Umwelt Bundes Amt
For our Environment

TÜVRheinland®
Precisely Right.

CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000039320

Certified AMS:	Model 49i for O_3
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 14625: 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).

TÜVRheinland® CERTIFIED

Suitability Tested
EN 15267
QAL1 Certified
Regular
Surveillance

www.tuv.com
ID 0000039320

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

This certificate will expire on:
22 July 2018

German Federal Environment Agency
Dessau, 20 August 2013

i. A. Dr. Marcel Langner

TÜV Rheinland Energie und Umwelt GmbH
Cologne, 19 August 2013

ppa. Dr. Peter Wilbring

www.umwelt-tuv.de / www.eco-tuv.com
teu@umwelt-tuv.de
Tel. +49 221 806-5200

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.

10/221 2.08

Umwelt Bundes Amt
For our Environment

Certificate:
0000039320 / 20 August 2013

TÜVRheinland®
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Test report:	936/21203248/B1, Statement of 17 November 2011, Addendum 936/21221382/A
Initial certification:	23 July 2013
Date of expiry:	22 July 2018
Publication:	BAnz AT 23 July 2013 B4, chapter V, notification 22

Approved application
The certified AMS is suitable for continuous ambient air monitoring for O_3 (stationary operation).

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 +5 °C to +40 °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/B1 of 05 January 2006 of TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, Statement of 17 November 2011 and Addendum 936/21221382/A of 21 March 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. 3.2)
- publication in the German Federal Gazette (BAnz. 20 April 2007, No. 75, p. 4139, chapter IV, notification 1)
- publication in the German Federal Gazette (BAnz. 03 September 2008, No. 133, p. 3242, chapter IV, notification 15)
- publication in the German Federal Gazette (BAnz. 25 August 2009, No. 125, p. 2929, chapter III, notification 19)
- publication in the German Federal Gazette (BAnz. 28 July 2010, No. 111, p. 2597, chapter III, notification 7)
- publication in the German Federal Gazette (BAnz. 29 July 2011, No. 113, p. 2725, chapter III, notification 21)
- publication in the German Federal Gazette (BAnz. 02 March 2012, No. 36, p. 920, chapter V, notification 1)
- publication in the German Federal Gazette (BAnz AT 20 July 2012 B11, chapter IV, notification 26)
- publication in the German Federal Gazette (BAnz AT 23 July 2013 B4, chapter V, notification 22)

AMS designation:
Ozon analyzer Model 49 i

Manufacturer:
Thermo Electron Corporation Franklin, MA 02038 USA and 91056 Erlangen

Field of application:
For continuous ambient air monitoring for O_3 (stationary operation)

Measuring ranges during the performance test:
O_3 0 - 360 µg/m³
0 - 500 µg/m³

Software version:
Version: V 01.01.02.105

Testing institute:
TÜV Immissionsschutz und Energiesysteme GmbH, Köln, TÜV Rheinland Group

Test report:
No.: 936/21293248/B1 of 05 January 2006

1 Notification on announcements of the Federal Environment Agency of 12 April 2007 (BAnz. p. 4139, No. 75, chapter IV, notification 1)

The current name of the company Thermo Electron Corp., Franklin, USA, is Thermo Fisher Scientific, Franklin, USA.

Statement of TÜV Rheinland Immissionsschutz und Energiesysteme, 51101 Cologne, Dr. Peter Wilbring, of 20 December 2006

15 Notification on announcements of the Federal Environment Agency of 21 February 2006 (BAnz. p. 2655)

The current software version of the ambient air monitoring system 49i of the company Thermo Fisher Scientific is:

V 01.05.00 (105115-00)

Statement of TÜV Rheinland Immissionsschutz und Energiesysteme of 10 March 2008

19 Notification with regard to the UBA announcement of February 21st, 2006 (BAnz. p. 2655)

The current software version of the ambient air monitoring system 49i of the company Thermo Fisher Scientific is:

V 01.06.01 (108459-00)

Statement of TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, April 1st, 2009

7 Notification with regard to the Federal Environment Agency (UBA) announcement of 21 February 2006 (BAnz. p. 2655) and of 3 August 2009 (BAnz. p. 2936)

The ambient air measuring system 49i of the company Thermo Fisher Scientific may now also be used with the sample gas pump type PU1959-N86-3.07 of the company KNF.

Statement of TÜV Rheinland Immissionsschutz und Energiesysteme GmbH of 23 March 2010

21 Notification on announcements of the Federal Environment Agency of 12 February 2006 (BAnz. p. 2653, chapter IV number 3.2) and of 12 July 2010 (BAnz. p. 2597, chapter III, 7th notification)

The current software version of the ambient air monitoring system Model 49i for O_3 of the company Thermo Fisher Scientific is:

V 01.06.04 (109898-00)

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

1 Notification on announcements of the Federal Environment Agency of 21 February 2006 (BAnz. p. 2653, chapter IV number 3.2) and of 15 July 2011 (BAnz. p. 2725, chapter III 21th notification)

The current software version of the ambient air monitoring system Model 49i for O_3 of the company Thermo Fisher Scientific is:

V 01.06.08 (111276-00)

Instead of the so far used measuring cell consisting of a polyurethane-coated aluminimum tube, it is also possible now to use a measuring cell consisting of an aluminium tube and an integrated FEP tube.

Statement made by TÜV Rheinland Energie und Umwelt GmbH of 17 November 2011

26 Notification on announcements of the Federal Environment Agency of 21 February 2006 (BAnz. p. 2653, chapter IV number 3.2) and announcements of the Federal Environment Agency of 23 February 2012 (BAnz. p. 920, chapter V 1th notification)

The ambient air monitoring system Model 49i of the company Thermo Fisher Scientific for ozone will be equipped in future with a vacuum pump of the company KNF of the type PU2737-N86.

Statement made by TÜV Rheinland Energie und Umwelt GmbH of 20 March 2012

22 Notification on announcements of the Federal Environmental Agency of 21 February 2006 (BAnz. p. 2929, chapter IV no. 3.2) and of 6 July 2012 (BAnz. AT of 20 July 2012 B11, chapter IV, 26th notification)

The Model 49i measuring system for O_3, manufactured by Thermo Fisher Scientific, fulfils the requirements of EN 14625 (December 2012). In addition, the production and quality management system of the measuring system meet the requirements of EN 15267.

The performance test report no. 936/21203248/B1, a statement of TÜV Rheinland Energie und Umwelt GmbH dated 17 November 2011 as well as the addendum as integral part of report no. 936/21221382/A are available online at www.qal1.de.

Statement made by TÜV Rheinland Energie und Umwelt GmbH of 21 March 2013

Certified product

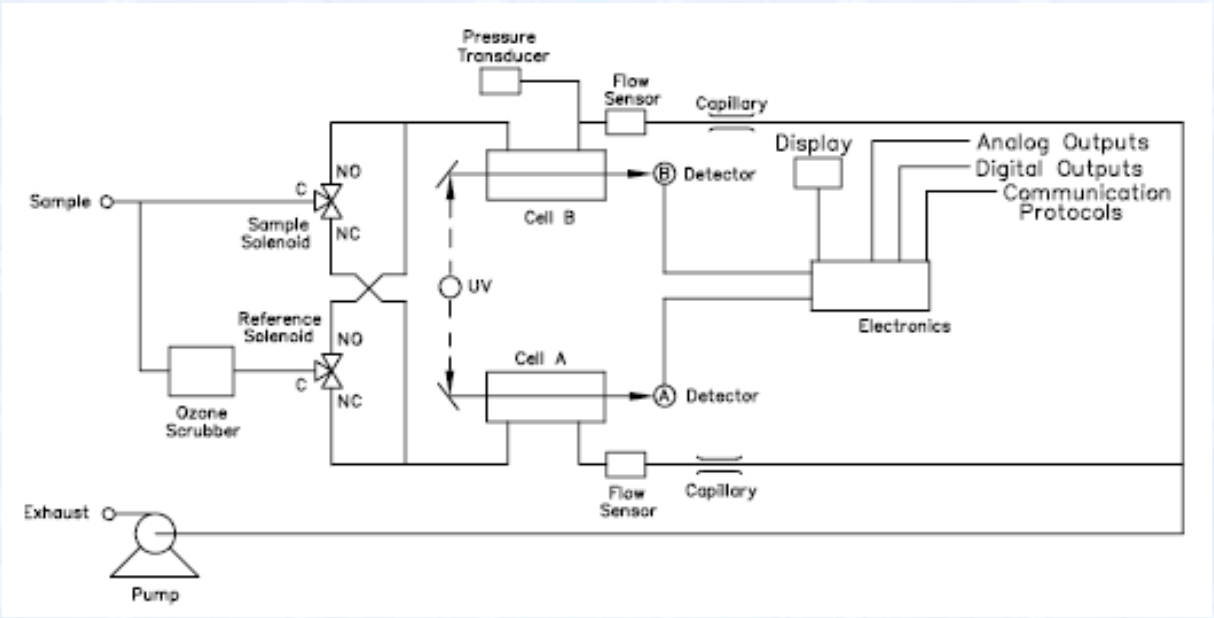
This certificate applies to automated measurement systems conforming to the following description:

The Model 49i measuring system operates under the principle of light absorption to determine the measured gas by its characteristic wavelength. For the component ozone, the absorption wavelength lies in the UV range of 254 nm, corresponding to the reference method described in Standard EN 14625.

The ambient air sample is sucked through the bulkhead connection with designation SAMPLE into the Model 49i measuring system and divided into two streams. One gas stream passes through an ozone scrubber and is used as reference gas (I_0). The reference gas then streams toward the magnetic valve. The sample gas (I) directly flows to the sampling magnetic valve. The magnetic valves alternate between reference and sample gas streams between cells A and B every 10 seconds. When cell A is filled with reference gas, cell B is filled with sample gas, and vice versa.

The UV light intensities of both cells are measured by detectors A and B. When the magnetic valves direct the reference and sample gas to the respective opposite cell, the light intensities are disregarded for a few seconds in order to flush the cells clean. The Model 49i measuring system calculates the ozone concentration in each cell. The average concentration is shown on the front display and produced via analogue outputs. The measurement data are provided via serial or Ethernet interface.

The following figure illustrates the spatial configuration of the analyser assemblies.



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 49i for O_3 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/B1 of 05 January 2006
TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, Cologne

Publication: BAnz. 08 April 2006, No. 70, p. 2653, chapter IV, No. 3.2
Announcement by UBA from 21 February 2006

Initial certification according to EN 15267:

Certificate No. 0000039320: 20 August 2013

Expiration date of the certificate: 22 July 2013

Test report: 936/21203248/B1 of 05 January 2006
TÜV Rheinland Energie und Umwelt GmbH, Cologne

Publication: BAnz AT 23 July 2013 B4, chapter V, notification 22
Announcement by UBA from 03 July 2013
(fulfils the requirements of EN 14625 (December 2012),fulfils the requirements of EN 15267for the production and quality management system of the measuring system)

Notification:

Publication: BAnz. 20 April 2007, No. 75, p. 4139, chapter IV, notification 1
Announcement by UBA from 12 April 2007 *(name change)*

Publication: BAnz. 03 September 2008, No. 133, p. 3242, chapter IV, notification 15
Announcement by UBA from 12 August 2008 *(software change)*

Publication: BAnz. 25 August 2009, No. 125, p. 2929, chapter III, notification 19
Announcement by UBA from 03 August 2009 *(software change)*

Publication: BAnz. 28 July 2010, No. 111, p. 2597, chapter III, notification 7
Announcement by UBA from 12 July 2010 *(pump)*

Publication: BAnz. 29 July 2011, No. 113, p. 2725, chapter III, notification 21
Announcement by UBA from 15 July 2011 *(software change)*

Publication: BAnz. 02 March 2012, No. 36, p. 920, chapter V, notification 1
Announcement by UBA from 23 February 2012 *(software + measuring cell)*

Publication: BAnz AT 20 July 2012 B11, chapter IV, notification 26)
Announcement by UBA from 06 July 2012 *(pump)*

Calculation of overall uncertainty (Device 1)

Measuring device:	Thermo Fisher Scientific Model 49i					Serial number:	Gerät 1	
Measured component:	O3					1h-Alert threshold:	120	nmol/mol

No.	Performance characteristic	Performance criterion	Result	Partial uncertainty		Square of partial uncertainty	
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0,100	$u_{r,z}$	0,03	0,0007	
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	0,100	$u_{r,lh}$	0,03	0,0007	
3	"lack of fit" at 1h-limit value	≤ 4.0% of meas. value	1,500	$u_{l,lh}$	1,04	1,0800	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 2.0 nmol/mol/kPa	0,100	u_{gp}	1,04	1,0800	
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0,054	u_{gt}	0,56	0,3149	
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 1.0 nmol/mol/K	-0,230	u_{st}	-1,59	2,5392	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0,020	u_V	0,30	0,0885	
8a	Interferent H_20 with 21 mmol/mol	≤ 10 nmol/mol (Zero)	-0,980	u_{H2O}	-1,07	1,1427	
		≤ 10 nmol/mol (Span)	-1,640				
8b	Interferent Toluene with 0,5 µmol/mol	≤ 5.0 nmol/mol (Zero)	0,100	$u_{int,pos}$	0,79	0,6280	
		≤ 5.0 nmol/mol (Span)	0,970				
8c	Interferent Xylene with 0,5 µmol/mol	≤ 5.0 nmol/mol (Zero)	0,100	or			
		≤ 5.0 nmol/mol (Span)	0,940	$u_{int,\ neg}$			
9	Averaging effect	≤ 7.0% of meas. value	3,150	u_{av}	2,18	4,7628	
18	Difference sample/calibration port	≤ 1%	0,000	$u_{\Delta sc}$	0,00	0,0000	
21	Uncertainty of test gas	≤ 3%	2,000	u_{cg}	1,20	1,4400	

Combined standard uncertainty	u_c	3,6163	nmol/mol
Expanded uncertainty	U	7,2326	nmol/mol
Relative expanded uncertainty	W	6,03	%
Maximum allowed expanded uncertainty	W_{req}	15	%

Measuring device:	Thermo Fisher Scientific Model 49i					Serial number:	Gerät 1	
Measured component:	O3					1h-Alert threshold:	120	nmol/mol

No.	Performance characteristic	Performance criterion	Result	Partial uncertainty		Square of partial uncertainty	
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0,100	$u_{r,z}$	0,03	0,0007	
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	0,100	$u_{r,lh}$	not considered, as ur,lh = 0,02 < ur,f	-	
3	"lack of fit" at 1h-limit value	≤ 4.0% of meas. value	1,500	$u_{l,lh}$	1,04	1,0800	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 2.0 nmol/mol/kPa	0,100	u_{gp}	1,04	1,0800	
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0,054	u_{gt}	0,56	0,3149	
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 1.0 nmol/mol/K	-0,230	u_{st}	-1,59	2,5392	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0,020	u_V	0,30	0,0885	
8a	Interferent H_20 with 21 mmol/mol	≤ 10 nmol/mol (Zero)	-0,980	u_{H2O}	-1,07	1,1427	
		≤ 10 nmol/mol (Span)	-1,640				
8b	Interferent Toluene with 0.5 µmol/mol	≤ 5.0 nmol/mol (Zero)	0,100	$u_{int,pos}$	0,79	0,6280	
		≤ 5.0 nmol/mol (Span)	0,970				
8c	Interferent Xylene with 0.5 µmol/mol	≤ 5.0 nmol/mol (Zero)	0,100	or			
		≤ 5.0 nmol/mol (Span)	0,940	$u_{int,\ neg}$			
9	Averaging effect	≤ 7.0% of meas. value	3,150	u_{av}	2,18	4,7628	
10	Reproducibility standard deviation under field conditions	≤ 5.0% of 3 month average	0,826	$u_{r,f}$	0,99	0,9825	
11	Long term drift at zero level	≤ 5.0 nmol/mol	1,000	$u_{d,l,z}$	0,58	0,3333	
12	Long term drift at 1h-limit value	≤ 5.0% of max. of cert. range	1,450	$u_{d,l,lh}$	1,00	1,0092	
18	Difference sample/calibration port	≤ 1%	0,000	$u_{\Delta sc}$	0,00	0,0000	
21	Uncertainty of test gas	≤ 3%	2,000	u_{cg}	1,20	1,4400	

Combined standard uncertainty	u_c	3,9245	nmol/mol
Expanded uncertainty	U	7,8490	nmol/mol
Relative expanded uncertainty	W	6,54	%
Maximum allowed expanded uncertainty	W_{req}	15	%

Calculation of overall uncertainty (Device 2)

Measuring device:	Thermo Fisher Scientific Model 49i					Serial number:	Gerät 2	
Measured component:	O3					1h-Alert threshold:	120	nmol/mol

No.	Performance characteristic	Performance criterion	Result	Partial uncertainty		Square of partial uncertainty
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0,100	$u_{r,Z}$	0,03	0,0007
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	0,100	$u_{r,lv}$	0,03	0,0007
3	"lack of fit" at 1h-limit value	≤ 4.0% of meas. value	1,600	$u_{l,lv}$	1,11	1,2288
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 2.0 nmol/mol/kPa	0,090	u_{gp}	0,94	0,8748
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0,003	u_{gt}	0,03	0,0010
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 1.0 nmol/mol/K	-0,290	u_{st}	-2,01	4,0368
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0,030	u_V	0,45	0,1992
8a	Interferent H_20 with 21 mmol/mol	≤ 10 nmol/mol (Zero)	-0,800	u_{H2O}	-0,99	0,9819
		≤ 10 nmol/mol (Span)	-1,570			
8b	Interferent Toluene with 0,5 µmol/mol	≤ 5.0 nmol/mol (Zero)	0,070	$u_{int,pos}$		
		≤ 5.0 nmol/mol (Span)	0,540	or	0,43	0,1864
8c	Interferent Xylene with 0,5 µmol/mol	≤ 5.0 nmol/mol (Zero)	0,040			
		≤ 5.0 nmol/mol (Span)	0,500	$u_{int,\ neg}$		
9	Averaging effect	≤ 7.0% of meas. value	3,760	u_{av}	2,61	6,7860
18	Difference sample/calibration port	≤ 1%	0,000	u_{Dsc}	0,00	0,0000
21	Uncertainty of test gas	≤ 3%	2,000	ucg	1,20	1,4400

Combined standard uncertainty	u_c	3,9669	nmol/mol
Expanded uncertainty	U	7,9338	nmol/mol
Relative expanded uncertainty	W	6,61	%
Maximum allowed expanded uncertainty	W_{req}	15	%

Measuring device:	Thermo Fisher Scientific Model 49i					Serial number:	Gerät 2	
Measured component:	O3					1h-Alert threshold:	120	nmol/mol

No.	Performance characteristic	Performance criterion	Result	Partial uncertainty		Square of partial uncertainty
1	Repeatability standard deviation at zero	≤ 1.0 nmol/mol	0,100	$u_{r,z}$	0,03	0,0007
2	Repeatability standard deviation at 1h-limit value	≤ 3.0 nmol/mol	0,100	$u_{r,lh}$	not considered, as ur,lh = 0,02 < ur,f	-
3	"lack of fit" at 1h-limit value	≤ 4.0% of meas. value	1,600	$u_{l,lh}$	1,11	1,2288
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤ 2.0 nmol/mol/kPa	0,090	u_{gp}	0,94	0,8748
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤ 1.0 nmol/mol/K	0,003	u_{gt}	0,03	0,0010
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤ 1.0 nmol/mol/K	-0,290	u_{st}	-2,01	4,0368
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤ 0.30 nmol/mol/V	0,030	u_V	0,45	0,1992
8a	Interferent H_20 with 21 mmol/mol	≤ 10 nmol/mol (Zero)	-0,800	u_{H2O}	-0,99	0,9819
		≤ 10 nmol/mol (Span)	-1,570			
8b	Interferent Toluene with 0.5 µmol/mol	≤ 5.0 nmol/mol (Zero)	0,070	$u_{int,pos}$		
		≤ 5.0 nmol/mol (Span)	0,540	or	0,43	0,1864
8c	Interferent Xylene with 0.5 µmol/mol	≤ 5.0 nmol/mol (Zero)	0,040			
		≤ 5.0 nmol/mol (Span)	0,500	$u_{int,\ neg}$		
9	Averaging effect	≤ 7.0% of meas. value	3,760	u_{av}	2,61	6,7860
10	Reproducibility standard deviation under field conditions	≤ 5.0% of 3 month average	0,826	$u_{r,f}$	0,99	0,9825
11	Long term drift at zero level	≤ 5.0 nmol/mol	1,040	$u_{d,l,z}$	0,60	0,3605
12	Long term drift at 1h-limit value	≤ 5.0% of max. of cert. range	-1,480	$u_{d,l,lh}$	-1,03	1,0514
18	Difference sample/calibration port	≤ 1%	0,000	$u_{\Delta sc}$	0,00	0,0000
21	Uncertainty of test gas	≤ 3%	2,000	u_{cg}	1,20	1,4400

Combined standard uncertainty	u_c	4,2579	nmol/mol
Expanded uncertainty	U	8,5159	nmol/mol
Relative expanded uncertainty	W	7,10	%
Maximum allowed expanded uncertainty	W_{req}	15	%