

CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000025927_03

Certified AMS: AR500 with ER120 for NO₂, SO₂ and O₃

Manufacturer: Opsis AB
Skytteskogsvägen 16
244 02 Furulund
Sweden

Test Institute: TÜV Rheinland Energy GmbH

**This is to certify that the AMS has been tested
and found to comply with the standards
EN 14211 (2005), EN 14212 (2005), EN 14625 (2005),
EN 15267-1 (2009), EN 15267-2 (2009).**

Certification is awarded in respect of the conditions stated in this certificate
(this certificate contains 18 pages).
The present certificate replaces certificate 0000025927_02 of 02 February 2015.



Suitability Tested
Complying with
2008/50/EC
EN 15267
Regular Surveillance
www.tuv.com
ID 0000025927

Publication in the German Federal Gazette
(BAnz.) of 02 March 2012

German Federal Environment Agency
Dessau, 12 February 2020

Dr. Marcel Langner
Head of Section II 4.1

This certificate will expire on:
11 February 2025

TÜV Rheinland Energy GmbH
Cologne, 11 February 2020

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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

Certificate:
0000025927_03 / 12 February 2020

Test report: 936/21211350/B dated 07 October 2011
Initial certification: 12 February 2010
Expiry date: 11 February 2025
Certificate: renewal (previous 0000025927_02 dated 02 February 2015
with validity up to the 11 February 2020)
Publication: BAnz 2 March 2012, no. 36, p. 920, chapter IV, no. 2.1

Approved application

The certified AMS is suitable for the continuous monitoring of concentrations of nitrogen dioxide, sulphur dioxide, and ozone in ambient air (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 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 valid at the time of performance testing. As changes in legal regulations are possible, any potential user should ensure in consultation with the manufacturer that this AMS is suitable for monitoring the limit value 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 936/21211350/B dated 07 October 2011 of 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. 12 February 2010, no. 24, p. 552, chapter III, no. 1.1, Announcement by UBA from 25 January 2010:

AMS designation:

AR500 with ER120 for NO₂, SO₂ and O₃

Manufacturer:

Opsis AB, Furulund, Sweden

Field of application:

For the continuous monitoring of concentrations of nitrogen dioxide, sulphur dioxide and ozone in ambient air (stationary operation)

Measuring ranges during the performance test:

Component	Certification range	supplementary measurement ranges	Unit
NO ₂	0 - 400	0 - 1800	µg/m ³
SO ₂	0 - 700	0 - 1000	µg/m ³
O ₃	0 - 360	0 - 500	µg/m ³

Software version:

7.21

Restrictions:

None

Notes:

1. The measuring path length during performance testing was 320 m.
2. The maintenance interval is four weeks.
3. Equivalence with the reference measurement methods according to the guideline „Demonstration of Equivalence of Ambient Air Monitoring Methods“ has been demonstrated for the components NO₂, SO₂ and O₃.
4. Functional tests by external sample gas feeding are possible.
5. The report on the performance test is available online at www.qal1.de.
6. Supplementary testing (Demonstration of Equivalence for the component SO₂ according the guideline “Demonstration of Equivalence of Ambient Air Monitoring Methods”) as regards Federal Environment Agency notices of 25 January 2010 (BAnz. p. 552, chapter III no. 1.1).

Test report:

TÜV Rheinland Energie und Umwelt GmbH, Cologne
Report No.: 936/21211350/B dated 07 October 2011

Publication in the German Federal Gazette: BAnz AT 05.03.2013 B10, chapter V notification 11, Announcement by UBA from 12 February 2013:

11 Notification as regards Federal Environment Agency notices of 23 February 2012 (Federal Gazette (BAnz.) p. 920, chapter IV, no. 2.1)

The AR500 measuring system with ER120 for NO₂, SO₂ and O₃ manufactured by Opsis AB can also be operated with the transmitter/receiver units ER 110 and ER150.

Statement of TÜV Rheinland Energie und Umwelt GmbH of 10 October 2012

Publication in the German Federal Gazette: BAnz AT 02.04.2015 B5, chapter IV notification 13, Announcement by UBA from 25 February 2015:

13 Notification as regards Federal Environment Agency (UBA) notices of 23 February 2012 (Federal Gazette (BAnz.) p. 920, chapter IV number 2.1) and of 12 February 2013 (Federal Gazette (BAnz) AT 05 March 2013 B10, chapter V 11th notification)

The step motor for the automatic grid finding type RDM 543/100A, of manufacturer BERGER LAHR, in the AR500 measuring system with ER120 for NO₂, SO₂ and O₃, of the company Opsis AB, was discontinued and therefore replaced by the step motor for the automatic grid finding type RDM 545/100A of manufacturer BERGER LAHR.

Statement of TÜV Rheinland Energie und Umwelt GmbH of 20 September 2014

Certified product

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

The measurement system AR500 operates on the basis of the Differential Optical Absorption Spectroscopy (DOAS). The DOAS measuring principle uses the characteristic radiation absorption by gaseous components for quantification of the respective concentrations.

The DOAS monitor AR500 with ER120 consists of a combined transmitter-receiver unit, a reflector unit and an analyser. The absorbed light is transferred from the transmitter-receiver unit to the analyser via fibre optic cable.

Combined transmitter-receiver Unit ER 120

The combined transmitter-receiver unit ER120 comprises the optical components, the xenon light-source and the power supply PS150 for igniting the xenon light-source.

The used high-pressure xenon lamp is a point light source. The light is generated by ignition of ultra pure xenon gas at a pressure of approx. 30 bar. The lamp is powered by a stabilised D.C. voltage source and requires a short high-voltage ignition pulse.

The radiation of the lamp includes the ultraviolet, the visible, and the infrared range. The wavelengths are continuously distributed over the entire spectrum, with the exception of some peaks in the near infrared range.

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 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. With revocation of the publication the certificate loses its validity. After the expiration of the certificate and on requests of the TÜV Rheinland Energy GmbH this document shall be returned and the certificate mark must not be employed anymore.

The relevant version of this certificate and its expiration is also accessible on the internet: gal1.de.

History of documents

Certification of AR500 with ER120 is based on the documents listed below and the regular, continuous monitoring of the Quality Management System of the manufacturer:

Initial certification according to EN 15267

Certificate No. 0000025927: 10 March 2010
Expiry date of the certificate: 11 February 2015
Test report 936/21211350/A dated 26 October 2009
TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, Cologne
Publication: BAnz. 12 February 2010, no. 24, p. 552, chapter III no. 1.1
Announcement by UBA dated 25 January 2010
(Demonstration of equivalence for NO₂ and O₃)

Supplementary testing according to EN 15267

Certificate No. 0000025927_01: 16 March 2012
Expiry date of the certificate: 11 February 2015
Test report 936/21211350/B dated 7 October 2011
TÜV Rheinland Energy GmbH, Cologne
Publication: BAnz. 2 March 2012, no. 36, p. 920, chapter IV no. 2.1
Announcement by UBA dated 23 February 2012
(Demonstration of equivalence for SO₂)

Notifications

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 10 October 2012
Publication: BAnz AT 05.03.2013 B10, chapter V notification 11
Announcement by UBA dated 2 February 2015
(additional transmitter / receiver ER110 and ER150)

Renewal of the certificate

Certificate No. 0000025927_02 02 February 2015
Expiry date of the certificate: 11 February 2020

Notifications

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 20 September 2014
Publication: BAnz. AT 02.04.2015 B5, chapter IV notification 13
Announcement by UBA dated 25 February 2015
(hardware changes)

Renewal of the certificate

Certificate No. 0000025927_03 12 February 2020
Expiry date of the certificate: 11 February 2025

Table 1: Total expanded uncertainty with the results of the laboratory test according to EN 14211 (component NO₂) for system 1329

Device: AR500		Serial No: 1329		1h-limit value: 104,6		nmol/mol	
Component: NO ₂							
No.	Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty		
1	Repeatability at zero	≤ 1,0 nmol/mol	0,000	u _{r,z}	0,00	0,0000	
2	Repeatability at concentration ct	≤ 3,0 nmol/mol	2,000	u _{r,ln}	0,04	0,0015	
3	"lack of fit"	≤ 4,0% of measured value	0,800	u _{l,ln}	0,48	0,2334	
4	Sensitivity coefficient of sample gas pressure	≤ 8,0 nmol/mol/kPa	0,000	u _{gp}	0,00	0,0000	
5	Sensitivity coefficient of sample gas temperature	≤ 3,0 nmol/mol/K	0,026	u _{gt}	0,04	0,0016	
6	Sensitivity coefficient of surrounding temperature	≤ 3,0 nmol/mol/K	-0,050	u _{st}	-0,06	0,0036	
7	Sensitivity coefficient of electrical voltage	≤ 0,30 nmol/mol/V	-0,021	u _v	-0,07	0,0046	
8a	H2O with concentration 21 mmol/mol	≤ 5,0 nmol/mol	0,000	u _{H2O}	0,00	0,0000	
8b	CO2 with concentration 500 µmol/mol	≤ 5,0 nmol/mol	0,001	u _{int,pos}			
8c	O3 with concentration 200 nmol/mol	≤ 2,0 nmol/mol	0,002	or			
8d	NH3 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	0,002	u _{int,neg}	0,48	0,2304	
9	Averaging effect	≤ 7,0% of measured value	-0,600	u _{av}	-0,36	0,1313	
18	Difference sample/calibration port	≤ 1,0%	0,000	u _{ssc}	0,00	0,0000	
21	Converter efficiency	≤ 98%	100,000	u _{CE}	0,00	0,0000	
22	Increase of NO2 concentration due to residence time	≤ 4,0 nmol/mol	0,000	u _{dr}	0,00	0,0000	
23	Uncertainty calibration gas	≤ 3,0%	2,000	u _{cg}	1,05	1,0941	
				combined standard uncertainty	u _c	1,3046	nmol/mol
				expanded uncertainty	U _c	2,6092	nmol/mol
				expanded uncertainty actual	U _{crel}	2,49	%
				expanded uncertainty required	U _{req,rel}	15	%

Table 2: Total expanded uncertainty with the results of the laboratory test and field test according to EN 14211 (component NO₂) for system 1329

Device: AR500		Serial No.: 1329		1h-limit value: 104,6		nmol/mol	
Component: NO ₂		1h-limit value:		104,6		nmol/mol	
No.	Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty		
				U _z	0,000		
1	Repeatability at zero	≤ 1,0 nmol/mol	0,000	U _z	0,000		
2	Repeatability at concentration ct	≤ 3,0 nmol/mol	2,000	U _{r,th}	-		
3	"lack of fit"	≤ 4,0% of measured value	0,800	U _{ln}	0,2334		
4	Sensitivity coefficient of sample gas pressure	≤ 8,0 nmol/mol/kPa	0,000	U _{gp}	0,0000		
5	Sensitivity coefficient of sample gas temperature	≤ 3,0 nmol/mol/K	0,026	U _{gt}	0,0016		
6	Sensitivity coefficient of surrounding temperature	≤ 3,0 nmol/mol/K	-0,050	U _{st}	0,0036		
7	Sensitivity coefficient of electrical voltage	≤ 0,30 nmol/mol/V	-0,021	U _v	0,0046		
8a	H2O with concentration 21 nmol/mol	≤ 5,0 nmol/mol	0,000	U _{H2O}	0,0000		
8b	CO2 with concentration 500 µmol/mol	≤ 5,0 nmol/mol	0,001	U _{int,pos}			
8c	O3 with concentration 200 nmol/mol	≤ 2,0 nmol/mol	0,002	0'	0,2304		
8d	NH3 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	0,002	U _{int,neg}			
9	Averaging effect	≤ 7,0% of measured value	-0,600	U _{av}	0,1313		
10	Reproducibility under field conditions	≤ 5,0% of the average of 3 Mon.	4,720	U _r	24,3752		
11	Long term drift at zero level	≤ 5,0 nmol/mol	-1,420	U _{l,z}	0,6721		
12	Long term drift at span level	≤ 5,0% of max. of certification range	0,430	U _{l,th}	0,0674		
18	Difference sample/calibration port	≤ 1,0%	0,000	uDsc	0,0000		
21	Converter efficiency	≥ 98%	100,000	uCE	0,0000		
22	Increase of NO2 concentration due to residence time	≤ 4,0 nmol/mol	0,000	uctr	0,0000		
23	Uncertainty calibration gas	≤ 3,0%	2,000	ucg	1,0941		
				U _c	7,1546	nmol/mol	
				U _e	14,3093	nmol/mol	
				U _{z,rel}	13,68	%	
				U _{rel,rel}	15	%	

Table 3: Total expanded uncertainty with the results of the laboratory test according to EN 14211 (component NO₂) for system 1330

Device: AR500		Serial No: 1330		1h-limit value: 104,6		nmol/mol	
Component: NO ₂							
No.	Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty		
1	Repeatability at zero	≤ 1,0 nmol/mol	0,100	U _{r,z} 0,02	0,0003		
2	Repeatability at concentration ct	≤ 3,0 nmol/mol	0,900	U _{r,ct} 0,02	0,0004		
3	"lack of fit"	≤ 4,0% of measured value	0,000	U _{l,fit} 0,36	0,1313		
4	Sensitivity coefficient of sample gas pressure	≤ 8,0 nmol/mol/kPa	0,000	U _{sp} 0,00	0,0000		
5	Sensitivity coefficient of sample gas temperature	≤ 3,0 nmol/mol/K	0,000	U _{gt} -0,05	0,0025		
6	Sensitivity coefficient of surrounding temperature	≤ 3,0 nmol/mol/K	0,000	U _{st} 0,00	0,0000		
7	Sensitivity coefficient of electrical voltage	≤ 0,30 nmol/mol/V	0,000	U _v 0,24	0,0553		
8a	H2O with concentration 21 mmol/mol	≤ 5,0 nmol/mol	0,000	U _{H2O} 0,00	0,0000		
8b	CO2 with concentration 500 µmol/mol	≤ 5,0 nmol/mol	0,000	U _{int,pos} 0,00	0,1764		
8c	O3 with concentration 200 nmol/mol	≤ 2,0 nmol/mol	0,000	or			
8d	NH3 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	0,000	U _{int,neg} 0,42			
9	Averaging effect	≤ 7,0% of measured value	0,000	U _{av} -0,18	0,0328		
18	Difference sample/calibration port	≤ 1,0%	0,000	U _{ssc} 0,00	0,0000		
21	Converter efficiency	≤ 98%	100,000	U _{CE} 0,00	0,0000		
22	Increase of NO2 concentration due to residence time	≤ 4,0 nmol/mol	0,000	U _{ct} 0,00	0,0000		
23	Uncertainty calibration gas	≤ 3,0%	2,000	U _{cg} 1,05	1,0941		
				combined standard uncertainty	U _c	1,2222	nmol/mol
				expanded uncertainty	U _e	2,4445	nmol/mol
				expanded uncertainty actual	U _{c,rel}	2,34	%
				expanded uncertainty required	U _{req,rel}	15	%

Table 4: Total expanded uncertainty with the results of the laboratory test and field test according to EN 14211 (component NO₂) for system 1330

Device: AR500		Serial No: 1330		1h-limit value: 104.6		nmol/mol	
Component: NO ₂		1h-limit value:		104.6		nmol/mol	
No.	Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty		
1	Repeatability at zero	≤ 1.0 nmol/mol	0.100	U _{r,z} 0.02	0.0003		
2	Repeatability at concentration ct	≤ 3.0 nmol/mol	0.900	U _{r,ct} not respected because: $u_{r,ct} = 0.034 < u_{r,f}$	-		
3	"lack of fit"	≤ 4.0% of measured value	0.600	U _{l,fit} 0.36	0.1313		
4	Sensitivity coefficient of sample gas pressure	≤ 8.0 nmol/mol/kPa	0.000	U _{sp} 0.00	0.0000		
5	Sensitivity coefficient of sample gas temperature	≤ 3.0 nmol/mol/K	-0.032	U _{gt} -0.05	0.0025		
6	Sensitivity coefficient of surrounding temperature	≤ 3.0 nmol/mol/K	0.000	U _{st} 0.00	0.0000		
7	Sensitivity coefficient of electrical voltage	≤ 0.30 nmol/mol/V	0.073	U _v 0.24	0.0553		
8a	H2O with concentration 21 mmol/mol	≤ 5.0 nmol/mol	0.000	U _{h2o} 0.00	0.0000		
8b	CO2 with concentration 500 μmol/mol	≤ 5.0 nmol/mol	0.001	U _{in,pos}			
8c	CO3 with concentration 200 nmol/mol	≤ 2.0 nmol/mol	0.002	or	0.1764		
8d	NH3 with concentration 200 nmol/mol	≤ 5.0 nmol/mol	0.000	U _{int,neg}			
9	Averaging effect	≤ 7.0% of measured value	-0.300	U _{av} -0.18	0.0328		
10	Reproducibility under field conditions	≤ 5.0% of the average of 3 Mon.	4.720	U _{r,f} 4.94	24.3752		
11	Long term drift at zero level	≤ 5.0 nmol/mol	1.620	U _{dr,z} 0.94	0.8748		
12	Long term drift at span level	≤ 5.0% of max. of certification range	0.500	U _{dr,ct} 0.30	0.0912		
18	Difference sample/calibration port	≤ 1.0%	0.000	uDsc 0.00	0.0000		
21	Converter efficiency	≥ 0.98	100.000	uCE 0.00	0.0000		
22	Increase of NO2 concentration due to residence time	≤ 4.0 nmol/mol	0.000	uctr 0.00	0.0000		
23	Uncertainty calibration gas	≤ 3.0%	2.000	ucg 1.05	1.0941		
combined standard uncertainty				U _c	7.1561	nmol/mol	
expanded uncertainty				U _e	14.3121	nmol/mol	
expanded uncertainty actual				U _{e,rel}	13.68	%	
expanded uncertainty required				U _{req,rel}	15	%	

Table 5: Total expanded uncertainty with the results of the laboratory test according to EN 14212 (component SO₂) for system 1329

Device: AR500		Serial-No.: Gerät 1 (1329)		1h-limit value: 132		nmol/mol	
Component: SO ₂		Performance characteristic		Criterion	Result	Uncertainty	Square of uncertainty
1	Repeatability at zero	≤ 1,0 nmol/mol	0,100	U _z	0,02	0,0003	
2	Repeatability at concentration ct	≤ 3,0 nmol/mol	0,100	U _{iv}	0,02	0,0003	
3	"lack of fit"	≤ 4,0% of measured value	1,600	U _{lv}	1,22	1,4868	
4	Sensitivity coefficient of sample gas pressure	≤ 3,0 nmol/mol/kPa	0,000	U _{gp}	0,00	0,0000	
5	Sensitivity coefficient of sample gas temperature	≤ 1,0 nmol/mol/K	0,071	U _{gt}	0,54	0,2908	
6	Sensitivity coefficient of surrounding temperature	≤ 1,0 nmol/mol/K	-0,030	U _{st}	-0,23	0,0523	
7	Sensitivity coefficient of electrical voltage	≤ 0,30 nmol/mol/V	-0,010	U _v	-0,10	0,0103	
8a	H2O with concentration 21 nmol/mol	≤ 10 nmol/mol	0,000	U _{H2O}	0,00	0,0000	
8b	H2S with concentration 200 nmol/mol	≤ 5,0 nmol/mol	-0,409	U _{int,pos}			
8c	NH3 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	0,406				
8d	NO with concentration 500 nmol/mol	≤ 5,0 nmol/mol	-0,604	or	0,40	0,1600	
8e	NO2 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	-0,404				
8f	m-XyloI with concentration 1 µmol/mol	≤ 10 nmol/mol	1,421	U _{int,neg}			
9	Averaging effect	≤ 7,0% of measured value	-0,100	U _{av}	-0,08	0,0058	
18	Difference sample/calibration port	≤ 1,0%	0,000	U _{bsc}	0,00	0,0000	
23	Uncertainty calibration gas	≤ 3,0%	2,000	ucg	1,32	1,7424	
				combined standard uncertainty	U _c	1,9363	nmol/mol
				expanded uncertainty	U _e	3,8726	nmol/mol
				expanded uncertainty actual	U _{e,rel}	2,93	%
				expanded uncertainty required	U _{req,rel}	15	%

Table 6: Total expanded uncertainty with the results of the laboratory test and field test according to EN 14212 (component SO₂) for system 1329

Device: AR500		SeriatNo.: Gerat 1 (1329)		1h-limit value: 132		nmol/mol	
Component: SO ₂		Performance characteristic		Criterion	Result	Uncertainty	Square of uncertainty
No.		Repeatability at zero	Repeatability at concentration ct	≤ 1,0 nmol/mol	0,100	u _{r,z}	0,003
2				≤ 3,0 nmol/mol	0,100	u _{r,lv}	-
3		"lack of fit"		≤ 4,0% of measured value	1,600	u _{lv}	1,4868
4		Sensitivity coefficient of sample gas pressure		≤ 3,0 nmol/mol/kPa	0,000	u _{gp}	0,0000
5		Sensitivity coefficient of sample gas temperature		≤ 1,0 nmol/mol/K	0,071	u _{gt}	0,2908
6		Sensitivity coefficient of surrounding temperature		≤ 1,0 nmol/mol/K	-0,030	u _{st}	-0,0523
7		Sensitivity coefficient of electrical voltage		≤ 0,30 nmol/mol/V	-0,010	u _v	0,0103
8a		H2O with concentration 21 nmol/mol		≤ 10 nmol/mol	0,000	u _{H2O}	0,0000
8b		H2S with concentration 200 nmol/mol		≤ 5,0 nmol/mol	-0,409	u _{H2Spos}	
8c		NH3 with concentration 200 nmol/mol		≤ 5,0 nmol/mol	0,406		
8d		NO with concentration 500 nmol/mol		≤ 5,0 nmol/mol	-0,604	or	0,1600
8e		NO2 with concentration 200 nmol/mol		≤ 5,0 nmol/mol	-0,404		
8f		m-Xylol with concentration 1 µmol/mol		≤ 10 nmol/mol	1,421	u _{m,xylolneg}	
9		Averaging effect		≤ 7,0% of measured value	-0,100	u _{av}	0,0058
10		Reproducibility under field conditions		≤ 5,0% of the average of 3 Mon.	4,830	u _{r,f}	40,6483
11		Long term drift at zero level		≤ 5,0 nmol/mol	-0,920	u _{dl,z}	0,2821
12		Long term drift at span level		≤ 5,0% of max. of certification range	1,490	u _{dl,lv}	1,2894
18		Differenz Proben-/Kalibergasegang		≤ 1,0%	0,000	u _{bsc}	0,0000
23		Unsicherheit Prüfgas		≤ 3,0%	2,000	u _{cg}	1,7424
				combined standard uncertainty		u _c	6,7800
				expanded uncertainty		U _c	13,5600
				expanded uncertainty actual		U _{creal}	10,27
				expanded uncertainty required		U _{req,net}	15

Table 7: Total expanded uncertainty with the results of the laboratory test according to EN 14212 (component SO₂) for system 1330

Device: AR500		Serial No.: Gerät 2 (1330)		1h-limit value: 132		nmol/mol	
Component: SO ₂							
No.	Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty		
1	Repeatability at zero	≤ 1,0 nmol/mol	0,000	U _{rz} 0,00	0,0000		
2	Repeatability at concentration ct	≤ 3,0 nmol/mol	0,100	U _{r,lv} 0,02	0,0003		
3	"lack of fit"	≤ 4,0% of measured value	1,400	U _{lv} 1,07	1,1384		
4	Sensitivity coefficient of sample gas pressure	≤ 3,0 nmol/mol/kPa	0,000	U _{gp} 0,00	0,0000		
5	Sensitivity coefficient of sample gas temperature	≤ 1,0 nmol/mol/K	0,011	U _{gt} 0,08	0,0070		
6	Sensitivity coefficient of surrounding temperature	≤ 1,0 nmol/mol/K	-0,060	U _{st} -0,46	0,2091		
7	Sensitivity coefficient of electrical voltage	≤ 0,30 nmol/mol/V	0,010	U _v 0,10	0,0103		
8a	H2O with concentration 21 nmol/mol	≤ 10 nmol/mol	0,000	U _{H2O} 0,00	0,0000		
8b	H2S with concentration 200 nmol/mol	≤ 5,0 nmol/mol	0,503	U _{H2S, pos}	1,5129		
8c	NH3 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	0,203	or			
8d	NO with concentration 500 nmol/mol	≤ 5,0 nmol/mol	0,202	1,23			
8e	NO2 with concentration 200 nmol/mol	≤ 5,0 nmol/mol	0,401				
8f	m-Xylol with concentration 1 µmol/mol	≤ 10 nmol/mol	0,809	U _{int, neg}			
9	Averaging effect	≤ 7,0% of measured value	0,100	U _{av} 0,08	0,0058		
18	Difference sample/calibration port	≤ 1,0%	0,000	U _{bac} 0,00	0,0000		
23	Uncertainty calibration gas	≤ 3,0%	2,000	0	1,7424		
combined standard uncertainty						U _c	2,1509
expanded uncertainty						U _s	4,3017
expanded uncertainty actual						U _{s,rel}	3,26
expanded uncertainty required						U _{req,rel}	15

Table 8: Total expanded uncertainty with the results of the laboratory test and field test according to EN 14212 (component SO₂) for system 1330

Device: AR500		Serial-No.: Gerat 2 (1330)		1h-limit value: 132		nmol/mol
Component: SO ₂		Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty
1	Repeatability at zero	≤	1,0 nmol/mol	0,000	U _{r,z} 0,00	0,0000
2	Repeatability at concentration ct	≤	3,0 nmol/mol	0,100	U _{r,v} not respected because: $u_{r,v} = 0,01 < u_{r,f}$	-
3	"lack of fit"	≤	4,0% of measured value	1,400	U _{lv} 1,07	1,1384
4	Sensitivity coefficient of sample gas pressure	≤	3,0 nmol/mol/kPa	0,000	U _{gp} 0,00	0,0000
5	Sensitivity coefficient of sample gas temperature	≤	1,0 nmol/mol/K	0,011	U _{gt} 0,08	0,0070
6	Sensitivity coefficient of surrounding temperature	≤	1,0 nmol/mol/K	-0,060	U _{st} -0,46	0,2091
7	Sensitivity coefficient of electrical voltage	≤	0,30 nmol/mol/V	0,010	U _v 0,10	0,0103
8a	H2O with concentration 21 mmol/mol	≤	10 nmol/mol	0,000	U _{eco} 0,00	0,0000
8b	H2S with concentration 200 nmol/mol	≤	5,0 nmol/mol	0,503	U _{rl,pos}	
8c	NH3 with concentration 200 nmol/mol	≤	5,0 nmol/mol	0,203		
8d	NO with concentration 500 nmol/mol	≤	5,0 nmol/mol	0,202	or 1,23	1,5129
8e	NO2 with concentration 200 nmol/mol	≤	5,0 nmol/mol	0,401		
8f	m-Xylol with concentration 1 µmol/mol	≤	10 nmol/mol	0,809	U _{rl,neg}	
9	Averaging effect	≤	7,0% of measured value	0,100	U _{av} 0,08	0,0058
10	Reproducibility under field conditions	≤	5,0% of the average of 3 Mon.	4,830	U _{r,f} 6,38	40,6483
11	Long term drift at zero level	≤	5,0 nmol/mol	1,160	U _{rl,z} 0,67	0,4485
12	Long term drift at span level	≤	5,0% of max. of certification range	-2,070	U _{rl,v} -1,58	2,4887
18	Differenz Proben-/Kalibergassengang	≤	1,0%	0,000	U _{pc} 0,00	0,0000
23	Unsicherheit Prüfgas	≤	3,0%	2,000	U _{pc} 1,32	1,7424
				combined standard uncertainty		U _c 6,9434
				expanded uncertainty		U _s 13,8869
				expanded uncertainty actual		U _{c,rel} 10,52
				expanded uncertainty required		U _{req,rel} 15

Table 9: Total expanded uncertainty with the results of the laboratory test according to EN 14625 (component O₃) for system 1329

Device: AR500		Serial No. Gerät 1 (1329)		hourly alert threshold		120		nmol/mol		
Measured component: O ₃										
No.	Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty					
1	Repeatability standard deviation at zero	1,0 nmol/mol	0,200	u _{r,z}	0,04	0,0013				
2	Repeatability standard deviation at ct	3,0 nmol/mol	0,600	u _{r,w}	0,11	0,0120				
3	"lack of fit" at the hourly alert threshold value	4,0% of measured value	0,400	u _{l,w}	0,28	0,0768				
4	Variations in sample gas pressure	2,0 nmol/mol/kPa	0,000	u _{gp}	0,00	0,0000				
5	Variations in sample gas temperature	1,0 nmol/mol/K	0,014	u _{gt}	0,15	0,0212				
6	Variations in surrounding temperature	1,0 nmol/mol/K	0,150	u _{st}	0,52	0,2700				
7	Variations in electrical voltage	0,30 nmol/mol/V	-0,010	u _v	-0,12	0,0147				
8a	Interference H2O with 21 nmol/mol	10 nmol/mol	0,000	u _{H2O}	0,00	0,0000				
8b	Interference Toluol with 0,5 µmol/mol	5,0 nmol/mol	2,147	u _{int,pos}	1,47	2,1573				
8c	Interference Xylol with 0,5 µmol/mol	5,0 nmol/mol	0,397	or u _{int,neg}						
9	Averaging effect	7,0% of measured value	0,200	u _{av}	0,14	0,0192				
18	Difference sample/calibration port	1,0%	0,000	u _{D,sc}	0,00	0,0000				
23	Uncertainty test gas	3,0%	2,000	ucg	1,20	1,4400				
				Combined standard uncertainty		u _c	2,0031	nmol/mol		
				Expanded uncertainty		U _c	4,0062	nmol/mol		
				Expanded uncertainty actual		U _{crel}	3,34	%		
				Expanded uncertainty required		U _{req,rel}	15	%		

Table 10: Total expanded uncertainty with the results of the laboratory test and field test according to EN 14625 (component O₃) for system 1329

Device: AR500		Serial No. Gerat 1 (1329)		hourly alert threshold 120 nmol/mol		
Measured component: O ₃		Performance characteristic	Criterion	Result	Uncertainty	Square of uncertainty
1	Repeatability standard deviation at zero	1.0 nmol/mol	1.0 nmol/mol	0.200	u _{r,z} 0.04	0.0013
2	Repeatability standard deviation at ct	3.0 nmol/mol	3.0 nmol/mol	0.600	u _{r,lv} not respected because: u _{r,lv} = 0.1 < u _{r,f}	-
3	"lack of fit" at the hourly alert threshold value	4.0% of measured value	4.0% of measured value	0.400	u _{lv} 0.28	0.0768
4	Variations in sample gas pressure	2.0 nmol/mol/kPa	2.0 nmol/mol/kPa	0.000	u _{gp} 0.00	0.0000
5	Variations in sample gas temperature	1.0 nmol/mol/K	1.0 nmol/mol/K	0.014	u _{gt} 0.15	0.0212
6	Variations in surrounding temperature	1.0 nmol/mol/K	1.0 nmol/mol/K	0.150	u _{st} 0.52	0.2700
7	Variations in electrical voltage	0.30 nmol/mol/V	0.30 nmol/mol/V	-0.010	u _v -0.12	0.0147
8a	Interference H2O with 21 mmol/mol	10 nmol/mol	10 nmol/mol	0.000	u _{H2O} 0.00	0.0000
8b	Interference Toluol with 0.5 µmol/mol	5.0 nmol/mol	5.0 nmol/mol	2.147	u _{toluol} 1.47	2.1573
8c	Interference Xylol with 0.5 µmol/mol	5.0 nmol/mol	5.0 nmol/mol	0.397	or u _{toluol, neg}	
9	Averaging effect	7.0% of measured value	7.0% of measured value	0.200	u _{av} 0.14	0.0192
10	Reproducibility standard deviation in field	5.0% of average of 3 month	5.0% of average of 3 month	2.410	u _{r,f} 2.89	8.3637
11	Long term drift at zero	5.0 nmol/mol	5.0 nmol/mol	1.460	u _{gl,z} 0.84	0.7105
12	Long term drift at span level	5.0% of range	5.0% of range	-2.450	u _{gl,lv} -1.70	2.8812
18	Difference sample/calibration port	1.0%	1.0%	0.000	u _{sc} 0.00	0.0000
23	Uncertainty test gas	3.0%	3.0%	2.000	ucg 1.20	1.4400
		Combined standard uncertainty	Combined standard uncertainty		u _c	3.9945
		Expanded uncertainty	Expanded uncertainty		U _c	7.9890
		Expanded uncertainty actual	Expanded uncertainty actual		U _{crit}	6.66
		Expanded uncertainty required	Expanded uncertainty required		U _{req/rel}	15

Table 11: Total expanded uncertainty with the results of the laboratory test according to EN 14625 (component O₃) for system 1330

Device: AR500		Serial No.	Gerät 2 (1330)	hourly alert threshold	120	nmol/mol
Measured component: O ₃		Criterion	Result	Uncertainty	Square of uncertainty	
1	Repeatability standard deviation at zero	1,0 nmol/mol	0,200	u _{r,z}	0,04	0,0013
2	Repeatability standard deviation at ct	3,0 nmol/mol	0,400	u _{r,lv}	0,07	0,0053
3	"lack of fit" at the hourly alert threshold value	4,0% of measured value	-0,300	u _{lv}	-0,21	0,0432
4	Variations in sample gas pressure	2,0 nmol/mol/kPa	0,000	u _{gp}	0,00	0,0000
5	Variations in sample gas temperature	1,0 nmol/mol/K	0,007	u _{gt}	0,07	0,0053
6	Variations in surrounding temperature	1,0 nmol/mol/K	-0,120	u _{st}	-0,42	0,1728
7	Variations in electrical voltage	0,30 nmol/mol/V	0,010	u _v	0,12	0,0147
8a	Interference H ₂ O with 21 nmol/mol	10 nmol/mol	0,000	u _{H₂O}	0,00	0,0000
8b	Interference Toluol with 0,5 µmol/mol	5,0 nmol/mol	0,396	u _{Int,pos}		
8c	Interference Xylol with 0,5 µmol/mol	5,0 nmol/mol	2,574	or u _{Int,neg}	1,72	2,9416
9	Averaging effect	7,0% of measured value	-0,900	u _{av}	-0,62	0,3888
18	Difference sample/calibration port	1,0%	0,000	u _{D,ss}	0,00	0,0000
23	Uncertainty test gas	3,0%	2,000	0	1,20	1,4400
		Combined standard uncertainty		u _c		2,2390
		Expanded uncertainty		U _e		4,4780
		Expanded uncertainty actual		U _{crel}		3,73
		Expanded uncertainty required		U _{req,rel}		15

Table 12: Total expanded uncertainty with the results of the laboratory test and field test according to EN 14625 (component O₃) for system 1330

Device: AR500		Serial No. Gerät 2 (1330)		hourly alert threshold		120		nmol/mol	
Measured component: O ₃		Performance characteristic		Criterion		Result		Uncertainty	
No.	Performance characteristic	Criterion	Result	U _{i,z}	U _i	Square of uncertainty			
1	Repeatability standard deviation at zero	1.0 nmol/mol	0.200	0.04	0.0013				
2	Repeatability standard deviation at ct	3.0 nmol/mol	0.400	not respected, because $u_{i,IV} = 0,07 < u_{i,f}$	-				
3	"lack of fit" at the hourly alert threshold value	4.0% of measured value	-0.300	U _{i,IV}	0.0432				
4	Variations in sample gas pressure	2.0 nmol/mol/kPa	0.000	U _{sp}	0.0000				
5	Variations in sample gas temperature	1.0 nmol/mol/K	0.007	U _{gt}	0.0053				
6	Variations in surrounding temperature	1.0 nmol/mol/K	-0.120	U _{st}	0.1728				
7	Variations in electrical voltage	0.30 nmol/mol/V	0.010	U _v	0.0147				
8a	Interference H ₂ O with 21 mmol/mol	10 nmol/mol	0.000	U _{H2O}	0.0000				
8b	Interference Toluol with 0.5 µmol/mol	5.0 nmol/mol	0.396	U _{int,pos}	2.9416				
8c	Interference Xylol with 0.5 µmol/mol	5.0 nmol/mol	2.574	or U _{int,neg}					
9	Averaging effect	7.0% of measured value	-0.900	U _{av}	0.3888				
10	Reproducibility standard deviation in field	5.0% of average of 3 month	2.410	U _{rf}	8.3637				
11	Long term drift at zero	5.0 nmol/mol	-1.840	U _{gl,z}	1.1285				
12	Long term drift at span level	5.0% of range	2.900	U _{gl,IV}	4.0368				
18	Difference sample/calibration port	1.0%	0.000	uDJsc	0.0000				
23	Uncertainty test gas	3.0%	2.000	0	1.4400				
		Combined standard uncertainty	U _c	U _c	4.3054				
		Expanded uncertainty	U _e	U _e	8.6109				
		Expanded uncertainty actual	U _{e,rel}	U _{e,rel}	7,18				
		Expanded uncertainty required	U _{req,rel}	U _{req,rel}	15				