

CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000039320_01

AMS designation: Modell 49i for O₃

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

Test Laboratory: TÜV Rheinland Energy GmbH

This is to certify that the AMS has been tested and certified
according to the standards
VDI 4202-1 (2002), VDI 4203-3 (2004), EN 14625 (2012),
EN 15267-1 (2009) and DIN EN 15267-2 (2009).

Certification is awarded in respect of the conditions stated in this certificate
(this certificate contains 12 pages).



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

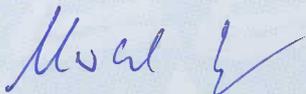
www.tuv.com
ID 0000039320

Publication in the German Federal Gazette
(BAnz) of 8 April 2006

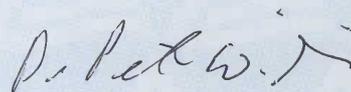
This certificate will expire on:
22 July 2023

German Federal Environment Agency
Dessau, 22 July 2018

TÜV Rheinland Energy GmbH
Cologne, 21 July 2018



Dr Marcel Langner
Head of Section II 4.1



ppa. Dr Peter Wilbring

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TÜV Rheinland Energy GmbH
Am Grauen Stein
51105 Köln

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:	936/21203248/B1 dated 5 January 2006, Addendum 936/21221382/A dated 21 March 2013
Initial certification:	23 July 2013
Expiry date:	22 July 2023
Certificate:	Renewal (of previous certificate 0000039320 dated 20 August 2013 valid until 22 July 2018)
Publication:	BAnz 08 April 2006, no. 70, p. 2653, chapter IV no. 3.2

Approved application

The certified AMS is suitable for continuous ambient air monitoring of O₃ (stationary operation).

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

The AMS is approved for an ambient temperature range of +5 °C to +40 °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 limit values 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. 936/21203248/B1 dated 5 January 2011 issued by TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, statement issued on 17 November 2011 and Addendum 936/21221382/A dated 21 March 2013 issued by 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 08 April 2006, no. 70, p. 2653, chapter IV no. 3.2, UBA announcement dated 21 February 2006:

AMS designation:

Model 49i Ozone Analyzer

Manufacturer:

Thermo Electron Corporation Franklin, MA 02038 USA and 91056 Erlangen

Field of application:

For continuous ambient air monitoring of O₃ (stationary operation)

Measuring ranges during performance testing:

O₃ 0–360 µg/m³

0–500 µg/m³

Software version:

Version: V 01.01.02.105

Test Laboratory:

TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, Cologne, TÜV Rheinland Group

Test Report:

No. 936/21203248/B1 dated 5 January 2006

Publication in the German Federal Gazette: BAnz 20 April 2007, no. 75, p. 4139, chapter IV notification 1, UBA announcement dated 12 April 2007:

1 Notification issued by the Federal Environment Agency

Thermo Electron Corp., Franklin, USA, now trade under the new name Thermo Fisher Scientific, Franklin, USA.

Statement issued by TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, 51101 Cologne, Dr Peter Wilbring, dated 20 December 2006

Publication in the German Federal Gazette: BAnz 03 September 2008, no. 133, p. 3242, chapter IV notification 15, UBA announcement dated 12 August 2008:

15 Notification as regards Federal Environment Agency notice of 21 February 2006 (BAnz. p. 2655)

The current software version for the Model 49i air quality monitor manufactured by Thermo Fisher Scientific is:

V 01.05.00 (105115-00)

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

Publication in the German Federal Gazette: BAnz 25 August 2009 no. 125, p. 2929, chapter III notification 19, UBA announcement dated 03 August 2009:

19 Notification as regards Federal Environment Agency notice of 21 February 2006 (BAnz. p. 2655)

The current software version for the Model 49i air quality monitor manufactured by Thermo Fisher Scientific is:

V 01.06.01 (108459-00)

Statement issued by TÜV Rheinland Immissionsschutz und Energiesysteme GmbH dated 01 April 2009

Publication in the German Federal Gazette: BAnz 28 July 2010, no. 111, p. 2597, chapter III notification 7, UBA announcement dated 12 July 2010:

7 Notification as regards Federal Environment Agency (UBA) notices of 21 February 2006 (BAnz. p. 2655) and of 03 August 2009 (BAnz. p. 2936)

The Model 49i air quality monitor manufactured by Thermo Fisher Scientific can also be used with the PU1959-N86-3.07 sample gas pump manufactured by KNF.

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

Publication in the German Federal Gazette: BAnz 29 July 2011 no. 113, p. 2725, chapter III notification 21, UBA announcement dated 15 July 2011:

21 Notification as regards Federal Environment Agency (UBA) notices 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 for the Model 49i air quality monitor for O₃ manufactured by Thermo Fisher Scientific is:

V 01.06.04 (109898-00)

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 30 March 2011

Publication in the German Federal Gazette: BAnz 02 March 2012, no. 36, p. 920, chapter V notification 1, UBA announcement dated 23 February 2012:

1 Notification as regards Federal Environment Agency (UBA) notices of 21 February 2006 (BAnz. p. 2653, chapter IV number 3.2) and of 15 July 2011 (BAnz. p. 2725, chapter III, 21st notification)

The current software version for the Model 49i air quality monitor for ozone manufactured by Thermo Fisher Scientific is:

V 01.06.08 (111276-00)

Instead of the measurement cell used so far that consists of the polyurethane-coated aluminium tube, an alternative measurement cell can be used which consists of an aluminium tube and an integrated FEP hose (FEP: fluorinated ethylene propylene).

Statement issued by TÜV Rheinland Energie und Umwelt GmbH
dated 17 November 2011

Publication in the German Federal Gazette: BAnz AT 20.07.2012 B11, chapter IV notification 26, UBA announcement dated 06 July 2012:

26 Notification as regards Federal Environment Agency (UBA) notices of 21 February 2006 (BAnz. p. 2653, chapter IV number 3.2) and of 23 February 2012 (BAnz. p. 920, chapter V 1st notification)

The Model 49i air quality monitor for O₃ manufactured by Thermo Fisher Scientific will be equipped with the PU2737-N86 vacuum pump manufactured by KNF in the future.

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

Publication in the German Federal Gazette: BAnz AT 23.07.2013 B4, chapter V notification 22, UBA announcement dated 03 July 2013:

22 Notification as regards Federal Environment Agency (UBA) notices of 21 February 2006 (BAnz. p. 2653, chapter IV no 3.2) and of 06 July 2012 (BAnz AT 20.07.2012 B11, chapter IV 26th notification)

The Model 49i air quality monitor for O₃ manufactured by Thermo Fisher Scientific complies with the requirements of EN 14625 (December 2012 version). Furthermore, the manufacturing process and the quality management for the measuring system meet the requirements of EN 15267.

Test report 936/21203248/B1 on the performance testing, a statement issued by TÜV Rheinland Energie und Umwelt GmbH issued on 17 November 2011 and an addendum no. 936/21221382/A which forms an integral part of the cited test report are available online at www.qal1.de.

Statement issued by TÜV Rheinland Energie und Umwelt GmbH
dated 21 March 2013

Publication in the German Federal Gazette: BAnz AT 01.04.2014 B12, chapter IV notification 35, UBA announcement dated 27 February 2014:

35 Notification as regards Federal Environment Agency (UBA) notices of 21 February 2006 (BAnz. p. 2653, chapter IV no 3.2) and of 3 July 2013 (BAnz AT 23.07.2013 B4, chapter V 22nd notification)

Production of the Arcturus Bd. 101491-xx processor board for the Model 49i air quality monitor for O₃ manufactured by Thermo Fisher Scientific has been discontinued and replaced by the Arcturus Bd. 110570-xx processor board.

The current software version of the measuring system is: V 02.00.00 (113421-00)

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

Publication in the German Federal Gazette: BAnz AT 05.08.2014 B11, chapter V notification 23, UBA announcement dated 17 July 2014:

23 Notification as regards Federal Environment Agency (UBA) notices of 21 February 2006 (BAnz. p. 2653, chapter IV number 3.2) and of 27 February 2014 (BAnz AT 01.04.2014 B12, chapter VI 35th notification)

The detector unit of the Model 49i ozone analyzer manufactured by Thermo Fisher Scientific has been re-engineered in order to increase production safety regarding earthing/insulation.

Addendum no. 936/21221382/A to the original test report has been revised and is now available online as addendum no. 936/21221382/A1 at www.qal1.de.

The current software version of the model 49i measuring system for O₃ manufactured by Thermo Fisher Scientific is: V 02.00.04 (114183-00)

Statement issued by TÜV Rheinland Energie und Umwelt GmbH
dated 29 March 2014

Publication in the German Federal Gazette: BAnz AT 02.04.2015 B5, chapter IV notification 19, UBA announcement dated 25 February 2015:

19 Notification as regards Federal Environment Agency (UBA) notices of 21 February 2006 (BAnz. p. 2653, chapter IV no 3.2) and of 17 July 2014 (BAnz AT 05.08.2014 B11, chapter V 23rd notification)

The solenoid valves (SV-111747-501) that had been used so far for the Model 49i O₃ analyser manufactured by Thermo Fisher Scientific, have been replaced by new solenoid valves (KL344-T-1S1-C204).

The current software version of the model 49i measuring system for O₃ manufactured by Thermo Fisher Scientific is:

V 02.02.01 (114620-00)

Statement issued by TÜV Rheinland Energie und Umwelt GmbH
dated 22 September 2014

Publication in the German Federal Gazette: BAnz AT 14.03.2016 B7, chapter V
notification 15, UBA announcement dated 18 February 2016:

**15 Notification as regards Federal Environment Agency (UBA) notices
of 21 February 2006 (BAnz. p. 2653, chapter IV number 3.2) and
of 25 February 2015 (BAnz AT 02.04.2015 B5, chapter VI 19th notification)**

The current software version of the model 49i measuring system for O₃
manufactured by Thermo Fisher Scientific is:

V 02.02.06

Ventilator EBM-Papst 8314 HL may be used instead of the ventilator
that has been in use so far.

Statement issued by TÜV Rheinland Energie und Umwelt GmbH
dated 22 October 2015

Certified product

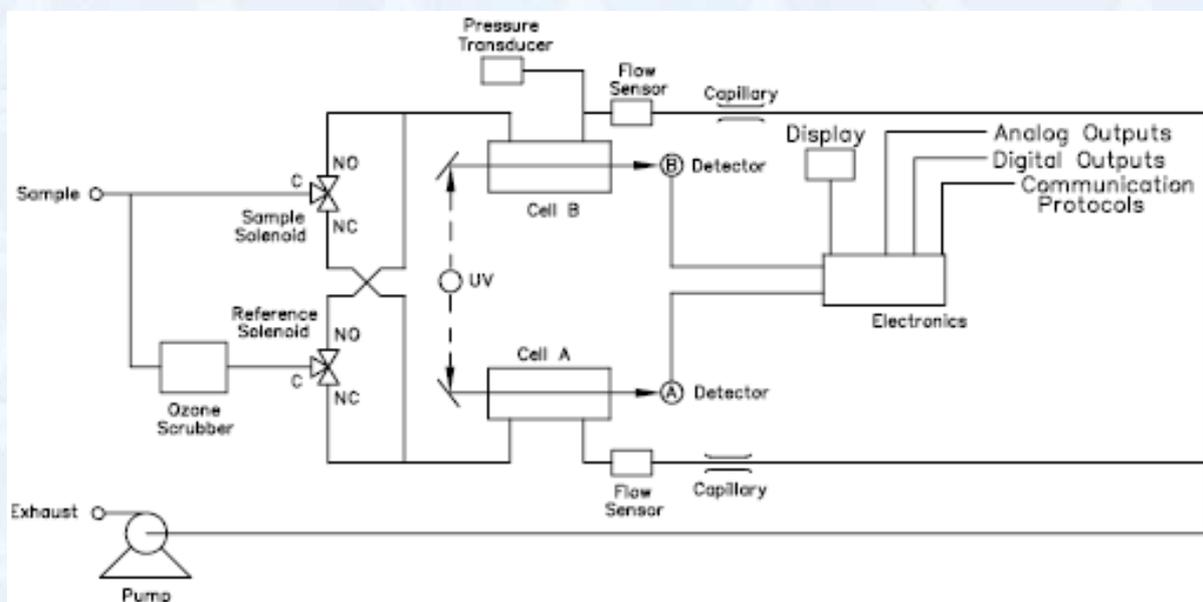
This certification applies to automated measurement systems conforming to the following description:

The measuring principle of the Model 49i measuring system relies on the determination of light absorption caused by the gas to be measured in the ranges of wave lengths characteristic of this gas, which, for ozone, is at 254 nm (UV) and thus complies with the reference method described in standard EN 14625.

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

Detectors A and B measure the UV light intensities of both cells. When the solenoid valves direct the reference and sample gas to the respective opposite cell, the light intensities are disregarded for a few seconds in order to purge the cells. 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.



The current software version is:

V 02.02.06

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 systems 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 certification mark may be applied to the product or used in advertising materials for the certified product.

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.

Certification of the Modell 49i measuring system is based on the documents listed below and the regular, continuous surveillance of the manufacturer's quality management system:

Basic testing

Test report: 936/21203248/B1 dated 5 January 2006

TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, Cologne

Publication: BAnz. 08 April 2006, no. 70, p. 2653, chapter IV no. 3.2

UBA announcement dated 21 February 2006

Notifications

Statement issued by TÜV Rheinland Immissionsschutz und Energiesysteme GmbH dated 20 December 2006

Publication: BAnz 20 April 2007, no. 75, p. 4139, chapter IV notification 1

UBA announcement dated 12 April 2007

(change of company name)

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

Publication: BAnz 03 September 2008, no. 133, p. 3242, chapter IV notification 15

UBA announcement dated 12 August 2008

(software changes)

Statement issued by TÜV Rheinland Immissionsschutz und Energiesysteme GmbH dated 01 April 2009

Publication: BAnz 25 August 2009 no. 125, p. 2929, chapter III notification 19

UBA announcement dated 03 August 2009

(software changes)

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

Publication: BAnz 28 July 2010, no. 111, p. 2597, chapter III notification 7

UBA announcement dated 12 July 2010

(pump)

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 30 March 2011
Publication: BAnz 29 July 2011, no. 113, p. 2725, chapter III notification 21
UBA announcement dated 15 July 2011
(software changes)

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 17 November 2011
Publication: BAnz 02 March 2012, no. 36, p. 920, chapter V notification 1,
UBA announcement dated 23 February 2012
(software + measurement cell)

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 20 March 2012
Publication: BAnz AT 20.07.2012 B11, chapter IV notification 26
UBA announcement dated 06 July 2012
(pump)

Initial certification according to EN 15267

Certificate no. 0000039320: 20 August 2013
Expiry date of the certificate: 22 July 2018

Test report: 936/21203248/B1 dated 5 January 2006
TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, Cologne
Publication: BAnz AT 23.07.2013 B4, chapter V notification 22
UBA announcement dated 03 July 2013
(complies with the requirements of EN 14625 (December 2012), complies with the requirements of EN 15267 for the manufacturing process and QM of the measuring system)

Notifications in accordance with EN 15267

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 01 October 2013
Publication: BAnz AT 01.04.2014 B12, chapter IV notification 35
UBA announcement dated 27 February 2014
(software changes)

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 29 March 2014
Publication: BAnz AT 05.08.2014 B11, chapter V notification 23
UBA announcement dated 17 July 2014
(revision of the addendum and software changes)

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 22 September 2014
Publication: BAnz AT 02.04.2015 B5, chapter IV notification 19,
UBA announcement dated 25 February 2015
(replacement of the solenoid valve and software changes)

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 22 October 2015
Publication: BAnz AT 14.03.2016 B7, chapter V notification 15,
UBA announcement dated 18 February 2016
(software changes and alternative fan)

Renewal of the certificate

Certificate no. 0000039320_01: 22 July 2018
Expiry date of the certificate: 22 July 2023

Calculation of overall uncertainty (instrument 1 in the laboratory)

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,1h}	0,03	0,0007	
3	"lack of fit" at 1h-limit value	≤ 4.0% of meas. value	1,500	U _{l,1h}	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 ₂ O 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}	or	0,79	
		≤ 5.0 nmol/mol (Span)	0,970				
8c	Interferent Xylene with 0,5 µmol/mol	≤ 5.0 nmol/mol (Zero)	0,100	U _{int,neg}			
		≤ 5.0 nmol/mol (Span)	0,940				
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 _{ssc}	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	%

Calculation of overall uncertainty (instrument 1 in the laboratory and in the field)

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,1h}	not considered, as U _{r,1h} = 0,02 < U _{r,f}	-	
3	"lack of fit" at 1h-limit value	≤ 4.0% of meas. value	1,500	U _{l,1h}	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 ₂ O 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}	or	0,79	
		≤ 5.0 nmol/mol (Span)	0,970				
8c	Interferent Xylene with 0,5 µmol/mol	≤ 5.0 nmol/mol (Zero)	0,100	U _{int,neg}			
		≤ 5.0 nmol/mol (Span)	0,940				
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,1h}	1,00	1,0092	
18	Difference sample/calibration port	≤ 1%	0,000	U _{ssc}	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 (instrument 2 in the laboratory)

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 ₂ O with 21 mmol/mol	≤ 10 nmol/mol (Zero)	-0,800	u_{H_2O}	-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	$u_{int,pos}$	0,43	0,1864
		≤ 5.0 nmol/mol (Span)	0,540			
8c	Interferent Xylene with 0,5 µmol/mol	≤ 5.0 nmol/mol (Zero)	0,040	or	0,43	0,1864
		≤ 5.0 nmol/mol (Span)	0,500			
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_{psc}	0,00	0,0000
21	Uncertainty of test gas	≤ 3%	2,000	u_{cg}	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	%

Calculation of overall uncertainty (instrument 2 in the laboratory and in the field)

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	$u_{r,lv}$	not considered, as $u_{r,lv} = 0,02 < u_{r,f}$	-
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 ₂ O with 21 mmol/mol	≤ 10 nmol/mol (Zero)	-0,800	u_{H_2O}	-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	$u_{int,pos}$	0,43	0,1864
		≤ 5.0 nmol/mol (Span)	0,540			
8c	Interferent Xylene with 0,5 µmol/mol	≤ 5.0 nmol/mol (Zero)	0,040	or	0,43	0,1864
		≤ 5.0 nmol/mol (Span)	0,500			
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	$u_{d,l,lv}$	-1,03	1,0514
18	Difference sample/calibration port	≤ 1%	0,000	u_{psc}	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	%