

CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000062070

AMS designation: Model 405 nm for NO, NO₂ and NO_x

Manufacturer: 2B Technologies
2100 Central Avenue
Boulder, Colorado 80301
USA

Test Laboratory: TÜV Rheinland Energy GmbH

This is to certify that the AMS has been tested and found to comply with the standards:

VDI 4202-1 (2018), EN 14211 (2012),
Guide to the demonstration of equivalence of ambient air monitoring methods
(2010), EN 15267-1 (2009) and EN 15267-2 (2009)

Certification is awarded in respect of the conditions stated in this certificate
(this certificate contains 13 pages).



Suitability Tested
Complying with
2008/50/EC
EN 15267
Regular Surveillance

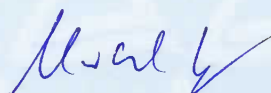
www.tuv.com
ID 0000062070

Publication in the German Federal Gazette
(BAnz) of 22 July 2019


Expiry date:
21 July 2024

Federal Environment Agency
Dessau, 05 November 2019

TÜV Rheinland Energy GmbH
Cologne, 04 November 2019



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Test institute accredited to EN ISO/IEC 17025:2005 by DAkkS (German Accreditation Body).
This accreditation is limited to the accreditation scope defined in the enclosure to the certificate D-PL-11120-02-00.

Test Report:	936/21242468/A dated 19 February 2019
Initial certification:	22 July 2019
Expiry date:	21 July 2024
Publication:	BAnz AT 22.07.2019 B8, chapter III number 1.1

Approved application

The certified AMS is suitable for continuous ambient air monitoring of nitrogen oxides (stationary operation).

The suitability of the AMS for this application was assessed on the basis of a laboratory test and a seven-months field test.

The AMS is approved for an ambient temperature range of 0 °C to +30 °C.

The notification of suitability of the AMS, performance testing and the uncertainty calculation have been effected on the basis of the regulations applicable at the time of testing. As changes in legal provisions are possible, any potential user should ensure, in consultation with the manufacturer, that this AMS is suitable for monitoring the AMS readings relevant to the application.

Any potential user should ensure, in consultation with the manufacturer, that this AMS is suitable for the intended purpose.

Basis of the certification

This certification is based on:

- Test report no. 936/21242468/A dated 19 February 2019 issued by TÜV Rheinland Energy 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 22.07.2019 B8, chapter III number 1.1,
UBA announcement dated 28 June 2019:

AMS designation:

Model 405 nm for NO, NO₂ and NO_x

Manufacturer:

2B Technologies, Boulder, USA

Field of application:

For the continuous measurement of nitrogen oxide concentrations from stationary sources
in ambient air

Measurement ranges during performance testing:

Component	Certification range	Unit
Nitrogen monoxide	0–1 200	µg/m ³
Nitrogen dioxide	0–500	µg/m ³

Software version:

Version 36B

Restriction:

None

Notes:

1. The test report on performance testing is available on the internet at www.qal1.de.
2. As the measuring system does not provide password protection, it has to be mounted in a lockable cabinet.
3. Equivalence to the reference method in accordance with the requirements of the Guide to the Demonstration of Equivalence of Ambient Air Monitoring Methods was demonstrated.

Test Report:

TÜV Rheinland Energy GmbH, Cologne
Report no. 936/21242468/A dated 19 February 2019

Certified product

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

The Model 405 nm ambient air monitor is a continuous nitrogen oxide analyser. The instrument uses direct UV absorption as a measuring principle. It was designed for the continuous measurement of NO, NO₂ and NO_x in ambient air.

The model 405 NO₂/NO/NO_x monitor is designed to measure atmospheric nitrogen dioxide (NO₂), nitrogen oxide (NO) and NO_x (NO + NO₂) in a dynamic range from just a few ppb up to 10 ppm for NO₂ and 2 ppm for NO based on the detection of visible light at a wave length of 405 nanometres (nm).

The model 405 inside the analyser uses the absolute method to measure NO₂ on the basis of Beer-Lambert law. NO₂ measurement relies on a conventional absorption method. NO₂ is analysed at a UV light wave length of 405 nm. The necessary measurement path length of 2 m is realised by using a measurement cell with a tube design which facilitates low volumes and fast gas replacement.

Nitrogen oxide is measured by measuring UV light intensities with and without adding ozone for oxidising NO to NO₂. As described in more detail below, the result is a "semi-direct" measurement of NO in that the NO concentration is output directly and not based on subtraction of NO₂ concentration from a total NO_x concentration. Instead, the NO_x concentration is computed as the sum of the measurements of NO₂ and NO.

The pump sucks in sample air through the instrument at a constant flow rate of 1.5 l/min. The NO₂ scrubber valve alternately bypasses and sends the sample air through a heated NO₂ scrubber to remove all NO₂ in the sample. The NO₂-scrubbed or unscrubbed air passes through the reactor volume and the DewLine™ Nafion Tubes, through the optical cell and through the cell flow meter. Alternate switching of the NO₂ scrubber valve once every 5 seconds allows the measurement of a light intensity in the absence (I_0) of NO₂ and presence (I) of NO₂. The Beer-Lambert Law is then used to calculate the concentration of NO₂ from I and I_0 .

Nitrogen oxide is measured by bypassing the NO₂ scrubber and measuring the light intensity while adding (I) or not adding (I_0) ozone to convert NO to NO₂ according to the well-known reaction:

NO_x is computed from the measurement of NO and NO₂.

General remarks

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 manufacturing process for the certified product. Both the product and the quality management system shall be subject to regular surveillance.

If a product of the current production does not conform to the certified product, TÜV Rheinland Energy 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 document as well as the certification mark remains property of TÜV Rheinland Energy GmbH. Upon revocation of the publication the certificate loses its validity. After the expiration of the certificate and on request of TÜV Rheinland Energy GmbH this document shall be returned and the certificate mark must no longer be used.

The relevant version of this certificate and its expiration date are also accessible on the internet at gal1.de.

Document history

Certification of the Model 405 nm measuring system is based on the documents listed below and the regular, continuous surveillance of the manufacturer's quality management system.

Initial certification according to EN 15267

Certificate no. 0000062070: 05 November 2019
Expiry date of the certificate: 21 July 2024
Test report 936/21242468/A dated 19 February 2019
TÜV Rheinland Energy GmbH, Cologne
Publication: BAnz AT 22.07.2019 B8, chapter III number 1.1
UBA announcement dated 28 June 2019

Expanded uncertainty, laboratory, NO, system 1

Measuring device:		Serial-No.:		1h-limit value:	
M405nm		1073		104.6	
Measured component:		Performance criterion		Square of partial uncertainty	
NO		1h-limit value:		nmol/mol	
No.	Performance characteristic	Result	Partial uncertainty	Square of partial uncertainty	
1	Repeatability standard deviation at zero	0.670	$u_{r,z}$ 0.12	0.0140	
2	Repeatability standard deviation at 1h-limit value	1.070	$u_{r,1h}$ 0.04	0.0015	
3	"lack of fit" at 1h-limit value	0.660	$u_{l,1h}$ 0.40	0.1589	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	0.340	u_{gp} 0.86	0.7319	
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	0.080	u_{gt} 0.20	0.0405	
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	0.250	u_{st} 0.63	0.3957	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	0.010	u_v 0.04	0.0015	
8a	Interferent H ₂ O with 19 nmol/mol	1.870	u_{H_2O} 1.47	2.1687	
8b	Interferent CO ₂ with 500 µmol/mol	2.370			
		1.270	$u_{int,pos}$		
8c	Interferent NH ₃ mit 200 nmol/mol	-0.070			
		1.370	of	2.1166	
		2.130	$u_{int,neg}$		
9	Averaging effect	0.500	u_{av} 0.30	0.0912	
18	Difference sample/calibration port	0.000	u_{asc} 0.00	0.0000	
21	Converter efficiency	99.80	u_{ec} 0.21	0.0438	
23	Uncertainty of test gas	2.000	u_{cg} 1.05	1.0941	
Combined standard uncertainty			u_c	2.6218	
Expanded uncertainty			U	5.2436	
Relative expanded uncertainty			W	5.01	
Maximum allowed expanded uncertainty			W_{req}	15	

Expanded uncertainty, laboratory, NO, system 2

Measuring device:		M405nm		Serial-No.: 1076		nmol/mol	
Measured component:		NO		1h-limit value:		104.6	
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty		
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0.500	U _{r,z}	0.09	0.0076	
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	1.030	U _{r,h}	0.04	0.0014	
3	"lack of fit" at 1h-limit value	≤ 4.0% of measured value	1.150	U _{l,h}	0.69	0.4823	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 8.0 nmol/mol/kPa	0.430	U _{gp}	1.08	1.1707	
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 3.0 nmol/mol/K	0.050	U _{gt}	0.13	0.0158	
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 3.0 nmol/mol/K	0.253	U _{st}	0.64	0.4053	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0.000	U _v	0.00	0.0000	
8a	Interferent H ₂ O with 19 mmol/mol	≤ 10 nmol/mol (Zero) ≤ 10 nmol/mol (Span)	0.330 2.800	U _{H2O}	0.63	0.3944	
8b	Interferent CO ₂ with 500 µmol/mol	≤ 5.0 nmol/mol (Zero)	1.030	U _{int,pos}			
8c	Interferent NH ₃ mit 200 nmol/mol	≤ 5.0 nmol/mol (Span) ≤ 5.0 nmol/mol (Zero)	-0.330 1.670	or	1.31	1.7227	
9	Averaging effect	≤ 5.0 nmol/mol (Zero) ≤ 5.0 nmol/mol (Span)	0.970	U _{int,neg}			
18	Difference sample/calibration port	≤ 7.0% of measured value	3.800	U _{av}	2.29	5.2663	
21	Converter efficiency	≤ 1.0%	0.000	U _{u,sc}	0.00	0.0000	
23	Uncertainty of test gas	≥ 98	99.60	U _{EC}	0.42	0.1751	
		≤ 3.0%	2.000	U _{cg}	1.05	1.0941	
				Combined standard uncertainty	u _c	3.2779	nmol/mol
				Expanded uncertainty	U	6.5558	nmol/mol
				Relative expanded uncertainty	W	6.27	%
				Maximum allowed expanded uncertainty	W _{req}	15	%

Combined uncertainty, laboratory and field, NO, system 1

Measuring device:		M405nm		Serial-No.:		1073	
Measured component:		NO		1h-limit value:		104.6	
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty	nmol/mol	
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0.670	$u_{r,z}$	0.0140		
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	1.070	$u_{r,1h}$	-		
3	"lack of fit" at 1h-limit value	≤ 4.0% of measured value	0.660	$u_{l,1h}$	0.1589		
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 8.0 nmol/mol/kPa	0.340	u_{gp}	0.7319		
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 3.0 nmol/mol/K	0.080	u_{gt}	0.0405		
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 3.0 nmol/mol/K	0.250	u_{st}	0.3957		
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0.010	u_v	0.0015		
8a	Interferent H ₂ O with 19 mmol/mol	≤ 10 nmol/mol (Zero)	1.870	u_{H_2O}	2.1687		
		≤ 10 nmol/mol (Span)	2.370				
8b	Interferent CO ₂ with 500 µmol/mol	≤ 5.0 nmol/mol (Zero)	1.270	$u_{int,pos}$			
		≤ 5.0 nmol/mol (Span)	-0.070	or	2.1166		
8c	Interferent NH ₃ mit 200 nmol/mol	≤ 5.0 nmol/mol (Zero)	1.370				
		≤ 5.0 nmol/mol (Span)	2.130	$u_{int,neg}$			
9	Averaging effect	≤ 7.0% of measured value	0.500	u_{av}	0.0912		
10	Reproducibility standard deviation under field conditions	≤ 5.0% of average over 3 months	3.410	$u_{r,f}$	12.7225		
11	Long term drift at zero level	≤ 5.0 nmol/mol	0.390	$u_{d,l,z}$	0.0507		
12	Long term drift at span level	≤ 5.0% of max. of certification range	1.290	$u_{d,l,1h}$	0.6069		
18	Difference sample/calibration port	≤ 1.0%	0.000	u_{asc}	0.0000		
21	Converter efficiency	≥ 98	99.800	u_{ec}	0.0438		
23	Uncertainty of test gas	≤ 3.0%	2.000	u_{eg}	1.0941		
Combined standard uncertainty				u_c	4.5001	nmol/mol	
Expanded uncertainty				U	9.0002	nmol/mol	
Relative expanded uncertainty				W	8.60	%	
Maximum allowed expanded uncertainty				W_{req}	15	%	

Combined uncertainty, laboratory and field, NO, system 2

Measuring device:		M405nm		Serial-No.:		1076	
Measured component:		NO		1h-limit value:		104.6	
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty	nmol/mol	
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0.500	U _{r,z}	0.0076		
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	1.030	U _{r,1h}	-		
3	"lack of fit" at 1h-limit value	≤ 4.0% of measured value	1.150	U _{l,1h}	0.4823		
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 8.0 nmol/mol/kPa	0.430	U _{sp}	1.1707		
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 3.0 nmol/mol/K	0.050	U _{gt}	0.0158		
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 3.0 nmol/mol/K	0.253	U _{st}	0.4053		
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0.000	U _v	0.0000		
8a	Interferent H ₂ O with 19 mmol/mol	≤ 10 nmol/mol (Zero) ≤ 10 nmol/mol (Span)	0.330 2.800	U _{H2O}	0.63		
8b	Interferent CO ₂ with 500 μmol/mol	≤ 5.0 nmol/mol (Zero) ≤ 5.0 nmol/mol (Span)	1.030 -0.330	U _{int,pos} or	1.31	1.7227	
8c	Interferent NH ₃ mit 200 nmol/mol	≤ 5.0 nmol/mol (Zero) ≤ 5.0 nmol/mol (Span)	1.670 0.970	U _{int,neg}			
9	Averaging effect	≤ 7.0% of measured value	3.800	U _{av}	2.29	5.2663	
10	Reproducibility standard deviation under field conditions	≤ 5.0% of average over 3 months	3.410	U _{r,f}	3.57	12.7225	
11	Long term drift at zero level	≤ 5.0 nmol/mol	0.940	U _{l,z}	0.54	0.2945	
12	Long term drift at span level	≤ 5.0% of max. of certification range	0.890	U _{l,1h}	0.54	0.2889	
18	Difference sample/calibration port	≤ 1.0%	0.000	U _{asc}	0.00	0.0000	
21	Converter efficiency	≥ 98	99.600	U _{EC}	0.42	0.1751	
23	Uncertainty of test gas	≤ 3.0%	2.000	U _{cg}	1.05	1.0941	
				Combined standard uncertainty		u _c	
				Expanded uncertainty		U	
				Relative expanded uncertainty		W	
				Maximum allowed expanded uncertainty		W _{req}	
						nmol/mol	
						nmol/mol	
						%	
						%	

Expanded uncertainty, laboratory, NO₂, system 1

Measuring device:		M405nm		Serial No.:		1073	
Measured component:		NO2		1h-limit value:		104.6	
						nmol/mol	
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty		
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0.350	u _{r,z}	0.07	0.0048	
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	0.880	u _{r,1h}	0.17	0.0303	
3	"lack of fit" at 1h-limit value	≤ 4.0% of measured value	2.360	u _{l,1h}	1.43	2.0313	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 8.0 nmol/mol/kPa	0.190	u _{sp}	1.91	3.6572	
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 3.0 nmol/mol/K	0.100	u _{gt}	0.91	0.8206	
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 3.0 nmol/mol/K	0.197	u _{st}	1.78	3.1846	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0.000	u _v	0.00	0.0000	
8a	Interferent H ₂ O with 19 mmol/mol	≤ 10 nmol/mol (Zero)	0.070	u _{H2O}	1.69	2.8479	
8b	Interferent CO ₂ with 500 µmol/mol	≤ 5.0 nmol/mol (Zero)	-0.070	u _{int,pos} or	0.48	0.2299	
		≤ 5.0 nmol/mol (Span)	-0.570				
8c	Interferent NH ₃ mit 200 nmol/mol	≤ 5.0 nmol/mol (Zero)	0.970	u _{int,neg}			
		≤ 5.0 nmol/mol (Span)	0.830				
9	Averaging effect	≤ 7.0% of measured value	3.400	u _{av}	2.05	4.2160	
18	Difference sample/calibration port	≤ 1.0%	0.000	u _{ssc}	0.00	0.0000	
21	Converter efficiency	≥ 98	99.80	u _{EC}	0.21	0.0438	
23	Uncertainty of test gas	≤ 3.0%	2.000	u _{cg}	1.05	1.0941	
				Combined standard uncertainty		u _c	
				Expanded uncertainty		U	
				Relative expanded uncertainty		W	
				Maximum allowed expanded uncertainty		W _{req}	
						4.2656	
						8.5313	
						8.16	
						15	

Expanded uncertainty, laboratory, NO₂, system 2

Measuring device:		M405nm		Serial-No.:		1076	
Measured component:		NO ₂		1h-limit value:		104.6	
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty	nmol/mol	
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0.570	U _{r,z}	0.12	0.0134	
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	0.780	U _{r,h}	0.16	0.0248	
3	"lack of fit" at 1h-limit value	≤ 4.0% of measured value	3.290	U _{l,h}	1.99	3.9476	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 8.0 nmol/mol/kPa	0.170	U _{gp}	1.71	2.9278	
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 3.0 nmol/mol/K	0.100	U _{gt}	0.91	0.8206	
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 3.0 nmol/mol/K	0.206	U _{st}	1.87	3.4822	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0.020	U _v	0.28	0.0772	
8a	Interferent H ₂ O with 19 mmol/mol	≤ 10 nmol/mol (Zero) ≤ 10 nmol/mol (Span)	0.230 2.130	U _{H2O}	1.58	2.5089	
8b	Interferent CO ₂ with 500 µmol/mol	≤ 5.0 nmol/mol (Zero) ≤ 5.0 nmol/mol (Span)	0.070 0.370	U _{int,pos} or	0.68	0.4558	
8c	Interferent NH ₃ mit 200 nmol/mol	≤ 5.0 nmol/mol (Zero) ≤ 5.0 nmol/mol (Span)	0.930 0.800	U _{int,neg}			
9	Averaging effect	≤ 7.0% of measured value	1.600	U _{av}	0.97	0.9336	
18	Difference sample/calibration port	≤ 1.0%	0.000	U _{Δsc}	0.00	0.0000	
21	Converter efficiency	≥ 98	99.60	U _{EC}	0.42	0.1751	
23	Uncertainty of test gas	≤ 3.0%	2.000	U _{cg}	1.05	1.0941	
Combined standard uncertainty						u _c	4.0619
Expanded uncertainty						U	8.1239
Relative expanded uncertainty						W	7.77
Maximum allowed expanded uncertainty						W _{req}	15

Combined uncertainty, laboratory and field, NO₂, system 1

Measuring device:		M405nm		Serial-No.:		1073	
Measured component:		NO ₂		1h-limit value:		104.6	
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty	nmol/mol	
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0.350	u _{r,z}	0.07	0.0048	
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	0.880	u _{r,1h}	not considered, as $\sqrt{2} \cdot u_{r,1h} = 0,24 < u_{r,f}$	-	
3	"lack of fit" at 1h-limit value	≤ 4.0% of measured value	2.360	u _{l,1h}	1.43	2.0313	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 8.0 nmol/mol/kPa	0.190	u _{gp}	1.91	3.6572	
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 3.0 nmol/mol/K	0.100	u _{gt}	0.91	0.8206	
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 3.0 nmol/mol/K	0.197	u _{st}	1.78	3.1846	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0.000	u _y	0.00	0.0000	
8a	Interferent H ₂ O with 19 nmol/mol	≤ 10 nmol/mol (Zero) ≤ 10 nmol/mol (Span)	0.070 2.270	u _{H2O}	1.69	2.8479	
8b	Interferent CO ₂ with 500 µmol/mol	≤ 5.0 nmol/mol (Zero) ≤ 5.0 nmol/mol (Span)	-0.070 -0.570	u _{CO2, pos} or	0.48	0.2299	
8c	Interferent NH ₃ mit 200 nmol/mol	≤ 5.0 nmol/mol (Zero) ≤ 5.0 nmol/mol (Span)	0.970 0.830	u _{NH3, neg}			
9	Averaging effect	≤ 7.0% of measured value	3.400	u _{av}	2.05	4.2160	
10	Reproducibility standard deviation under field conditions	≤ 5.0% of average over 3 months	3.410	u _{r,f}	3.57	12.7225	
11	Long term drift at zero level	≤ 5.0 nmol/mol	-0.610	u _{d,l,z}	-0.35	0.1240	
12	Long term drift at span level	≤ 5.0% of max. of certification range	0.610	u _{d,l,h}	0.37	0.1357	
18	Difference sample/calibration port	≤ 1.0%	0.000	u _{Δsc}	0.00	0.0000	
21	Converter efficiency	≥ 98	99.800	u _{EC}	0.21	0.0438	
23	Uncertainty of test gas	≤ 3.0%	2.000	u _{cg}	1.05	1.0941	
Combined standard uncertainty						u _c	5.5783
Expanded uncertainty						U	11.1566
Relative expanded uncertainty						W	10.67
Maximum allowed expanded uncertainty						W _{req}	15

Combined uncertainty, laboratory and field, NO₂, system 2

Measuring device:		M405nm		Serial-No.:		1076	
Measured component:		NO ₂		1h-limit value:		104.6	
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty	nmol/mol	
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0.570	U _{r,z}	0.12	0.0134	
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	0.780	U _{r,1h}	not considered, as $\sqrt{2} \cdot u_{r,1h} = 0.22 < u_{r,f}$	-	
3	"lack of fit" at 1h-limit value	≤ 4.0% of measured value	3.290	U _{l,1h}	1.99	3.9476	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 8.0 nmol/mol/kPa	0.170	U _{sp}	1.71	2.9278	
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 3.0 nmol/mol/K	0.100	U _{gt}	0.91	0.8206	
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 3.0 nmol/mol/K	0.206	U _{st}	1.87	3.4822	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0.020	U _v	0.28	0.0772	
8a	Interferent H ₂ O with 19 nmol/mol	≤ 10 nmol/mol (Zero) ≤ 10 nmol/mol (Span)	0.230 2.130	U _{H2O}	1.58	2.5089	
8b	Interferent CO ₂ with 500 µmol/mol	≤ 5.0 nmol/mol (Zero) ≤ 5.0 nmol/mol (Span)	0.070 0.370	U _{int,pos} or	0.68	0.4558	
8c	Interferent NH ₃ mit 200 nmol/mol	≤ 5.0 nmol/mol (Zero) ≤ 5.0 nmol/mol (Span)	0.930 0.800	U _{int,neg}			
9	Averaging effect	≤ 7.0% of measured value	1.600	U _{av}	0.97	0.9336	
10	Reproducibility standard deviation under field conditions	≤ 5.0% of average over 3 months	3.410	U _{r,f}	3.57	12.7225	
11	Long term drift at zero level	≤ 5.0 nmol/mol	0.530	U _{gl,z}	0.31	0.0936	
12	Long term drift at span level	≤ 5.0% of max. of certification range	1.330	U _{gl,1h}	0.80	0.6451	
18	Difference sample/calibration port	≤ 1.0%	0.000	U _{sc}	0.00	0.0000	
21	Converter efficiency	≥ 98	99.600	U _{EC}	0.42	0.1751	
23	Uncertainty of test gas	≤ 3.0%	2.000	U _{cg}	1.05	1.0941	
				Combined standard uncertainty		U _c	5.4691
				Expanded uncertainty		U	10.9382
				Relative expanded uncertainty		W	10.46
				Maximum allowed expanded uncertainty		W _{req}	15