sup>2</sup>
Zero drift from field test	u <sub>z,d</sub> mg/m <sup>3</sup>	0.706 (mg/m <sup>3</sup> ) <sup>2</sup>
Span drift from field test	u <sub>s,d</sub> -0.675 mg/m <sup>3</sup>	0.456 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of ambient temperature at span	u <sub>t</sub> 0.868 mg/m <sup>3</sup>	0.750 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of supply voltage	u <sub>v</sub> 0.288 mg/m <sup>3</sup>	0.082 (mg/m <sup>3</sup> ) <sup>2</sup>
Cross sensitivity (interference)	u <sub>i</sub> mg/m <sup>3</sup>	0.142 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of sample gas flow	u <sub>p</sub> mg/m <sup>3</sup>	0.001 (mg/m <sup>3</sup> ) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	u <sub>rm</sub> mg/m <sup>3</sup>	0.368 (mg/m <sup>3</sup> ) <sup>2</sup>
* The larger value is used: "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"		
Combined standard uncertainty (u <sub>c</sub> )	$u_c = \sqrt{\sum (u_{max,i})^2}$	1.71 mg/m <sup>3</sup>
Total expanded uncertainty	$U = u_c \cdot k = u_c \cdot 1.96$	3.35 mg/m <sup>3</sup>
<b>Relative total expanded uncertainty</b>	<b>U in % of the ELV 50 mg/m<sup>3</sup></b>	<b>6.7</b>
Requirement of 2000/76/EC and 2001/80/EC	<b>U in % of the ELV 50 mg/m<sup>3</sup></b>	<b>10.0</b>
Requirement of EN 15267-3	<b>U in % of the ELV 50 mg/m<sup>3</sup></b>	<b>7.5</b>



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	<p align="center"><b>Certificate:</b> 0000032301 / 22 March 2013</p>	
<p><b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b></p>		
<b>Measuring system</b>		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB9 / XL7LTUL1	
Measuring principle	NDIR	
<b>Test report</b>	21217617/A	
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
<b>Measured component</b>	CO <sub>2</sub>	
Certification range	0 - 20 Vol.-%	
<b>Evaluation of the cross sensitivity (CS)</b> (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.-%
<b>Calculation of the combined standard uncertainty</b>		
<b>Tested parameter</b>		<b>U<sup>2</sup></b>
Standard deviation from paired measurements under field conditions *	U <sub>D</sub>	Vol.-% 0.000 (Vol.-%) <sup>2</sup>
Lack of fit	U <sub>LOF</sub>	Vol.-% 0.013 (Vol.-%) <sup>2</sup>
Zero drift from field test	U <sub>ZD</sub>	Vol.-% 0.071 (Vol.-%) <sup>2</sup>
Span drift from field test	U <sub>SD</sub>	0.238 Vol.-% 0.057 (Vol.-%) <sup>2</sup>
Influence of ambient temperature at span	U <sub>t</sub>	0.115 Vol.-% 0.013 (Vol.-%) <sup>2</sup>
Influence of supply voltage	U <sub>v</sub>	0.051 Vol.-% 0.003 (Vol.-%) <sup>2</sup>
Cross sensitivity (interference)	U <sub>i</sub>	Vol.-% 0.004 (Vol.-%) <sup>2</sup>
Influence of sample gas flow	U <sub>g</sub>	Vol.-% 0.000 (Vol.-%) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	U <sub>rm</sub>	Vol.-% 0.026 (Vol.-%) <sup>2</sup>
* The larger value is used : "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"		
Combined standard uncertainty (u <sub>c</sub> )	$u_c = \sqrt{\sum (u_{max,i})^2}$	0.43 Vol.-%
Total expanded uncertainty	$U = u_c \cdot k = u_c \cdot 1.96$	0.85 Vol.-%
<b>Relative total expanded uncertainty</b>	<b>U in % of the range 20 Vol.-%</b>	<b>4.2</b>
Requirement of 2000/76/EC and 2001/80/EC	<b>U in % of the range 20 Vol.-%</b>	<b>10.0**</b>
Requirement of EN 15267-3	<b>U in % of the range 20 Vol.-%</b>	<b>7.5</b>
** 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.		
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	<p align="center"><b>Certificate:</b> 0000032301 / 22 March 2013</p>	
<p align="center"><b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b></p>		
<b>Measuring system</b>		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB9 / XL7LTUL1	
Measuring principle	Paramagnetism	
<b>Test report</b>	21217617/A	
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
<b>Measured component</b>	O <sub>2</sub>	
Certification range	0 - 25 Vol.-%	
<b>Evaluation of the cross sensitivity (CS)</b> (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.-%	
<b>Calculation of the combined standard uncertainty</b>		
<b>Tested parameter</b>		<b>u<sup>2</sup></b>
Standard deviation from paired measurements under field conditions *	u <sub>D</sub> Vol.-%	0.004 (Vol.-%) <sup>2</sup>
Lack of fit	u <sub>lof</sub> Vol.-%	0.000 (Vol.-%) <sup>2</sup>
Zero drift from field test	u <sub>dz</sub> Vol.-%	0.006 (Vol.-%) <sup>2</sup>
Span drift from field test	u <sub>ds</sub> 0.092 Vol.-%	0.008 (Vol.-%) <sup>2</sup>
Influence of ambient temperature at span	u <sub>t</sub> 0.064 Vol.-%	0.007 (Vol.-%) <sup>2</sup>
Influence of supply voltage	u <sub>v</sub> 0.018 Vol.-%	0.000 (Vol.-%) <sup>2</sup>
Cross sensitivity (Interference)	u <sub>i</sub> Vol.-%	0.000 (Vol.-%) <sup>2</sup>
Influence of sample gas flow	u <sub>g</sub> Vol.-%	0.000 (Vol.-%) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	u <sub>rm</sub> Vol.-%	0.041 (Vol.-%) <sup>2</sup>
* The larger value is used : "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"		
Combined standard uncertainty (u <sub>c</sub> )	$u_c = \sqrt{\sum (u_{max,i})^2}$	0.26 Vol.-%
Total expanded uncertainty	$U = u_c \cdot k = u_c \cdot 1.96$	0.51 Vol.-%
<b>Relative total expanded uncertainty</b>	<b>U in % of the range 25 Vol.-%</b>	<b>2.0</b>
Requirement of 2000/76/EC and 2001/80/EC	<b>U in % of the range 25 Vol.-%</b>	<b>10.0**</b>
Requirement of EN 15267-3	<b>U in % of the range 25 Vol.-%</b>	<b>7.5</b>
** 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.		
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## 17 ANNEX 7 – 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  
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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.





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

TetraTec Instruments GmbH · Gewerbestrasse 8 · 71144 Steinbronn · Germany  
Tel +497157/53870 · Fax +497157/538710 · [www.tetratec.de](http://www.tetratec.de) · [info@tetratec.de](mailto:info@tetratec.de)

File: CAL032528



## 18 ANNEX 8 - 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](http://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](http://www.accredia.it)) or on direct request to appointed Department.

Data di 1° 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)



## 19 ANNEX 9 - 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](mailto: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/m<sup>3</sup>  
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](mailto: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	PROPRIETA' 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](mailto: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 (ΔC%) Relative Uncertainty (ΔC%)
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 (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 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](mailto: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  
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:





**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**



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# 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 13<sup>th</sup> 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 <sup>3</sup>	55
Nitrogen Oxides	mg/Nm <sup>3</sup>	176
Sulfur Dioxide	mg/Nm <sup>3</sup>	132
Carbon Monoxide	mg/Nm <sup>3</sup>	264
Ammonia	mg/Nm <sup>3</sup>	2,6
<b>Note:</b> 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 <sup>2</sup> ]	3,14
Number of Sampling Lines (Access Ports)	2
Conformance of the Sampling Platform	
Sampling platform area > 5 m <sup>2</sup> 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 <sub>3</sub>	EPA CTM 027:1997	Procedure for collection and analysis of ammonia in stationary sources.
NO <sub>x</sub>	UNI EN 14792:2006	Stationary source emissions. Determination of mass concentration of nitrogen oxides (NO <sub>x</sub> ). Reference method: Chemiluminescence.
SO <sub>2</sub>	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 <sub>2</sub>	ISO 11042-1:1996	Gas turbines - Exhaust gas emission - Part 1: Measurement and evaluation. Principle of Measurement: Non-dispersive infrared (NDIR).
O <sub>2</sub>	UNI EN 14789:2006	Determination of volume concentration of oxygen (O <sub>2</sub> ). Reference method - Paramagnetism.
H <sub>2</sub> 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 <sub>3</sub>	Dado Lab - ST5	Sampling	
NOx	Horiba / PG - 350 E	CLD chemiluminescence	0-25/50/100/250/ 500/1000/2500 ppm
SO <sub>2</sub>	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 <sub>2</sub>	Horiba / PG - 350 E	ND-IR	0-10/20/30 %
O <sub>2</sub>	Horiba / PG - 350 E	Paramagnetic	0-/10/25 %
H <sub>2</sub> 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 (SO<sub>2</sub>), nitrogen monoxide (NO), nitrogen dioxide (NO<sub>2</sub>), carbon dioxide (CO<sub>2</sub>), ammonia (NH<sub>3</sub>) and water vapor (H<sub>2</sub>O).

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 <sup>3</sup>
		MCS 100 E	ZrO <sub>2</sub>	O <sub>2</sub>	0 - 21 %
			IR Non-Dispersive (NDIR)	CO	0 - 300 mg/Nm <sup>3</sup>
				CO <sub>2</sub>	0 - 25 %
				NO	0 - 300 mg/Nm <sup>3</sup>
				NO <sub>2</sub>	0 - 100 mg/Nm <sup>3</sup>
				SO <sub>2</sub>	0 - 2000 mg/Nm <sup>3</sup>
				NH <sub>3</sub>	0 - 30 mg/Nm <sup>3</sup>



## 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 9<sup>th</sup> 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)

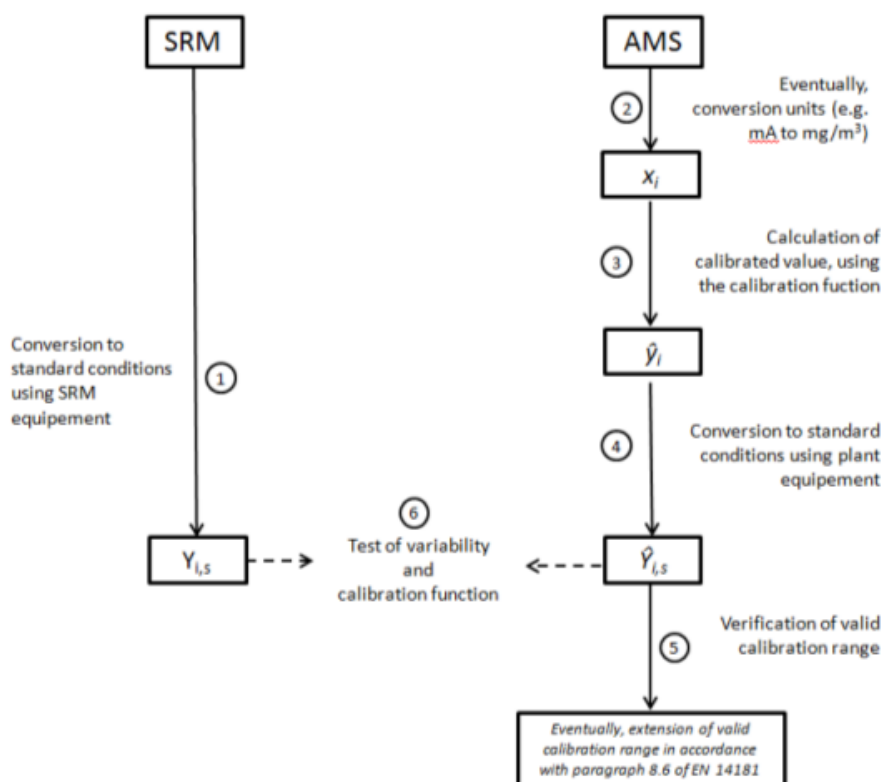
### 7.1 PARALLEL MEASUREMENTS WITH THE SRM

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 ( $\sigma_0$ ).

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

Where

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

$\hat{y}_{i,s}$  is the result  $i^{\text{th}}$  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



$\sigma_0$  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  $\chi^2$ -test with a  $\beta$ -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 <sub>2</sub>	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/Nm3 rif O2]	/	55	Positive	Positive
Nitrogen Oxide (NO)	1,292	0	0 – 118,4 [mg/Nm3 rif O2]	/	176	Positive	Positive
Carbon Monoxide (CO)	0,916	0	0 – 143,9 [mg/Nm3 rif O2]	/	132	Positive	Positive
Sulfur Dioxide (SO <sub>2</sub> )	0,805	0	0 – 90,5 [mg/Nm3 rif O2]	/	264	Positive	Positive
Ammonia (NH <sub>3</sub> )	0,978	0,407	0 – 0,5 [mg/Nm3 rif O2]	/	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/Nm<sup>3</sup>" was not included in the calculation, but half the instrumental detection limit that is 0,1 mg/Nm<sup>3</sup> (0,05 mg/Nm<sup>3</sup>). The obtained value was compared with the raw data of the AMS (equal to 0 mg/Nm<sup>3</sup> 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 )		
a	Description of the test	Result
	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 <sup>(1)</sup>						
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 <sub>2</sub>	mg/Nm3	0	0	0	140,77	139
				0,3		138
				0,2		139
O <sub>2</sub>	% Vol	0	0	0	16,707	16,38
				0,1		16,4
				0		16,4
CO <sub>2</sub>	% Vol	0	0	0,1	16,78	16,3
				0		16,3
				0		16,3
NH <sub>3</sub>	mg/Nm3	0	0	0	17,93	18
				0,1		17,7
				0		17,6
NO <sub>2</sub>	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 <sub>c,rel</sub> [%]	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 <sub>2</sub>	0 - 2000 mg/Nm3	0,996	0,662	0,2	Positive
O <sub>2</sub>	0 - 21 %vol	0,985	0,012	0,4	Positive
CO <sub>2</sub>	0 - 25 %vol	0,991	-0,297	1,3	Positive
NH <sub>3</sub>	0 - 30 mg/Nm3	0,944	0,234	2,0	Positive
NO <sub>2</sub>	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

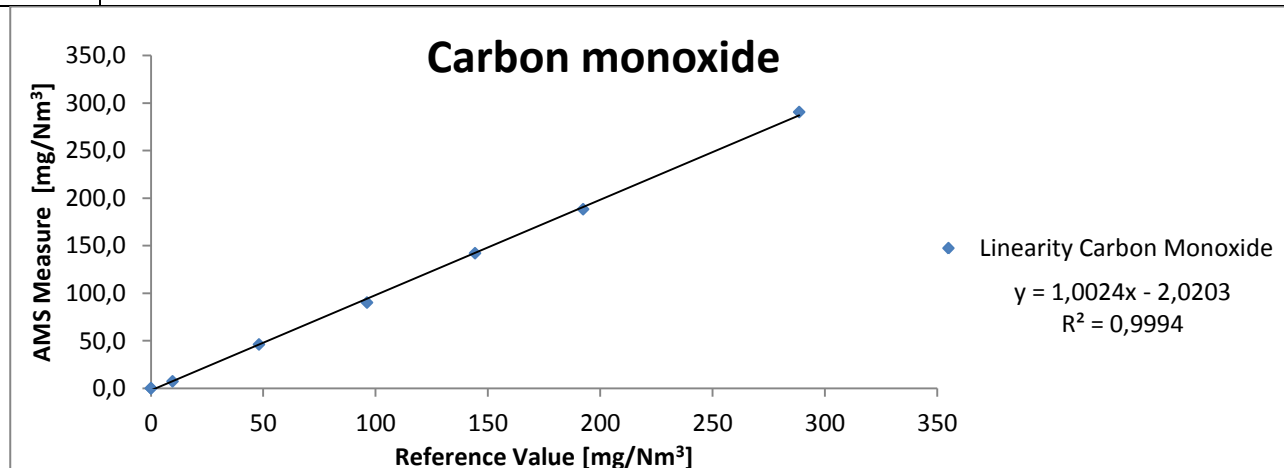
9	<i>Response time</i>	
	Type of Verification (visual)	Result
a	Response times were verified by directly setting the reference gas in the AMS and comparing the timing with those stated in QAL1.	Positive



## 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 <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	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 <sub>z</sub>	97,4	A'	95,6	B	1,002	A	-2,0203
Legend									
Yi: concentration of reference material; Xi: AMS measure corresponding to the Reference Material Concentration Level; Yz: 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/Nm <sup>3</sup>	Expiration	30/03/2019
Date measurements	09/05/2017		Diluter	Beta CAP30RK

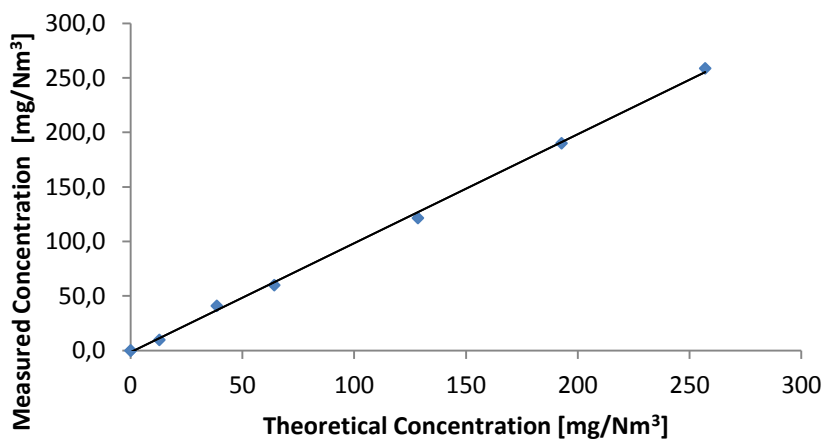
### Measurements and calculations

NO mg/Nm <sup>3</sup>	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	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 <sub>z</sub>			86,7	A'	85,2	B	0,999	A	-1,4117

### Legend

Y<sub>i</sub>: concentration of reference material;  
X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  
Y<sub>z</sub>: 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



◆ Linearity Nitrogen monoxide

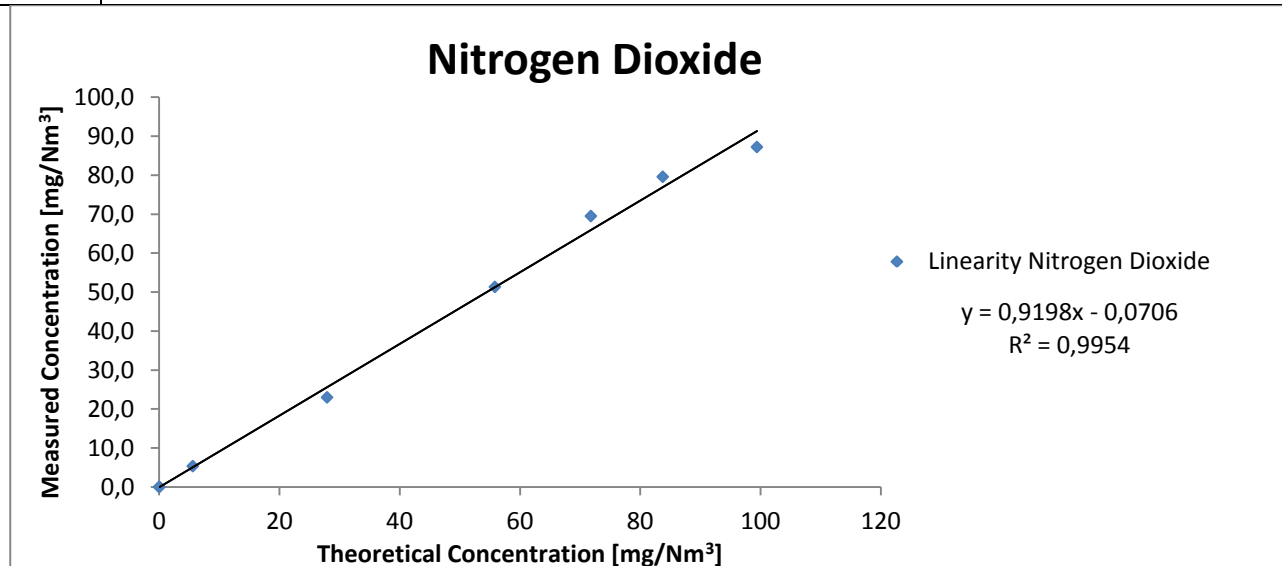
$$y = 0,9989x - 1,4117$$
$$R^2 = 0,9989$$





### 11.3 TEST LINEARITY OF NITROGEN DIOXIDE

Stack			6D			Data materials used			
Customer			D3 POWER GENERATION LIMITED			Cylinder Producer		SAPIO	
Parameter			NO <sub>2</sub>			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 <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	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 <sub>z</sub>	43,0	A'	39,5	B	0,920	A	-0,0706
Legend									
Y <sub>i</sub> : concentration of reference material; X <sub>i</sub> : AMS measure corresponding to the Reference Material Concentration Level; Y <sub>z</sub> : 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 <sub>2</sub>		Serial/Certificate	P69313YDEN
Analyzer	SICK MCS 100 E		Concentration	49,3 ppm
Full Scale set	0- 2000	mg/Nm <sup>3</sup>	Expiration	30/03/2019
Date measurements	09/05/2017		Diluter	Beta CAP30RK

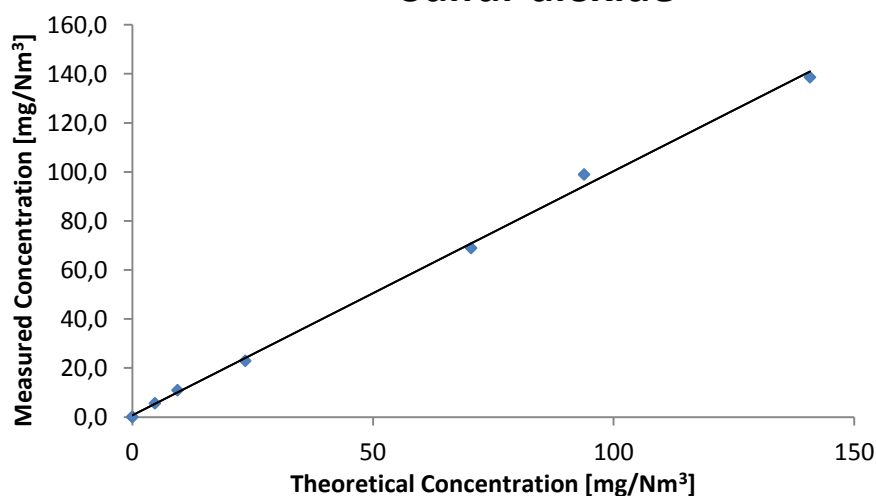
### Measurements and calculations

SO <sub>2</sub> mg/Nm <sup>3</sup>	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	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 <sub>z</sub>	42,8	A'	43,3	B	0,996	A	0,6618

### Legend

Y<sub>i</sub>: concentration of reference material;  
X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  
Y<sub>z</sub>: 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  
 $y = 0,9963x + 0,6618$   
 $R^2 = 0,9982$



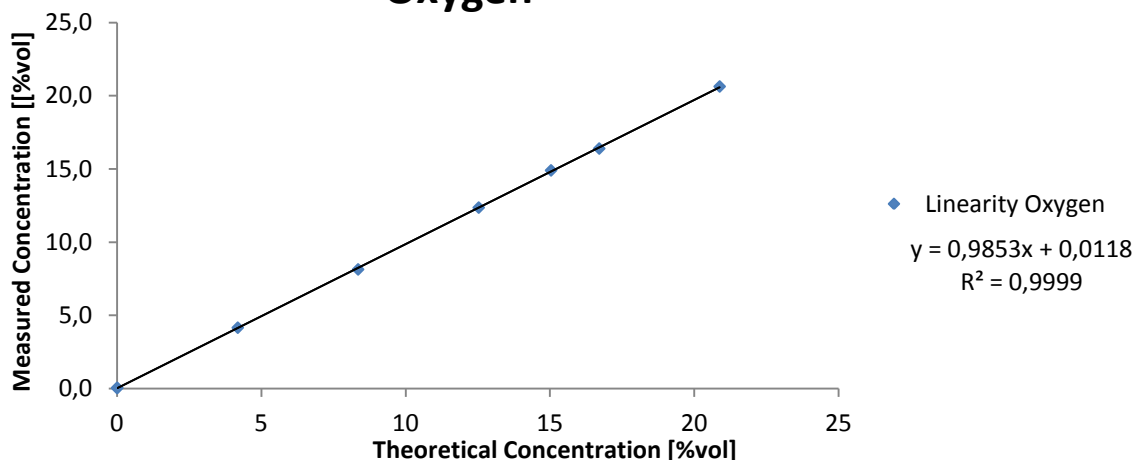
## 11.5 TEST LINEARITY OF OXYGEN

Stack	6D		Data materials used	
Customer	D3 POWER GENERATION LIMITED		Cylinder Producer	SAPIO
Parameter	O <sub>2</sub>		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 <sub>2</sub> %vol	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	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 <sub>z</sub>	9,7	A'	9,6	B	0,985	A	0,0118
Legend									
<p>Y<sub>i</sub>: concentration of reference material;  X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level;  Y<sub>z</sub>: 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

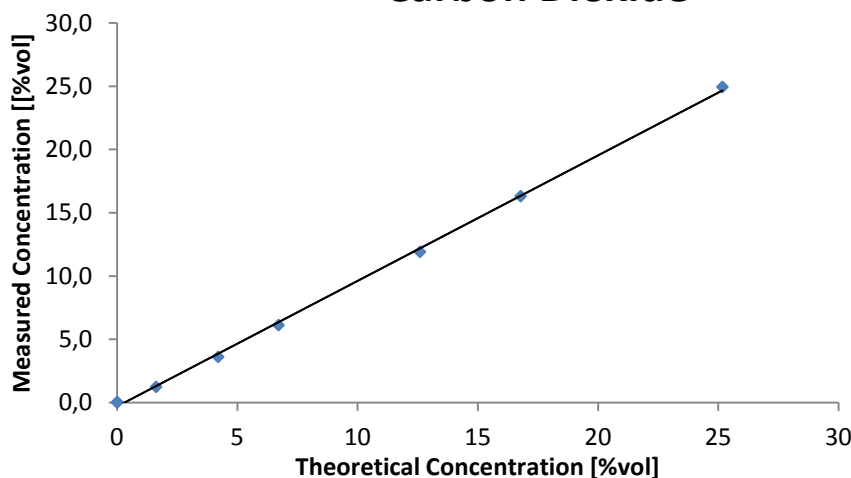




## 11.6 TEST LINEARITY OF CARBON DIOXIDE

Stack			6D			Data materials used			
Customer			D3 POWER GENERATION LIMITED			Cylinder Producer		SAPIO	
Parameter			CO <sub>2</sub>			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 <sub>2</sub> %vol	Level	Reference Value (Y <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	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 <sub>z</sub>	8,4	A'	8,0	B	0,991	A	-0,2965
Legend									
<p>Y<sub>i</sub>: concentration of reference material; X<sub>i</sub>: AMS measure corresponding to the Reference Material Concentration Level; Y<sub>z</sub>: 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>									

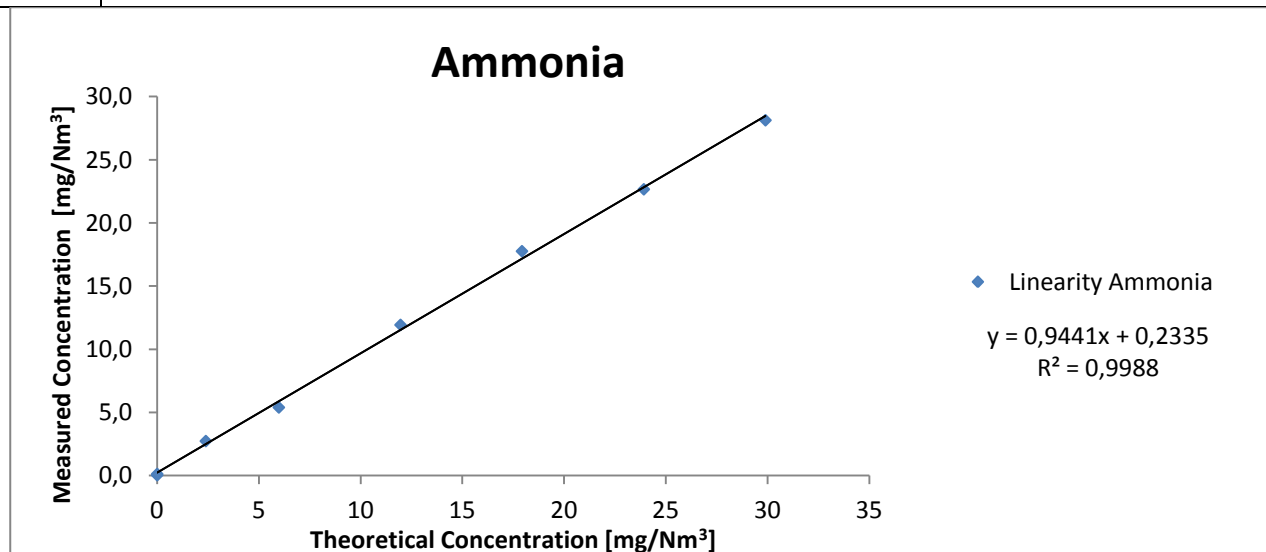
### Carbon Dioxide





## 11.7 TEST LINEARITY OF AMMONIA

Stack		6D		Data materials used					
Customer		D3 POWER GENERATION LIMITED		Cylinder Producer		SAPIO			
Parameter		NH <sub>3</sub>		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 <sub>i</sub> )	AMS Measure			X <sub>c</sub>	Residual d <sub>c</sub>	Relative Residual - % d <sub>c,rel</sub>	Result
			Reply 1 (X <sub>i</sub> )	Reply 2 (X <sub>i</sub> )	Reply 3 (X <sub>i</sub> )				
	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 <sub>z</sub>	11,5	A'	11,1	B	0,944	A	0,2335	
Legend									
Y <sub>i</sub> : concentration of reference material; X <sub>i</sub> : AMS measure corresponding to the Reference Material Concentration Level; Y <sub>z</sub> : 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									





## 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 <sub>2</sub> )	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 <sup>2</sup> ]		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 <sup>3</sup> )	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			
<b>Auxiliary Parameters</b>							
Velocity and Flow				UNI EN ISO 16911-1:2013 Annex A			
Oxygen (O <sub>2</sub> )				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			
<b>Information on the instrumentation and materials used for sampling and analysis</b>							
<b>Instrumentation</b>							
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)			
<b>Sampling material</b>							
Filter Material		Glass Fiber Filter		Diameter [mm]		47	
Filtration Temperature		Stack Temperature		Conditioning Temperature [° C]		180	
<b>Technical personnel who performed the sampling</b>							
Dott. Giorgio Rocchia							
Ing. Calogero Romano							
<b>Dust - Sampling and analysis Data</b>							<b>1</b>
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 <sup>3</sup> ] <sup>(1)</sup>
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
<sup>(1)</sup> For Blanks of the method is considered a volume of 1 m <sup>3</sup>							



Dust - Sampling and analysis Data							2
I.D. Sample	Stack Speed [m/s]	Temperature [°C]	Pressure [kPa]	H <sub>2</sub> O [%v/v]	O <sub>2</sub> [%v/v]	Dust Concentration [mg/Nm <sup>3</sup> ] <sup>(2)</sup>	Dust Concentration correct with O <sub>2</sub> [mg/Nm <sup>3</sup> ] <sup>(3)</sup>
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
<sup>(2)</sup> Dust Concentration (Wet).							
<sup>(3)</sup> 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 [%] <sup>(4)</sup>	Result	Dust Concentration correct with O <sub>2</sub> [mg/Nm <sup>3</sup> ] - Blank	Result <sup>(5)</sup>
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		
<sup>(4)</sup> Dust sampling must be done in isocinetics. The isocinet value must be within the Range -5% <G <+ 15%.							
<sup>(5)</sup> 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 <sub>2</sub> )					UNI EN 14789:2017
Nitrogen Oxide (NO)					UNI EN 14792:2017
Carbon Monoxide (CO)					UNI EN 15058:2017
Sulfur Dioxide (SO <sub>2</sub> )					ISO 11042-1:1996
Carbon Dioxide (CO <sub>2</sub> )					ISO 11042-1:1996
<b>Information on the instrumentation used for sampling and analysis</b>					
<b>Instrumentation</b>					
Analizzatore Gas		Horiba		MY25EG2X	Analizzatore Horiba PG-350E
<b>Technical personnel who performed the sampling</b>					
Dott. Giorgio Rocchia					
Ing. Calogero Romano					
<b>Determination of Nitrogen Oxide (NO) - Sampling and analysis Data</b>					<b>1</b>
<b>I.D. Sample</b>	<b>Reply</b>	<b>Date and time of Start of the Sampling</b>	<b>Sampling duration [min]</b>	<b>Nitrogen Oxide (NO) - [mg/Nm<sup>3</sup>] (2)</b>	<b>Oxygen (O<sub>2</sub>) - [%vol] <sup>(1)</sup></b>
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
<b>Notes:</b>					
(1) The oxygen value reported refers to the same measurement period of the parameter on which AST (NO <sub>x</sub> ) 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.					



<b>Determination of Carbon Monoxide (CO) - Sampling and analysis Data</b>	<b>2</b>
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I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Carbon Monoxide (CO) - [mg/Nm <sup>3</sup> ]	Oxygen (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
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.

<b>Determination of Sulfur Dioxide (SO<sub>2</sub>) - Sampling and analysis Data</b>	<b>3</b>
--	----------

I.D. Sample	Reply	Date and time of Start of the Sampling	Sampling duration [min]	Sulfur Dioxide (SO <sub>2</sub> ) - [mg/Nm <sup>3</sup> ]	Oxygen (O <sub>2</sub> ) - [%vol] <sup>(1)</sup>
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 (SO<sub>2</sub>) is performed.

(2) The sulfur dioxide (SO<sub>2</sub>) 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 <sub>2</sub> )				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 <sub>2</sub> SO <sub>4</sub> - 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 <sup>3</sup> ] <sup>(1)</sup>	Impinger G1 [mg]	Impinger G2 [mg]	Concentration [mg/Nm <sup>3</sup> ]
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

<sup>(1)</sup> For Blanks of the method is considered a volume of 1 m<sup>3</sup>





## 13 ANNEX 4 – AST REPORT

### 13.1 CARBON MONOXIDE - AST

Parameter		CO		
N. Test	DATE/TIME	SRM (Y) [mg/Nm <sup>3</sup> Rep. O <sub>2</sub> ]	AMS (X) [mg/Nm <sup>3</sup> Rep. O <sub>2</sub> ]	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 <sub>0</sub> )		3,47		
Y max -Y min		68,33		
Emission Limit Value [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]		264		
Confidence Internal limit value 95%		10		
Test value for variability kv		0,916		
Uncertainty σ <sub>0</sub>		13,47		
t student 0,95 (N-1)		2,13		
Test of variability S <sub>D</sub> ≤ 1,5σ <sub>0</sub> kv		Positive		
<b>Test of Validity of the calibration function</b> $\left  \bar{D} \right  \leq t_{0,95(N-1)} \frac{SD}{\sqrt{N}} + \sigma_0$		Positive		





## 13.2 NITROGEN OXIDE - AST

Parameter		NO		
N. Test	DATE/TIME	SRM (Y) [mg/Nm <sup>3</sup> Rep. O <sub>2</sub> ]	AMS (X) [mg/Nm <sup>3</sup> Rep. O <sub>2</sub> ]	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 <sub>D</sub> )		8,78		
Y max -Y min		42,43		
Emission Limit Value [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]		176		
Confidence Internal limit value 95%		20		
Test value for variability kv		0,916		
Uncertainty σ <sub>0</sub>		17,96		
t student 0,95 (N-1)		2,13		
Test of variability S <sub>D</sub> ≤ 1,5σ <sub>0</sub> kv		Positive		
<b>Test of Validity of the calibration function</b> $\left  \bar{D} \right  \leq t_{0,95(N-1)} \frac{SD}{\sqrt{N}} + \sigma_0$		Positive		



### 13.3 SULFUR DIOXIDE - AST

Parameter		SO <sub>2</sub>		
N. Test	DATE/TIME	SRM (Y) [mg/Nm <sup>3</sup> Rep. O <sub>2</sub> ]	AMS (X) [mg/Nm <sup>3</sup> Rep. O <sub>2</sub> ]	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 <sub>D</sub> )		11,84		
Y max -Y min		19,10		
Emission Limit Value [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]		132		
Confidence Internal limit value 95%		20		
Test value for variability kv		0,916		
Uncertainty σ <sub>0</sub>		13,47		
t student 0,95 (N-1)		2,13		
Test of variability S <sub>D</sub> ≤ 1,5σ <sub>0</sub> kv		Positive		
<b>Test of Validity of the calibration function</b> $ \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 <sup>3</sup> Rep. O <sub>2</sub> ]	AMS (X) [mg/Nm <sup>3</sup> Rep. O <sub>2</sub> ]	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 <sub>D</sub> )		0,24		
Y max -Y min		0,51		
Emission Limit Value [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]		55		
Confidence Internal limit value 95%		30		
Test value for variability kv		0,916		
Uncertainty σ <sub>0</sub>		8,42		
t student 0,95 (N-1)		2,13		
Test of variability S <sub>D</sub> ≤ 1,5σ <sub>0</sub> 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		



## 13.5 AMMONIA

Parameter		NH <sub>3</sub>		
N. Test	DATE/TIME	SRM (Y) [mg/Nm <sup>3</sup> Rep. O <sub>2</sub> ]	AMS (X) [mg/Nm <sup>3</sup> Rep. O <sub>2</sub> ]	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 <sub>D</sub> )		0,00		
Y max -Y min		0,00		
Emission Limit Value [mg/Nm <sup>3</sup> rif O <sub>2</sub> ]		2,6		
Confidence Internal limit value 95%		40		
Test value for variability kv		0,916		
Uncertainty σ <sub>0</sub>		0,53		
t student 0,95 (N-1)		2,13		
Test of variability S <sub>D</sub> ≤ 1,5σ <sub>0</sub> 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	
<b>Certified AMS:</b>	PG-350E for NO <sub>x</sub> , SO <sub>2</sub> , CO, CO <sub>2</sub> and O <sub>2</sub>
<b>Manufacturer:</b>	HORIBA Europe GmbH Julius-Kronenberg-Str. 9 42799 Leichlingen Germany
<b>Test Institute:</b>	TÜV Rheinland Energie und Umwelt GmbH
<p><b>This is to certify that the AMS has been tested and found to comply with:</b></p> <p><b>EN 15267-1: 2009, EN 15267-2: 2009, EN 15267-3: 2007 and EN 14181: 2004</b></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"><li>• EN 15267-3 tested</li><li>• QAL1 certified</li><li>• TÜV approved</li><li>• Annual inspection</li></ul>	
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
<a href="http://www.umwelt-tuv.de">www.umwelt-tuv.de</a> / <a href="http://www.eco-tuv.com">www.eco-tuv.com</a> 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.	
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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<sub>x</sub>, SO<sub>2</sub>, CO, CO<sub>2</sub> and O<sub>2</sub>

**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 <sub>x</sub>	0 - 205 <sup>1)</sup>	0 - 2050 <sup>2)</sup>	mg/m <sup>3</sup>
SO <sub>2</sub>	0 - 143	0 - 1430	mg/m <sup>3</sup>
CO	0 - 75	0 - 1250	mg/m <sup>3</sup>
CO <sub>2</sub>	0 - 20	-	Vol.-%
O <sub>2</sub>	0 - 25	0 - 10	Vol.-%

<sup>1)</sup> as NO<sub>2</sub>, this corresponds to apx 0 - 134 mg/m<sup>3</sup> NO

<sup>2)</sup> as NO<sub>2</sub>, this corresponds to apx. 0 - 1340 mg/m<sup>3</sup> NO

**Software version:**

P2000788001D / 1.11

**Restrictions:**

None

**Notes:**

1. The maintenance interval is four weeks.
2. The certification range for the component SO<sub>2</sub> 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 SO<sub>2</sub> 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 <sub>x</sub>	Chemiluminescence
CO, SO <sub>2</sub> , CO <sub>2</sub>	Non-dispersive absorption (NDIR) Infrared
O <sub>2</sub>	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](http://qal1.de).

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

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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

SO<sub>2</sub>  
Certification range 0 - 143 mg/m<sup>3</sup>

Evaluation of the cross sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point 0.54 mg/m<sup>3</sup>  
Sum of negative CS at zero point -0.69 mg/m<sup>3</sup>  
Sum of positive CS at reference point 0.70 mg/m<sup>3</sup>  
Sum of negative CS at reference point -2.60 mg/m<sup>3</sup>  
Maximum sum of cross sensitivities -2.60 mg/m<sup>3</sup>  
Uncertainty of cross sensitivity -1.503 mg/m<sup>3</sup>

Calculation of the combined standard uncertainty

Tested parameter

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

\* The larger value is used:

"Repeatability standard deviation at span" or

"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u<sub>c</sub>)  $u_c = \sqrt{\sum (u_{max,i})^2}$  4.23 mg/m<sup>3</sup>  
Total expanded uncertainty  $U = u_c \cdot k = u_c \cdot 1.96$  8.30 mg/m<sup>3</sup>



Relative total expanded uncertainty

U in % of the ELV 60 mg/m<sup>3</sup> 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/m<sup>3</sup> 15.0





	<p><b>Certificate:</b> 0000032301 / 22 March 2013</p>	
<p><b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b></p>		
<b>Measuring system</b>		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB0 / XL7LTUL1	
Measuring principle	NDIR	
<b>Test report</b>	21217617/A	
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
<b>Measured component</b>	CO	
Certification range	0 - 75 mg/m³	
<b>Evaluation of the cross sensitivity (CS)</b> (system with largest CS)		
Sum of positive CS at zero point	0.00 mg/m³	
Sum of negative CS at zero point	0.00 mg/m³	
Sum of positive CS at reference point	0.50 mg/m³	
Sum of negative CS at reference point	-0.65 mg/m³	
Maximum sum of cross sensitivities	-0.65 mg/m³	
Uncertainty of cross sensitivity	-0.377 mg/m³	
<b>Calculation of the combined standard uncertainty</b>		
<b>Tested parameter</b>		
Standard deviation from paired measurements under field conditions *	$u_D$	mg/m³ 0.356 (mg/m³)²
Lack of fit	$u_{of}$	mg/m³ 0.070 (mg/m³)²
Zero drift from field test	$u_{z,d}$	mg/m³ 0.706 (mg/m³)²
Span drift from field test	$u_{s,d}$	-0.675 mg/m³ 0.456 (mg/m³)²
Influence of ambient temperature at span	$u_t$	0.868 mg/m³ 0.750 (mg/m³)²
Influence of supply voltage	$u_v$	0.288 mg/m³ 0.082 (mg/m³)²
Cross sensitivity (interference)	$u_i$	mg/m³ 0.142 (mg/m³)²
Influence of sample gas flow	$u_p$	mg/m³ 0.001 (mg/m³)²
Uncertainty of reference material at 70% of certification range	$u_{rm}$	mg/m³ 0.368 (mg/m³)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/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	3.35 mg/m³
<b>Relative total expanded uncertainty</b>	<b>U in % of the ELV 50 mg/m³</b>	<b>6.7</b>
<b>Requirement of 2000/76/EC and 2001/80/EC</b>	<b>U in % of the ELV 50 mg/m³</b>	<b>10.0</b>
<b>Requirement of EN 15267-3</b>	<b>U in % of the ELV 50 mg/m³</b>	<b>7.5</b>



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	<p align="center"><b>Certificate:</b> 0000032301 / 22 March 2013</p>	
<p align="center"><b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b></p>		
<b>Measuring system</b>		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB9 / XL7LTUL1	
Measuring principle	NDIR	
<b>Test report</b>	21217617/A	
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
<b>Measured component</b>	CO <sub>2</sub>	
Certification range	0 - 20 Vol.-%	
<b>Evaluation of the cross sensitivity (CS)</b> (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.-%
<b>Calculation of the combined standard uncertainty</b>		
<b>Tested parameter</b>		<b>U<sup>2</sup></b>
Standard deviation from paired measurements under field conditions *	U <sub>D</sub>	Vol.-% 0.000 (Vol.-%) <sup>2</sup>
Lack of fit	U <sub>LOF</sub>	Vol.-% 0.013 (Vol.-%) <sup>2</sup>
Zero drift from field test	U <sub>ZD</sub>	Vol.-% 0.071 (Vol.-%) <sup>2</sup>
Span drift from field test	U <sub>SD</sub>	0.238 Vol.-% 0.057 (Vol.-%) <sup>2</sup>
Influence of ambient temperature at span	U <sub>t</sub>	0.115 Vol.-% 0.013 (Vol.-%) <sup>2</sup>
Influence of supply voltage	U <sub>v</sub>	0.051 Vol.-% 0.003 (Vol.-%) <sup>2</sup>
Cross sensitivity (Interference)	U <sub>i</sub>	Vol.-% 0.004 (Vol.-%) <sup>2</sup>
Influence of sample gas flow	U <sub>g</sub>	Vol.-% 0.000 (Vol.-%) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	U <sub>rm</sub>	Vol.-% 0.026 (Vol.-%) <sup>2</sup>
* The larger value is used : "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"		
Combined standard uncertainty (u <sub>c</sub> )	$u_c = \sqrt{\sum (u_{max,i})^2}$	0.43 Vol.-%
Total expanded uncertainty	$U = u_c \cdot k = u_c \cdot 1.96$	0.85 Vol.-%
<b>Relative total expanded uncertainty</b>	<b>U in % of the range 20 Vol.-%</b>	<b>4.2</b>
Requirement of 2000/76/EC and 2001/80/EC	<b>U in % of the range 20 Vol.-%</b>	<b>10.0**</b>
Requirement of EN 15267-3	<b>U in % of the range 20 Vol.-%</b>	<b>7.5</b>
** 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



	<p align="center"><b>Certificate:</b> 0000032301 / 22 March 2013</p>	
<p align="center"><b>Calculation of overall uncertainty according to EN 14181 and EN 15267-3</b></p>		
<b>Measuring system</b>		
Manufacturer	Horiba Europe GmbH	
Name of measuring system	PG-350E	
Serial number of the candidates	VC4DFKB9 / XL7LTUL1	
Measuring principle	Paramagnetism	
<b>Test report</b>	21217617/A	
Test laboratory	TÜV Rheinland	
Date of report	2012-10-08	
<b>Measured component</b>	O <sub>2</sub>	
Certification range	0 - 25 Vol.-%	
<b>Evaluation of the cross sensitivity (CS)</b> (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.-%	
<b>Calculation of the combined standard uncertainty</b>		
<b>Tested parameter</b>		<b>u<sup>2</sup></b>
Standard deviation from paired measurements under field conditions *	u <sub>D</sub> Vol.-%	0.004 (Vol.-%) <sup>2</sup>
Lack of fit	u <sub>lof</sub> Vol.-%	0.000 (Vol.-%) <sup>2</sup>
Zero drift from field test	u <sub>dz</sub> Vol.-%	0.006 (Vol.-%) <sup>2</sup>
Span drift from field test	u <sub>ds</sub> 0.092 Vol.-%	0.008 (Vol.-%) <sup>2</sup>
Influence of ambient temperature at span	u <sub>t</sub> 0.064 Vol.-%	0.007 (Vol.-%) <sup>2</sup>
Influence of supply voltage	u <sub>v</sub> 0.018 Vol.-%	0.000 (Vol.-%) <sup>2</sup>
Cross sensitivity (Interference)	u <sub>i</sub> Vol.-%	0.000 (Vol.-%) <sup>2</sup>
Influence of sample gas flow	u <sub>g</sub> Vol.-%	0.000 (Vol.-%) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	u <sub>rm</sub> Vol.-%	0.041 (Vol.-%) <sup>2</sup>
* The larger value is used : "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"		
Combined standard uncertainty (u <sub>c</sub> )	$u_c = \sqrt{\sum (u_{max,i})^2}$	0.26 Vol.-%
Total expanded uncertainty	$U = u_c \cdot k = u_c \cdot 1.96$	0.51 Vol.-%
<b>Relative total expanded uncertainty</b>	<b>U in % of the range 25 Vol.-%</b>	<b>2.0</b>
Requirement of 2000/76/EC and 2001/80/EC	<b>U in % of the range 25 Vol.-%</b>	<b>10.0**</b>
Requirement of EN 15267-3	<b>U in % of the range 25 Vol.-%</b>	<b>7.5</b>
** 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.		
qa11.de	info@qa11.de	page 10 of 10



## 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 Steinheim · Germany  
Tel +497157/53870 · Fax +497157/538710 · [www.tetratec.de](http://www.tetratec.de) · [info@tetratec.de](mailto: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.

TetraTec Instruments GmbH · Gewerbestrasse 8 · 71144 Steinenbronn · Germany  
Tel +497157/53870 · Fax +497157/538710 · [www.tetratec.de](http://www.tetratec.de) · [info@tetratec.de](mailto:info@tetratec.de)

File: CAL032528



Calibration Laboratory of TetraTec Instruments GmbH

Seite 3 of 3  
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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"),  $Q_{N,TG0} = Q_{OUT} - Q_{N,TG1}$   
 $c_S$  : 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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Tel +497157/53870 · Fax +497157/538710 · [www.tetratec.de](http://www.tetratec.de) · [info@tetratec.de](mailto:info@tetratec.de)

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](http://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](http://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](mailto: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/m<sup>3</sup>  
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](mailto: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, 20067, 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](mailto: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 RIPIEMIMENTO (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@sapiog.it](mailto:ordini@sapiog.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  
Vessel:  
INOX

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:

## Appendix 2: Evidence of notification of conclusion of full commissioning

To: Ing David Grixti  
D3 Power Generation Ltd  
Delimara Power Station  
Marsaxlokk  
MXK 1320

Date: 24 August 2017  
Our Ref: IP0002/07/F/Fi/Fii/Fiii  
: EPD/A/NE/17/1162

Dear Ing Grixti,

Reference is made to the communication received by e-mail on 18 August 2017 regarding the commercial operation of diesel engines 41 to 44.

ERA is hereby granting authorisation for the initiation of the commercial operations of engines 41 to 44. Such operations shall be in line with the provisions laid down in IPPC permit IP0002/07/Fii and emissions shall only arise from the associated emissions points as laid down in Table 2.2.1 of the IPPC permit.

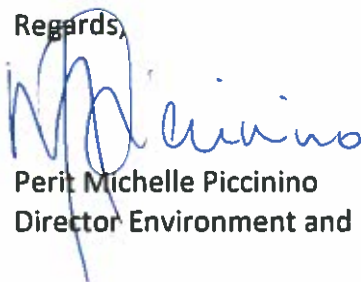
As communicated by ERA in its email dated 22 August 2017, you are kindly requested to submit the following information as per the dates indicated below:

- A copy of the calibration certification of the continuous emissions monitoring systems (CEMS) carried out for the emission point sources Chimney D6A and Chimney D6B by not later than 31 October 2017.
- Final reports related to the reliability and performance tests carried out by Warstila as part of the handing over process of the Phase 2 diesel engines by not later than 1 October 2017.

Kindly note that during the operations of the above-mentioned engines all emissions shall be in line with those stipulated in section 2.2 *Emissions to Air* of the IPPC permit.

This notification is without prejudice to all permit obligations stipulated in IP0002/07/Fii.

Regards,



Perit Michelle Piccinino  
Director Environment and Resources



## Appendix 3: Communication with Enemalta plc regarding air quality

## Angela Maria Pulis

---

**From:** David Griscti  
**Sent:** L-Erbgħa, 28 ta' Marzu 2018 08:35  
**To:** Zammit Johann at IESC; Camilleri Jan at IESC  
**Cc:** Angela Maria Pulis; Abela Carmen at Enemalta  
**Subject:** RE: Updates to the air dispersion modelling

Dear Ing. Camilleri

With reference to our discussion I would suggest to consider 6 engines running on Gas fuel for the air dispersion modelling.

Considering these facts :

- Diesel fuel is used as an emergency fuel
- D3 is dispatched for 2/3 of the year with less than 6 engines during which all engines are generally shut down during the night
- It is expected to run even less during low season once Italy- Sicily interconnection is re-enforced
- Provided dispatch plans ( to be considered approximate ) as per below :

2018 FORECASTED MONTHLY DISPATCH			
	D3 Availability (MWh)	D3 Units Generated (MWh)	D3 Gas Consump. (MMBtu)
JANUARY	96,720	8,545	69,216
FEBRUARY	90,816	9,983	80,861
MARCH	110,112	42,068	340,755
APRIL	106,560	15,460	125,226
MAY	110,112	9,622	77,941
JUNE	106,560	1,861	15,076
JULY	110,112	57,434	465,213
AUGUST	110,112	81,750	662,179
SEPTEMBER	106,560	61,666	499,491
OCTOBER	110,112	16,105	130,452
NOVEMBER	106,560	0	0
DECEMBER	110,112	0	0

The table above shows that peak season would be August with 81,750MWH equivalent to 6.6 engines running continuously.

Thus, taking 6 engines kept in service on 24\*7 basis should be a model generating an averaged level of emissions more than the expected actual. However these would then make up for some Diesel fuel operations and the frequent engine starts and stops during which emission levels are higher [ Nox in particular until SCR dosing gets in operation – Engines operating on Gas fuel without Urea injection would have an emission Nox level of 220mg/Nm3 with urea we go down to under 50mg/Nm3 ]

As Ing. Zammit described, Auxiliary Boiler is used for just few hours sparingly. This we can proof from log of operating hours and if required even from actual burner operating hours ( burner goes on and off while boiler is in

service ). In future we intend to install more electrical jacket water heaters to avoid the need of putting Auxiliary Boiler in service.

Feel free to comment back.

Thank you



**Ing. David Griscti**

Executive of Production and Technology Dept., D3 Power Generation Ltd.  
Delimara Power Station Administration, Triq il- Power Station, Marsaxlokk MXK1220,  
Malta  
+356 22473630 (Office) | +356 99103682 / 79224233 (Mobile)

---

**From:** Zammit Johann at IESC [mailto:johann.zammit@iesc.com.mt]

**Sent:** 28 March 2018 08:01

**To:** Camilleri Jan at IESC <jan.camilleri@iesc.com.mt>; David Griscti <david.griscti@d3pg.com>

**Cc:** Angela Maria Pulis <angela-maria.pulis@d3pg.com>; Abela Carmen at Enemalta  
<carmen.a.abela@enemalta.com.mt>

**Subject:** RE: Updates to the air dispersion modelling

Dear All,

In my opinion the auxiliary boiler shall not be considered as it will not be in operation if any of the DEs are in service.

Do we have to perform this exercise considering worst case scenario in normal operation or in emergency? ERA considers that in emergency gas will not be available and hence only the 4 df engines will run on diesel and no sg engines will be available.

Kind regards,  
Johann.



**Ing. Johann Zammit**  
General Manager

---

**T:** +356 2298 0874

**M:** +356 7962 1414

**E:** [johann.zammit@iesc.com.mt](mailto:johann.zammit@iesc.com.mt)



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---

**From:** Camilleri Jan at IESC

**Sent:** 28 March 2018 07:05

**To:** 'David Griscti' <[david.griscti@d3pg.com](mailto:david.griscti@d3pg.com)>

**Cc:** 'angela-maria.pulis@d3pg.com' <[angela-maria.pulis@d3pg.com](mailto:angela-maria.pulis@d3pg.com)>; Abela Carmen at Enemalta  
<[carmen.a.abela@enemalta.com.mt](mailto:carmen.a.abela@enemalta.com.mt)>; Zammit Johann at IESC <[johann.zammit@iesc.com.mt](mailto:johann.zammit@iesc.com.mt)>

**Subject:** RE: Updates to the air dispersion modelling

Dear Ing. Griscti,

Thanks, as I was not aware that ERA is considering diesel operation as an emergency fuel, in this case we agree that calculations should consider situation when all engines are running on gas fuel. On IPPC Framework Permit F we were asked to update this study twice, but on new IPPC Framework Permit G this was reduced to once.

So, for D3PG plant with whom should we correspond to be given go-ahead, for ERA submittal, regarding the mode of operation in which D3PG plant is going to be considered for this air dispersion modeling study update?

Please keep in view that if not opting for worst case scenario and instead considering the average dispatch demand or any other approach, an explanation for approach selected must also be given to ERA, in this explanation it would be beneficial to indicate how each release point is going to be considered e.g. Chimney D6D having both engines at MCR on natural gas. Another point worth highlighting at this point is on how release point Chimney D6E is going to be considered, my personal impression is that the auxiliary boiler is rarely in operation however, once again an explanation for this needs to be provided if D3PG intends considering auxiliary boiler in switched off mode for this exercise.

Extract from IP 0002/07/Gii – D3 Power Generation Ltd

**Table 2.2.1 Emission points to air**

Release Point	Source	Total Thermal Rating	UTM Co-ordinates <sup>[1]</sup>	
		MW <sub>TH</sub>	x-coordinates	y-coordinates
Chimney D6A	DPS6 (Diesel engines 1 & 2)	86	460,137	3,965,687
Chimney D6B	DPS6 (Diesel engines 3 & 4)	86	460,134	3,965,685
Chimney D6C	DPS6 (Diesel engines 5 & 6)	79	460,104	3,965,663
Chimney D6D	DPS6 (Diesel engines 7 & 8)	79	460,101	3,965,661
Chimney D6E	Auxiliary steam boiler	3.85	460,009	3,965,425

Extract from IPPC Framework Permit G

2.3.5.1 The Permit Coordinator, in collaboration with the Operators of the installation shall update the dispersion modelling study carried out by the Authority twice, using the data from the plant's air emissions monitoring systems, and ambient air monitoring data from Žejtun, Birzebbuga and Marsaxlokk (including the data collected as required by 2.3.5.2). The updated studies shall assess the dispersion of NO<sub>2</sub>, PM<sub>10</sub> and PM<sub>2.5</sub>, arsenic, cadmium, nickel, lead and vanadium and shall estimate the likelihood of there being any exceedances of the relevant limits laid down by S.L. 549.59 especially but not limited to the most sensitive receptor(s) in the prevailing wind direction within a 15 km radius. The Permit Coordinator shall submit to the Authority a proposed methodology for this study, which shall be to the Authority's satisfaction.

2.3.5.1.1 The proposed methodology to be submitted by end November 2017.

2.3.5.1.2 The study which shall include an assessment of the impact of closure and decommissioning of the Marsa Power Station and Delimara 1 plant and the conversion of the Delimara 3 plant to natural gas to be submitted by end June 2018.

Kind regards,  
**Jan Camilleri**

Ing. Jan Camilleri  
Professional Executive

---

**M: +356 79717192**  
**T: +356 22980 863**  
**E: [jan.camilleri@iesc.com.mt](mailto:jan.camilleri@iesc.com.mt)**

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---

**From:** David Griscti [<mailto:david.griscti@d3pg.com>]  
**Sent:** 27 March 2018 16:21  
**To:** Camilleri Jan at IESC <[jan.camilleri@iesc.com.mt](mailto:jan.camilleri@iesc.com.mt)>  
**Cc:** Angela Maria Pulis <[angela-maria.pulis@d3pg.com](mailto:angela-maria.pulis@d3pg.com)>  
**Subject:** RE: Updates to the air dispersion modelling

Dear Ing. Camilleri

Actually its very unusual to have 4DF engines on diesel mode and 4SGs on gas. Another point is that ERA is considering diesel operation as an emergency fuel so it would not be recommended to propose diesel operation as base load situation.

I would say 4DF engines on gas and 4SG engines on gas would be more realistic.

At what time intervals does this modelling needs to be repeated.

The above is only my opinion. Feel free to comment back.

Best Regards



**Ing. David Griscti**

Executive of Production and Technology Dept., D3 Power Generation Ltd.  
Delimara Power Station Administration, Triq il- Power Station, Marsaxlokk MXK1220,  
Malta  
+356 22473630 (Office) | +356 99103682 / 79224233 (Mobile)

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**From:** Camilleri Jan at IESC [<mailto:jan.camilleri@iesc.com.mt>]  
**Sent:** 27 March 2018 14:54  
**To:** David Griscti <[david.griscti@d3pg.com](mailto:david.griscti@d3pg.com)>  
**Cc:** Angela Maria Pulis <[angela-maria.pulis@d3pg.com](mailto:angela-maria.pulis@d3pg.com)>  
**Subject:** Updates to the air dispersion modelling

Dear Ing. Griscti,

Prior to the start of the air dispersion modelling study update, ERA is asking for the mode of operation on which model calculations are going to be carried out e.g. worst-case scenario or combinations will be considered

depending on the average dispatch demand etc. For D3PG plant, what mode of operation do you think is best to consider for this exercise? In my opinion it is best to go for the worst-case scenario, which I believe is having 4 diesel engines running on natural gas and 4 diesel engines running on diesel oil, rather than going for the average dispatch demand, as having future changes in operation trends could question the applicability of such air dispersion modelling update.

Kind regards,  
**Jan Camilleri**



**Ing. Jan Camilleri**  
Professional Executive

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**M: +356 79717192**  
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<sup>[1]</sup> Zone 33s, datum ED 50, ellipsoid – Hayford International.



## Appendix 4: Communication with Enemalta plc regarding noise data

## Angela Maria Pulis

---

**From:** Carmen Abela <carmen.a.abela@enemalta.com.mt>  
**Sent:** It-Tlieta, 5 ta' Jannar 2021 15:17  
**To:** David Griscti  
**Cc:** Angela Maria Pulis; Darren Cutajar; liyb  
**Subject:** RE: [External] - RE: Noise monitoring last point @ DPS

Dear David,

Thanks a lot. It looks like we can go ahead then with the monitoring.

I will inform AIS.

Thanks.

Best Regards,

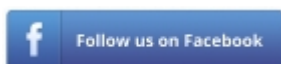
Carmen

**Ing. Carmen Abela**

Senior Professional Executive (Electrical) | Regulatory Affairs Office | Enemalta plc

---

T: +356 22980836 | M: +356 99457182 | E: [carmen.a.abela@enemalta.com.mt](mailto:carmen.a.abela@enemalta.com.mt) | W: [www.enemalta.com.mt](http://www.enemalta.com.mt)



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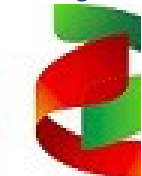
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**From:** David Griscti <david.griscti@d3pg.com>  
**Sent:** 05 January 2021 15:10  
**To:** Carmen Abela <carmen.a.abela@enemalta.com.mt>  
**Cc:** Angela Maria Pulis <angela-maria.pulis@d3pg.com>; Darren Cutajar <darren.cutajar@d3pg.com>; liyb <liyb@sep-malta.com>  
**Subject:** [External] - RE: Noise monitoring last point @ DPS

Dear Carmen

You can proceed with noise monitoring accordingly. We have no planned noise generating activities

Best Regards



**David Griscti**

CTO and Head of Production and Technology Department of D3

D3 Power Generation Ltd.

Delimara Power Station Administration, Triq il- Power Station, Marsaxlokk MXK1220, Malta

+356 22472100 (Reception)



---

**From:** Carmen Abela [<mailto:carmen.a.abela@enemalta.com.mt>]

**Sent:** 05 January 2021 13:23

**To:** David Griscti <[david.griscti@d3pg.com](mailto:david.griscti@d3pg.com)>

**Subject:** Noise monitoring last point @ DPS

Dear David,

We still need to carry out noise monitoring at the 4<sup>th</sup> and last point at Delimara behind the fuel tanks (near Mintoff's Villa)

AIS asked me if it is possible to carry out monitoring tomorrow starting at 10:00 duration 24hours.

Do you think it would be possible or do you have works scheduled for these 24hours?

Thanks.

Best Regards,

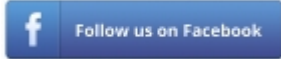
Carmen

**Ing. Carmen Abela**

Senior Professional Executive (Electrical) | Regulatory Affairs Office | Enemalta plc

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## Appendix 5: ISO14001 certificate

# Certificate of Approval

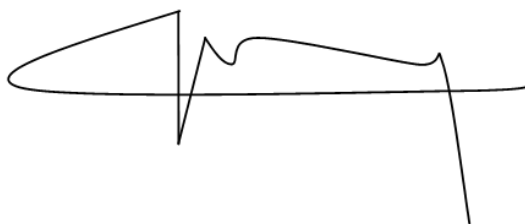
This is to certify that the Management System of:

## D3 Power Generation Ltd

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

has been approved by LRQA to the following standards:

ISO 14001:2015



Gilles Bessiere - Area Technical Manager

Issued by: Lloyd's Register Quality Assurance Italy Srl

for and on behalf of: Lloyd's Register Quality Assurance Limited

Current Issue Date: 18 April 2018

Expiry Date: 17 April 2021

Certificate Identity Number: 10075795

Original Approvals:

ISO 14001 – 18 April 2018

Approval Number(s): ISO 14001 – 00013519

The scope of this approval is applicable to:

Electrical power generation and supply through combined cycle technology.



001