Umwelt Bundesamt

TÜVRheinland®
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CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000062070

AMS designation:	Model 405 nm for NO, NO_2 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:

EN 14212 (2012), 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).

TÜVRheinland®
CERTIFIED

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, NO_2 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/m³
Nitrogen dioxide	0–500	µg/m³

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 pass-through protection, it has to be mounted in a blockable bypass.
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, NO_2 and NO_x in ambient air.

The model 405 NO_2/NO/NO_x monitor is designed to measure atmospheric nitrogen dioxide (NO_2), nitrogen oxide (NO) and NO_x (NO + NO_2) in a dynamic range from just a few ppb up to 10 ppm for NO_2 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 NO_2 on the basis of Beer-Lambert law. NO_2 measurement relies on a conventional absorption method. NO_2 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 NO_2. 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 NO_2 concentration from a total NO_x concentration. Instead, the NO_x concentration is computed as the sum of the measurements of NO_2 and NO.

The pump sucks in sample air through the instrument at a constant flow rate of 1.5 l/min. The NO_2 scrubber valve alternately bypasses and sends the sample air through a heated NO_2 scrubber to remove all NO_2 in the sample. The NO_2-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 NO_2 scrubber valve once every 5 seconds allows the measurement of a light intensity in the absence (I_o) of NO_2 and presence (I) of NO_2. The Beer-Lambert Law is then used to calculate the concentration of NO_2 from I and I_o.

Nitrogen oxide is measured by bypassing the NO_2 scrubber and measuring the light intensity while adding (I) or not adding (I_o) ozone to convert NO to NO_2 according to the well-known reaction:

NO_x is computed from the measurement of NO and NO_2.

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 **qal1.de**.

invalid since 2022-04-01

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

Umwelt Bundesamt

Certificate:
0000062070 / 05 November 2019

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Expanded uncertainty, laboratory, NO, system 1

Measuring device:	M405nm			Serial-No.:		1073	
Measured component:	NO			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	0.670	$u_{r,z}$	0.12	0.0140	
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	1.070	$u_{r,lh}$	0.04	0.0015	
3	"lack of fit" at 1h-limit value	≤ 4.0% of measured value	0.660	$u_{l,lh}$	0.40	0.1589	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ [illegible].0 nmol/mol/kPa	0.340	u_{gp}	0.86	0.7319	
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ [illegible].0 nmol/mol/K	0.080	u_{gt}	0.20	0.0405	
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 3.0 nmol/mol/K	0.250	u_{st}	0.63	0.3957	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0.010	u_V	0.04	0.0015	
8a	Interferent H_20 with 19 mmol/mol	≤ 1[illegible] nmol/mol (Zero)	1.870	u_{H2O}	1.47	2.1687	
		≤ 1[illegible] nmol/mol (Span)	2.370				
8b	Interferent CO_2 with 500 µmol/mol	≤ 5.0 nmol/mol (Zero)	1.270	$u_{int,pos}$			
		≤ [illegible] nmol/mol (Span)	[illegible]	or	1.45	2.1166	
8c	Interferent NH_3 mit 200 nmol/mol	≤ 5[illegible] nmol/mol (Zero)	1.370				
		≤ [illegible] nmol/mol (Span)	2.130	$u_{int,neg}$			
9	Averaging effect	≤ 7.0% of measured value	0.500	u_{av}	0.30	0.0912	
18	Difference sample/calibration port	≤ 1.0%	0.000	$u_{\Delta sc}$	0.00	0.0000	
21	Converter efficiency	≥ 98	[illegible]	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		2.6218	nmol/mol
		Expanded uncertainty		U		5.2436	nmol/mol
		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	
Measured component:	NO			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	0.500	$u_{r,z}$	0.09	0.0076	
2	Repeatability standard deviation at 1h-limit value	≤	3.0 nmol/mol	1.030	$u_{r,lh}$	0.04	0.0014	
3	"lack of fit" at 1h-limit value	≤	4.0% of measured value	1.150	$u_{l,lh}$	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_2O with 19 mmol/mol	≤	10 nmol/mol (Zero)	0.330	u_{H2O}	0.63	0.3944	
		≤	10 nmol/mol (Span)	2.800				
8b	Interferent CO_2 with 500 µmol/mol	≤	5.0 nmol/mol (Zero)	1.030	$u_{int,pos}$			
		≤	5.0 nmol/mol (Span)	-0.330	or	1.31	1.7227	
8c	Interferent NH_3 mit 200 nmol/mol	≤	5.0 nmol/mol (Zero)	1.670				
		≤	5.0 nmol/mol (Span)	0.970	$u_{int,neg}$			
9	Averaging effect	≤	7.0% of measured value	3.800	u_{av}	2.29	5.2663	
18	Difference sample/calibration port	≤	1.0%	0.000	$u_{\Delta sc}$	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		3.2779	nmol/mol
			Expanded uncertainty		U		6.5558	nmol/mol
			Relative expanded uncertainty		W		6.27	%
			Maximum allowed expanded uncertainty		W_{req}		15	%

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Certificate:
0000062070 / 05 November 2019

Combined uncertainty, laboratory and field, NO, system 1

invalid since 2022-04-01

Measuring device:	M405nm		Serial-No.:	1073	
Measured component:	NO		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	≤	[illegible]0 nmol/mol	0.670	$u_{r,z}$	0.12	0.0140	
2	Repeatability standard deviation at 1h-limit value	≤	[illegible].0 nmol/mol	1.070	$u_{r,lh}$	not considered, as √2*ur,lh = 0,05 < ur,f	-	
3	"lack of fit" at 1h-limit value	≤	4.0% of [illegible]easured val[illegible]	0.660	$u_{l,lh}$	0.40	0.1589	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤	[illegible] nmol/mol/kPa	[illegible]0.340	u_{gp}	0.86	0.7319	
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤	[illegible] nmol/mol/K	0.080	u_{gt}	0.20	0.0405	
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤	3.0 [illegible]mol/mol/K	[illegible].250	u_{st}	0.63	0.3957	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤	0.3[illegible]nmol/mol/V	[illegible].010	u_V	0.04	0.0015	
8a	Interferent H_20 with 19 mmol/mol	≤	10 nmol/mol (Zero)	1.870	u_{H2O}	1.47	2.1687	
		≤	10 [illegible]ol/mol (Span)	[illegible]				
8b	Interferent CO_2 with 500 µmol/mol	≤	5.0 n[illegible]ol/mol (Zero)	1.270	$u_{int,pos}$	1.45	2.1166	
		≤	5.0 n[illegible]ol/mol (Span)	[illegible]0.0[illegible]0				
8c	Interferent NH_3 mit 200 nmol/mol	≤	5.[illegible] nmol/mol (Zero)	1.370	or			
		≤	5.0 nmol/mol (Span[illegible]	[illegible].130	$u_{int,neg}$			
9	Averaging effect	≤	7.0% of measured val[illegible]	[illegible].500	u_{av}	0.30	0.0912	
10	Reproducibility standard deviation under field conditions	≤	5.0% of average over 3 months	[illegible]	$u_{r,f}$	3.57	12.7225	
11	Long term drift at zero level	≤	5.[illegible] nmol/mol	0.390	$u_{d,l,z}$	0.23	0.0507	
12	Long term drift at span level	≤	5.0% of max[illegible] of certification range	1.290	$u_{d,l,lh}$	0.78	0.6069	
18	Difference sample/calibration port	≤	1.0%	[illegible].000	$u_{\Delta sc}$	0.00	0.0000	
21	Converter efficiency	≥	98	[illegible]9.800	u_{EC}	0.21	0.0438	
23	Uncertainty of test gas	≤	3.0%	[illegible]2.000	u_{cg}	1.05	1.0941	
				Combined standard uncertainty	u_c		4.5001	nmol/mol
				Expanded uncertainty	U		9.0002	nmol/mol
				[illegible]nded uncertainty	W		8.60	%
				Maximum allowed ex[illegible]nded 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	nmol/mol

No.	Performance characteristic		Performance criterion	Result	Partial uncertainty		Square of partial uncertainty	
1	Repeatability standard deviation at zero	≤	1.0 nmol/mol	0.500	$u_{r,z}$	0.09	0.0076	
2	Repeatability standard deviation at 1h-limit value	≤	3.0 nmol/mol	1.030	$u_{r,lh}$	not considered, as √2*ur,lh = 0,05 < ur,f	-	
3	"lack of fit" at 1h-limit value	≤	0% of measured value	1.150	$u_{l,lh}$	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_20 with 19 mmol/mol	≤	10 nmol/mol (Zero)	0.330	u_{H2O}	0.63	0.3944	
		≤	10 nmol/mol (Span)	2.800				
8b	Interferent CO_2 with 500 µmol/mol	≤	5.0 nmol/mol (Zero)	1.030	$u_{int,pos}$ or $u_{int,neg}$	1.31	1.7227	
		≤	5.0 nmol/mol (Span)	-0.330				
8c	Interferent NH_3 mit 200 nmol/mol	≤	5.0 nmol/mol (Zero)	1.670				
		≤	5.0 nmol/mol (Span)	0.970				
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	$u_{d,l,z}$	0.54	0.2945	
12	Long term drift at span level	≤	5.0% of max. of certification range	0.890	$u_{d,l,lh}$	0.54	0.2889	
18	Difference sample/calibration port	≤	1.0%	0.000	$u_{\Delta sc}$	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	4.9039	nmol/mol
				Expanded uncertainty		U	9.8077	nmol/mol
				Relative expanded uncertainty		W	9.38	%
				Maximum allowed expanded uncertainty		W_{req}	15	%

invalid since 2022-04-01

Expanded uncertainty, laboratory, NO_2, 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.[illegible] nmol/mol	[illegible]50	$u_{r,z}$	0.07	0.0048	
2	Repeatability standard deviation at 1h-limit value	≤	3.[illegible] nmol/mol	0.[illegible]80	$u_{r,lh}$	0.17	0.0303	
3	"lack of fit" at 1h-limit value	≤	4.0% of measured value	2.360	$u_{l,lh}$	1.43	2.0313	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤	8.0 [illegible]mol/mol/kPa	[illegible]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.[illegible]97	u_{st}	1.78	3.1846	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤	0.[illegible]0 nmol/mol/V	[illegible]000	u_V	0.00	0.0000	
8a	Interferent H_20 with 19 mmol/mol	≤	10 n[illegible]ol/mol (Ze[illegible])	0.[illegible]70	u_{H2O}	1.69	2.8479	
		≤	[illegible]mol/mol (Spa[illegible])	[illegible]270				
8b	Interferent CO_2 with 500 µmol/mol	≤	5.0 nmol/mol (Zero)	-0.070	$u_{int,pos}$			
		≤	5.0 n[illegible]ol/mol (Span)	-0.570	or	0.48	0.2299	
8c	Interferent NH_3 mit 200 nmol/mol	≤	5.0 [illegible]ol/mol (Ze[illegible])	[illegible]70				
		≤	5.0 nmol/mol (Span)	0.830	$u_{int,neg}$			
9	Averaging effect	≤	7.0% of measured [illegible]alue	3.[illegible]00	u_{av}	2.05	4.2160	
18	Difference sample/calibration port	≤	1.0%	[illegible]	$u_{\Delta sc}$	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		4.2656	nmol/mol
				Expanded uncertainty	U		8.5313	nmol/mol
				Relative expanded uncertainty	W		8.16	%
				Maximum allowed expanded uncertainty	W_{req}		15	%

Expanded uncertainty, laboratory, NO_2, system 2

Measuring device:	M405nm			Serial-No.:		1076	
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	0.570	$u_{r,z}$	0.12	0.0134
2	Repeatability standard deviation at 1h-limit value	≤	3.0 nmol/mol	0.780	$u_{r,lh}$	0.16	0.0248
3	"lack of fit" at 1h-limit value	≤	4.0% of measured value	3.290	$u_{l,lh}$	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_20 with 19 mmol/mol	≤	10 nmol/mol (Zero)	0.230	u_{H2O}	1.58	2.5089
		≤	10 nmol/mol (Span)	2.130			
8b	Interferent CO_2 with 500 µmol/mol	≤	5.0 nmol/mol (Zero)	0.070	$u_{int,pos}$		
		≤	5.0 nmol/mol (Span)	0.370	or	0.68	0.4558
8c	Interferent NH_3 mit 200 nmol/mol	≤	5.0 nmol/mol (Zero)	0.930			
		≤	5.0 nmol/mol (Span)	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	$u_{\Delta sc}$	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	nmol/mol
Expanded uncertainty	U	8.1239	nmol/mol
Relative expanded uncertainty	W	7.77	%
Maximum allowed expanded uncertainty	W_{req}	15	%

Combined uncertainty, laboratory and field, NO_2, 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	≤	[illegible] nmol/mol	[illegible].350	$u_{r,z}$	0.07	0.0048	
2	Repeatability standard deviation at 1h-limit value	≤	3.0 nmol/mol	[illegible].880	$u_{r,lh}$	not considered, as √2*ur,lh = 0,24 < ur,f	-	
3	"lack of fit" at 1h-limit value	≤	4.0% of [illegible]easured valu[illegible]	2.360	$u_{l,lh}$	1.43	2.0313	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤	[illegible] nmol/mol/kPa	[illegible].190	u_{gp}	1.91	3.6572	
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤	3[illegible] nmol/mol/K	[illegible].100	u_{gt}	0.91	0.8206	
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤	3.0 n[illegible]ol/mol/K	[illegible].197	u_{st}	1.78	3.1846	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤	[illegible]0.30 [illegible]mol/mol/V	[illegible].000	u_V	0.00	0.0000	
8a	Interferent H_20 with 19 mmol/mol	≤	10 nmol/mol (Zero)	0.070	u_{H2O}	1.69	2.8479	
		≤	10 n[illegible]/mol (Span)	[illegible]				
8b	Interferent CO_2 with 500 µmol/mol	≤	5.0 nm[illegible]/mol (Zero)	-0.070	$u_{int,pos}$ or $u_{int,neg}$	0.48	0.2299	
		≤	[illegible]/mol (Span)	-0.570				
8c	Interferent NH_3 mit 200 nmol/mol	≤	5.0 nmol/mol (Zero)	0.970				
		≤	5.0 nmol/mol (Span)	[illegible].830				
9	Averaging effect	≤	[illegible].0% of measured valu[illegible]	[illegible].400	u_{av}	2.05	4.2160	
10	Reproducibility standard deviation under field conditions	≤	5[illegible]rage over 3 months	3.410	$u_{r,f}$	3.57	12.7225	
11	Long term drift at zero level	≤	5.0 [illegible]mol/mol	-0.610	$u_{d,l,z}$	-0.35	0.1240	
12	Long term drift at span level	≤	[illegible]0% of max[illegible]f certification range	0.610	$u_{d,l,lh}$	0.37	0.1357	
18	Difference sample/calibration port	≤	1.0%	[illegible].000	$u_{\Delta sc}$	0.00	0.0000	
21	Converter efficiency	≥	98	[illegible].800	u_{EC}	0.21	0.0438	
23	Uncertainty of test gas	≤	[illegible]3.0%	2.000	u_{cg}	1.05	1.0941	
				Co[illegible]da[illegible] uncertainty	u_c		5.5783	nmol/mol
				Expanded uncertainty	U		11.1566	nmol/mol
				Relative ex[illegible]nded uncertainty	W		10.67	%
				Maximum allowed exp[illegible]ded uncertainty	W_{req}		15	%

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Certificate:
0000062070 / 05 November 2019

Combined uncertainty, laboratory and field, NO_2, system 2

Measuring device:	M405nm	Serial-No.:	1076		
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.[illegible]mol/mol	[illegible].570	$u_{r,z}$	0.12	0.0134	
2	Repeatability standard deviation at 1h-limit value	≤	3.0 nmol/mol	[illegible].780	$u_{r,lh}$	not considered, as √2*ur,lh = 0,22 < ur,f	-	
3	"lack of fit" at 1h-limit value	≤	4.0% of m[illegible]asured value	3.290	$u_{l,lh}$	1.99	3.9476	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤	[illegible] nmol/mol/kPa	[illegible]170	u_{gp}	1.71	2.9278	
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤	3.0 [illegible]ol/mol/K	[illegible].100	u_{gt}	0.91	0.8206	
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤	3.0 n[illegible]l/mol/K	[illegible].206	u_{st}	1.87	3.4822	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤	[illegible]ol/mol/V	[illegible]020	u_V	0.28	0.0772	
8a	Interferent H_20 with 19 mmol/mol	≤	10 nmol/mol (Zero)	0.230	u_{H2O}	1.58	2.5089	
		≤	10 n[illegible]mol (Span)	[illegible]				
8b	Interferent CO_2 with 500 µmol/mol	≤	5.0 nm[illegible]mol (Zero)	[illegible]	$u_{int,pos}$ or $u_{int,neg}$	0.68	0.4558	
		≤	[illegible]mol (Span)	0.370				
8c	Interferent NH_3 mit 200 nmol/mol	≤	5.0 nmol/mol (Zero)	[illegible].930				
		≤	5.0 nmol/mol (Span)	[illegible]800				
9	Averaging effect	≤	[illegible]0% of measured value	[illegible]	u_{av}	0.97	0.9336	
10	Reproducibility standard deviation under field conditions	≤	[illegible]ge over 3 months	3.410	$u_{r,f}$	3.57	12.7225	
11	Long term drift at zero level	≤	5.0 [illegible]ol/mol	0.530	$u_{d,l,z}$	0.31	0.0936	
12	Long term drift at span level	≤	[illegible] certification range	1.330	$u_{d,l,lh}$	0.80	0.6451	
18	Difference sample/calibration port	≤	1.0%	[illegible]000	$u_{\Delta sc}$	0.00	0.0000	
21	Converter efficiency	≥	98	[illegible].600	u_{EC}	0.42	0.1751	
23	Uncertainty of test gas	≤	[illegible]0%	2.000	u_{cg}	1.05	1.0941	
				Com[illegible] uncertainty		u_c	5.4691	nmol/mol
				[illegible]ded uncertainty		U	10.9382	nmol/mol
				Relative exp[illegible]ded uncertainty		W	10.46	%
				Maximum allowed exp[illegible]ded uncertainty		W_{req}	15	%

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