

CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000040219

Certified AMS: Model 48i for CO

Manufacturer: Thermo Fisher Scientific
27 Forge Parkway
Franklin, MA 02038
USA

Test Institute: TÜV Rheinland Energie und Umwelt GmbH

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

**VDI 4202-1: 2002, VDI 4203-2: 2004, EN 14626: 2012,
EN 15267-1: 2009, EN 15267-2: 2009**

Certification is awarded in respect of the conditions stated in this certificate
(see also the following pages).




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

www.tuv.com
ID 0000040219

Publication in the German Federal Gazette
(BAnz.) of 08 April 2006

German Federal Environment Agency
Dessau, 29 April 2014



i. A. Dr. Marcel Langner

This certificate will expire on:
31 March 2019

TÜV Rheinland Energie und Umwelt GmbH
Cologne, 28 April 2014



ppa. Dr. Peter Wilbring

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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.

Certificate:
0000040219 / 29 April 2014

Test report: 936/21203248/A1 of 05 January 2006,
Addendum 936/21221382/D of 04 October 2013

Initial certification: 01 April 2014

Date of expiry: 31 March 2019

Publication: BAnz AT 01 April 2014 B12, chapter VI, notification 24

Approved application

The certified AMS is suitable for continuous monitoring of CO in ambient air.

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

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

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

Basis of the certification

This certification is based on:

- test report 936/21203248/A1 of 05 January 2006 of TÜV Rheinland Immissionsschutz und Energiesysteme GmbH and Addendum 936/21221382/D of 04 October 2013 of TÜV Rheinland Energie und Umwelt GmbH
- suitability announced by the German Federal Environment Agency (UBA) as the relevant body
- the on-going surveillance of the product and the manufacturing process
- publication in the German Federal Gazette (BAnz. 08 April 2006, No. 70, p. 2653, chapter IV, No. 2.2, UBA publication from 21 February 2006)
- publication in the German Federal Gazette (BAnz. 20 April 2007, No. 75, p. 4139, chapter IV, notification 1 and 6, UBA publication from 12 April 2007)
- publication in the German Federal Gazette (BAnz. 03 September 2008, No. 133, p. 3243, chapter IV, notification 14, UBA publication from 12 August 2008)
- publication in the German Federal Gazette (BAnz. 25 August 2009, No. 125, p. 2929, chapter III, notification 18, UBA publication from 03 August 2009)
- publication in the German Federal Gazette (BAnz. 28 July 2010, No. 111, p. 2597, chapter III, notification 6, UBA publication from 12 July 2010)
- publication in the German Federal Gazette (BAnz. 29 July 2011, No. 113, p. 2725, chapter III, notification 20, UBA publication from 15 July 2011)
- publication in the German Federal Gazette (BAnz AT 20 July 2012 B11, chapter IV, notification 25, UBA publication from 06 July 2012)
- publication in the German Federal Gazette (BAnz AT 05 March 2013 B10, chapter V, notification 14, UBA publication from 12 February 2013)
- publication in the German Federal Gazette (BAnz AT 01 April 2014 B12, chapter VI, notification 24, UBA publication from 27 February 2014)

AMS designation:

CO-analyzer Model 48i

Manufacturer:

Thermo Electron Corp. Franklin, MA 02038 USA and D-91056 Erlangen

Field of application:

For continuous monitoring of CO in ambient air.

Measuring ranges during the performance test:

CO 0 - 60 mg/m³
0 - 100 mg/m³

Software:

Version: V 01.02.14.097

Testing institute:

TÜV Immissionsschutz und Energiesysteme GmbH, Cologne
TÜV Rheinland Group

Test report:

Report No.: 936/21203248/A of 5 January 2006

1 Notification of German Federal Environment Agency

The new name of Thermo Electron Corp., Franklin, USA is Thermo Fisher Scientific, Franklin, USA.

Statement by TÜV Rheinland Immissionsschutz und Energiesysteme, 51101 Cologne, Germany, Dr. Peter Wilbring, dated 20th December 2006

6 Notification of announcements by the German Federal Environment Agency dated 21st February 2006 (BAnz. p. 2653) and 12th September 2006 (BAnz. p. 6715)

The measuring systems model 42i for nitrogen oxide, model 43i for sulphur dioxide, model 48i for carbon monoxide and model 49i for ozone, manufactured by Thermo Fisher Scientific, MA 02038, USA, are also manufactured and sold identically and to the same standards by MLU-Monitoring für Leben und Umwelt Ges.m.b.H., Mödling, Austria.

Statement by TÜV Rheinland Immissionsschutz und Energiesysteme, 51101 Cologne, Germany, Dr. Peter Wilbring, dated 14th December 2006

14 Notification of announcement by the German Federal Environment Agency dated 21st February 2006 (BAnz. p. 2655)

The current software version of the ambient air measuring system 48i by Thermo Fisher Scientific is:

V 01.05.03 (106423-00)

Statement by TÜV Rheinland Immissionsschutz und Energiesysteme GmbH dated 10th March 2008

18 Notification of announcement of the German Federal Environment Agency dated 21st February 2006 (BAnz. p. 2655)

The current software version of the ambient air measuring system 48i by Thermo Fisher Scientific is:

V 01.06.01 (108458-00)

Statement by TÜV Rheinland Immissionsschutz und Energiesysteme GmbH dated 1st April 2009

6 Notification of announcements by the German Federal Environment Agency dated 21st February 2006 (BAnz. p. 2655) and 3rd August 2009 (BAnz. p. 2936)

The ambient air measuring system 48i by Thermo Fisher Scientific can now also be operated with a sample gas pump of type PU1959-N86-3.07 manufactured by KNF.

Statement by TÜV Rheinland Immissionsschutz und Energiesysteme GmbH dated 23rd March 2010

20 Notification of announcements by the German Federal Environment Agency dated 21st February 2006 (BAnz. p. 2653, Chapter IV Number 2.2) and 12th July 2010 (BAnz. p. 2597, Chapter III 6th notification)

The current software version of the ambient air measuring system 48i for CO by Thermo Fisher Scientific is:

V 01.06.09 (110018-00)

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 30th March 2011

25 Notification of announcements by the German Federal Environment Agency dated 21st February 2006 (BAnz. p. 2653, Chapter IV Number 2.2) and 15th July 2011 (BAnz. p. 2725, Chapter III 20th notification)

The ambient air measuring system model 48i for CO by Thermo Fisher Scientific will be equipped with the PU2737-N86 vacuum pump manufactured by KNF.

Statement by TÜV Rheinland Energie und Umwelt GmbH dated 20th March 2012

14 Notification of announcements by the German Federal Environment Agency dated 21st February 2006 (BAnz. p. 2653, Chapter IV Number 2.2) and 6th July 2012 (BAnz AT 20.07.2012, Chapter IV 25th notification)

The current software version for the ambient air measuring system 48i for CO by Thermo Fisher Scientific is:

V 01.06.10 (112308-00)

Statement by TÜV Rheinland Energie und Umwelt GmbH dated 6th October 2012

24 Notification of announcements by the German Federal Environment Agency dated 21st February 2006 (BAnz. p. 2653, Chapter IV Number 2.2) and 12th February 2013 (BAnz AT 05.03.2013 B10, Chapter V, 14th notification).

The measuring system model 48i for CO by Thermo Fisher Scientific fulfils the requirements of Standard EN 14626 (December 2012). Furthermore, the manufacturing process and quality management system of the measuring system model 48i for CO fulfil the requirements of EN 15267.

The test report of the performance test with report number 936/21203248/A1 as well as an addendum as an integral part of the test report with report number 936/21221382/D can be viewed on the internet at www.qal1.de.

The Arcturus Bd. 101491-xx processor board was withdrawn and replaced by the new Arcturus Bd. 110570-xx processor board.

The current software version of the measuring system is:

V 02.00.01 (113420-00)

Statement by TÜV Rheinland Energie und Umwelt GmbH dated 1st October 2013

Certified product

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

The model 48i CO analyser measures CO concentration based on the gas filter correlation method. The model 48i analyser functions according to the principle that carbon monoxide (CO) absorbs infra-red radiation on a wavelength of 4.6 micrometres. The measuring system belongs to the photometric measuring system group. The measuring principle is based on the determination of light absorption by the gas to be measured in the gas's characteristic wavelength ranges. Analysis is performed by measuring absorption on the basis of the dependence between the gas concentration and the amount of absorbed light according to the Beer-Lambert law:

$$I = I_0 * e^{-\alpha Lc}$$

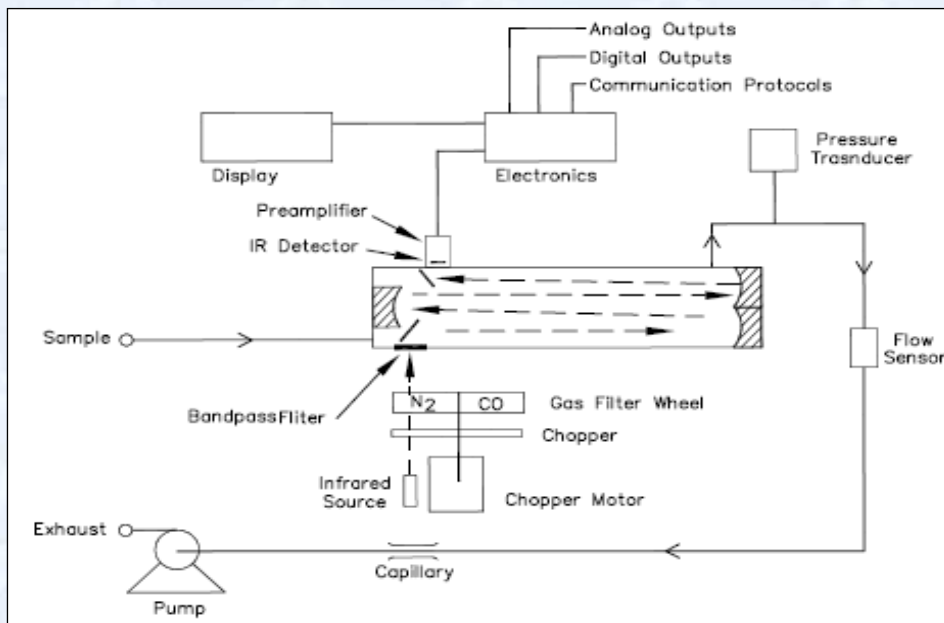
I_0 as light intensity without absorption

I as intensity with absorption

L as absorption path or distance that the light travels during absorption

c as concentration of the absorbing gas, in this case CO

α as absorption coefficient (provides information about degree of absorption)



The measuring principle complies with the standard reference method as stipulated in EN 14626.

The sample is drawn into the model 48i through the sample bulkhead. The sample flows through the optical bench. Radiation from an infrared source is chopped and then passed through a gas filter alternating between CO and N₂. The radiation then passes through a narrow band pass interference filter and enters the optical bench where absorption by the sample gas occurs. The infrared radiation then exits the optical bench and falls on an infrared detector.

The CO gas filter acts to produce a reference beam which cannot be further attenuated by CO in the sample cell. The N₂ side of the filter wheel is transparent to the infrared radiation and therefore produces a measure beam which can be absorbed in the cell. The chopped detector signal is modulated by the alternation between two gas filters with a amplitude related to the concentration of CO in the sample cell. Other gases do not cause modulation of the detector signal since they absorb the reference and measure beams equally. Thus, the GFC system responds specially to CO.

The Model 48i outputs the CO concentration to the front panel display, the analogue outputs, and also makes the data available over the serial or Ethernet connections.

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 is presented on page 1 of this certificate.

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 the validity is also accessible on the internet: qal1.de.

Certification of Model 48i for CO is based on the documents listed below and the regular, continuous monitoring of the Quality Management System of the manufacturer:

Initial test:

Test report: 936/21203248/A1 of 05 January 2006
TÜV Immissionsschutz und Energiesysteme GmbH, Cologne

Publication: BAnz. 08 April 2006, No. 70, p. 2653, chapter IV, No. 2.2
Announcement by UBA from 21 February 2006

Initial certification according to EN 15267:

Certificate No. 0000040219: 29 April 2014

Expiration date of the certificate: 31 March 2019

Test report: 936/21203248/A1 of 05 January 2006
TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, Cologne

Addendum 936/21221382/D of 04 October 2013
TÜV Rheinland Energie und Umwelt GmbH, Cologne

Publication: BAnz AT 01 April 2014 B12, chapter VI, notification 24
Announcement by UBA from 27 February 2014

Notification:

Publication: BAnz. 20 April 2007, No. 75, p. 4139, chapter IV, notification 1 and 6
Announcement by UBA from 12 April 2007

Publication: BAnz. 03 September 2008, No. 133, p. 3243, chapter IV, notification 14
Announcement by UBA from 12 August 2008

Publication: BAnz. 25 August 2009, No. 125, p. 2929, chapter III, notification 18
Announcement by UBA from 03 August 2009

Publication: BAnz. 28 July 2010, No. 111, p. 2597, chapter III, notification 6
Announcement by UBA from 12 July 2010

Publication: BAnz. 29 July 2011, No. 113, p. 2725, chapter III, notification 20
Announcement by UBA from 15 July 2011

Publication: BAnz AT 20 July 2012 B11, chapter IV, notification 25
Announcement by UBA from 06 July 2012

Publication: BAnz AT 05 March 2013 B10, chapter V, notification 14
Announcement by UBA from 12 February 2013

Publication: BAnz AT 01 April 2014 B12, chapter VI, notification 24
Announcement by UBA from 27 February 2014

Calculation of overall uncertainty lab test (Device 1)

Measuring device:		Thermo Fisher Scientific Modell 481		Serial-No.:		Device 1	
Measured component:		CO		8h-limit value:		8.62	
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty	µmol/mol	
1	Repeatability standard deviation at zero	≤ 0.3 µmol/mol	0.000	$u_{r,z}$	0.00	0.0000	
2	Repeatability standard deviation at 8h-limit value	≤ 0.4 µmol/mol	0.020	u_r	0.00	0.0000	
3	"lack of fit" at 8h-limit value	≤ 4.0% of measured value	0.800	u_f	0.04	0.0016	
4	Sensitivity coefficient of sample gas pressure at 8h-limit value	≤ 0.7 µmol/mol/kPa	0.090	u_{gp}	0.22	0.0502	
5	Sensitivity coefficient of sample gas temperature at 8h-limit value	≤ 0.3 µmol/mol/K	0.010	u_{gt}	0.02	0.0005	
6	Sensitivity coefficient of surrounding temperature at 8h-limit value	≤ 0.3 µmol/mol/K	0.030	u_{st}	0.07	0.0047	
7	Sensitivity coefficient of electrical voltage at 8h-limit value	≤ 0.3 µmol/mol/V	0.000	u_v	0.00	0.0000	
8a	Interferent H ₂ O with 21 mmol/mol	≤ 1.0 µmol/mol (Zero) ≤ 1.0 µmol/mol (Span)	0.040 0.000	u_{H_2O}	0.03	0.0009	
8b	Interferent CO ₂ with 500 µmol/mol	≤ 0.5 µmol/mol (Zero) ≤ 0.5 µmol/mol (Span)	-0.060 -0.010	$u_{CO_2, pos}$			
8c	Interferent NO with 1 µmol/mol	≤ 0.5 µmol/mol (Zero) ≤ 0.5 µmol/mol (Span)	0.000 -0.010	or	0.04	0.0014	
8d	Interferent N ₂ O with 50 mmol/mol	≤ 0.5 µmol/mol (Zero) ≤ 0.5 µmol/mol (Span)	0.170 0.060	$u_{N_2O, neg}$			
9	Averaging effect	≤ 7.0% of measured value	-5.970	u_{av}	-0.30	0.0883	
18	Difference sample/calibration port	≤ 1.0%	0.000	u_{sc}	0.00	0.0000	
21	Uncertainty of test gas	≤ 3.0%	2.000	u_{sg}	0.09	0.0074	
				Combined standard uncertainty	u_c	0.3937	
				Expanded uncertainty	U	0.7875	
				Relative expanded uncertainty	W	9.14	
				Maximum allowed expanded uncertainty	W_{req}	15	

Calculation of overall uncertainty lab test (Device 2)

Measuring device:		Thermo Fisher Scientific Modell 481		Serial-No.:		Device 2	
Measured component:		CO		8h-limit value:		8.62	
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty	μmol/mol	
1	Repeatability standard deviation at zero	≤ 0.3 μmol/mol	0.000	u _{r,z}	0.00	0.0000	
2	Repeatability standard deviation at 8h-limit value	≤ 0.4 μmol/mol	0.020	u _r	0.00	0.0000	
3	"lack of fit" at 8h-limit value	≤ 4.0% of measured value	-0.300	u _l	-0.01	0.0002	
4	Sensitivity coefficient of sample gas pressure at 8h-limit value	≤ 0.7 μmol/mol/kPa	0.090	u _{gp}	0.22	0.0502	
5	Sensitivity coefficient of sample gas temperature at 8h-limit value	≤ 0.3 μmol/mol/K	0.040	u _{gt}	0.09	0.0084	
6	Sensitivity coefficient of surrounding temperature at 8h-limit value	≤ 0.3 μmol/mol/K	0.030	u _{st}	0.07	0.0047	
7	Sensitivity coefficient of electrical voltage at 8h-limit value	≤ 0.3 μmol/mol/V	0.000	u _v	0.00	0.0000	
8a	Interferent H ₂ O with 21 mmol/mol	≤ 1.0 μmol/mol (Zero)	-0.020	u _{H2O}	-0.01	0.0002	
		≤ 1.0 μmol/mol (Span)	0.000				
8b	Interferent CO ₂ with 500 μmol/mol	≤ 0.5 μmol/mol (Zero)	0.000	u _{int,pos}			
		≤ 0.5 μmol/mol (Span)	-0.020				
8c	Interferent NO with 1 μmol/mol	≤ 0.5 μmol/mol (Zero)	0.000		0.07	0.0052	
		≤ 0.5 μmol/mol (Span)	-0.030	or			
8d	Interferent N ₂ O with 50 mmol/mol	≤ 0.5 μmol/mol (Zero)	0.000				
		≤ 0.5 μmol/mol (Span)	0.130	u _{int,neg}			
9	Averaging effect	≤ 7.0% of measured value	-4.560	u _{av}	-0.23	0.0515	
18	Difference sample/calibration port	≤ 1.0%	0.000	u _{Δsc}	0.00	0.0000	
21	Uncertainty of test gas	≤ 3.0%	2.000	u _{tg}	0.09	0.0074	
				Combined standard uncertainty		u _c	0.3577
				Expanded uncertainty		U	0.7153
				Relative expanded uncertainty		W	8.30
				Maximum allowed expanded uncertainty		W _{reg}	15

Calculation of overall uncertainty lab and field test (Device 1)

Measuring device:		Thermo Fisher Scientific Modell 48i		Serial-No.:		Device 1	
Measured component:		CO		8h-limit value:		8.62	
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty	µmol/mol	
1	Repeatability standard deviation at zero	≤ 0.3 µmol/mol	0.000	u _{r,z}	0.00	0.0000	
2	Repeatability standard deviation at 8h-limit value	≤ 0.4 µmol/mol	0.020	u _r	not considered, as u _r = 0 < u _{r,f}	-	
3	"lack of fit" at 8h-limit value	≤ 4.0% of measured value	0.800	u _f	0.04	0.0016	
4	Sensitivity coefficient of sample gas pressure at 8h-limit value	≤ 0.7 µmol/mol/kPa	0.090	u _{sp}	0.22	0.0502	
5	Sensitivity coefficient of sample gas temperature at 8h-limit value	≤ 0.3 µmol/mol/K	0.010	u _{gt}	0.02	0.0005	
6	Sensitivity coefficient of surrounding temperature at 8h-limit value	≤ 0.3 µmol/mol/K	0.030	u _{st}	0.07	0.0047	
7	Sensitivity coefficient of electrical voltage at 8h-limit value	≤ 0.3 µmol/mol/V	0.000	u _v	0.00	0.0000	
8a	Interferent H ₂ O with 21 mmol/mol	≤ 1.0 µmol/mol (Zero) ≤ 1.0 µmol/mol (Span)	0.000 0.040	u _{H2O}	0.03	0.0009	
8b	Interferent CO ₂ with 500 µmol/mol	≤ 0.5 µmol/mol (Zero) ≤ 0.5 µmol/mol (Span)	-0.060 -0.010	u _{CO2,pos}			
8c	Interferent NO with 1 µmol/mol	≤ 0.5 µmol/mol (Zero) ≤ 0.5 µmol/mol (Span)	0.000 -0.010	or	0.04	0.0014	
8d	Interferent N ₂ O with 50 nmol/mol	≤ 0.5 µmol/mol (Zero) ≤ 0.5 µmol/mol (Span)	0.170 0.060	u _{N2O,neg}			
9	Averaging effect	≤ 7.0% of measured value	-5.970	u _{av}	-0.30	0.0883	
10	Reproducibility standard deviation under field conditions	≤ 5.0% of average over 3 months	3.530	u _{r,f}	0.30	0.0926	
11	Long term drift at zero level	≤ 0.5 µmol/mol	0.500	u _{d,z}	0.29	0.0833	
12	Long term drift at span level	≤ 5.0% of max. of certification range	-2.590	u _{d,span}	-0.13	0.0166	
18	Difference sample/calibration port	≤ 1.0%	0.000	u _{Asc}	0.00	0.0000	
21	Uncertainty of test gas	≤ 3.0%	2.000	u _{cg}	0.09	0.0074	
Combined standard uncertainty						u _c	0.5895
Expanded uncertainty						U	1.1791
Relative expanded uncertainty						W	13.68
Maximum allowed expanded uncertainty						W _{req}	15

Calculation of overall uncertainty lab and field test (Device 2)

Measuring device:		Serial-No.:		Device 2		µmol/mol	
Thermo Fisher Scientific Modell 48i		CO		8h-limit value:		8.62	
Measured component:		Performance characteristic		Performance criterion		Result	
No.	Performance characteristic	Performance criterion	Result	Partial uncertainty	Square of partial uncertainty		
1	Repeatability standard deviation at zero	≤ 0.3 µmol/mol	0.000	u _{r,z}	0.00	0.0000	
2	Repeatability standard deviation at 8h-limit value	≤ 0.4 µmol/mol	0.020	u _r	not considered, as u _r = 0 < u _{r,f}	-	
3	"lack of fit" at 8h-limit value	≤ 4.0% of measured value	-0.300	u _l	-0.01	0.0002	
4	Sensitivity coefficient of sample gas pressure at 8h-limit value	≤ 0.7 µmol/mol/kPa	0.090	u _{gp}	0.22	0.0502	
5	Sensitivity coefficient of sample gas temperature at 8h-limit value	≤ 0.3 µmol/mol/K	0.040	u _{gt}	0.09	0.0084	
6	Sensitivity coefficient of surrounding temperature at 8h-limit value	≤ 0.3 µmol/mol/K	0.030	u _{st}	0.07	0.0047	
7	Sensitivity coefficient of electrical voltage at 8h-limit value	≤ 0.3 µmol/mol/V	0.000	u _v	0.00	0.0000	
8a	Interferent H ₂ O with 21 mmol/mol	≤ 1.0 µmol/mol (Zero)	0.000	u _{H2O}	-0.01	0.0002	
		≤ 1.0 µmol/mol (Span)	-0.020				
8b	Interferent CO ₂ with 500 µmol/mol	≤ 0.5 µmol/mol (Zero)	0.000	u _{int,pos}			
		≤ 0.5 µmol/mol (Span)	-0.020				
8c	Interferent NO with 1 µmol/mol	≤ 0.5 µmol/mol (Zero)	0.000	or	0.07	0.0052	
		≤ 0.5 µmol/mol (Span)	-0.030				
8d	Interferent N ₂ O with 50 nmol/mol	≤ 0.5 µmol/mol (Zero)	0.000	u _{int,neg}			
		≤ 0.5 µmol/mol (Span)	0.130				
9	Averaging effect	≤ 7.0% of measured value	-4.560	u _{av}	-0.23	0.0515	
10	Reproducibility standard deviation under field conditions	≤ 5.0% of average over 3 months	3.530	u _{r,f}	0.30	0.0926	
11	Long term drift at zero level	≤ 0.5 µmol/mol	0.500	u _{d,l,z}	0.29	0.0833	
12	Long term drift at span level	≤ 5.0% of max. of certification range	1.840	u _{d,l,8h}	0.09	0.0084	
18	Difference sample/calibration port	≤ 1.0%	0.000	u _{asc}	0.00	0.0000	
21	Uncertainty of test gas	≤ 3.0%	2.000	u _{cg}	0.09	0.0074	
				Combined standard uncertainty		u _c	µmol/mol
				Expanded uncertainty		U	µmol/mol
				Relative expanded uncertainty		W	%
				Maximum allowed expanded uncertainty		W _{req}	%