Umwelt Bundesamt

Certificate number: 1797266-ts

TÜV SÜD Industrie Service

DAkkS Deutsche Akkreditierungsstelle D-PL-14153-03-00

CERTIFICATE

of product conformity (QAL 1)

Certificate number: 1797266-ts

AMS	Set CEM CERT 7MB1957 monitoring CO, NO, NO_x, SO_2 and O_2
Manufacturer	Siemens AG Östliche Rheinbrückenstraße 50 76187 Karlsruhe Germany
Test institute	TÜV SÜD Industrie Service GmbH

This is to certify that the AMS fulfils the requirements of the DIN EN 15267-1: 2009, DIN EN 15267-2: 2009, DIN EN 15267-3: 2008 and DIN EN 14181: 2004 standards.

This certificate replaces the certificates 1630664.4a-ts and 1630664.4b-ts dated 5th August 2014

DIN EN 15267 TÜV SÜD Eignungsprüfung Valid until 03/2018 Produktion überwacht

Certificate No.: 1797266-ts

Publication in the German Federal Gazette
dated 2nd April 2015

Certificate validity
until 4th March 2018

Umweltbundesamt
Dessau, 15th April 2015

p.p. Dr. Marcel Langner

TÜV SÜD Industrie Service GmbH
Testing laboratory Emission measurement/ calibration
Munich, 14th April 2015

Dr. Michael Waeber

TÜV®

CERTIFICATE ◆ 認証書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

Certification applies to the conditions listed in this certificate

Test report	1797266 from 18.09.2014
Initial certification	5th March 2013
Certificate validity until	4th March 2018 (5 years)
Publication	BAnz AT 02.04.2015 B5, chapter I, no. 4.1

Approved application

The AMS tested is suitable for plants in compliance with the 13th and 27th BImSchV and plants in compliance with TA Luft. The suitability of the AMS for this application was assessed on the basis of a laboratory test and a field test of the modular measuring system Set CEM CERT 7MB1957 lasting over three months at a plant in compliance with the 17th BImSchV. The modular measuring system is authorized for the ambient temperature range from +5 °C to +40 °C.

The AMS publication, the suitability test and the performance of the uncertainty calculations were based on the requirements valid at the time of testing. Due to possible amendments to the legal basics each user should ensure before use of the AMS that it is suitable to monitor the respective relevant limit values.

The AMS publication and the performance of the uncertainty calculations were based on the requirements valid at the time of testing.

The operator should consult the manufacturer to ensure that the AMS is suitable for the plant where it is being installed.

Certification basis

This certificate is based on:

- TÜV SÜD Industrie Service GmbH test report 1797266 from 18th September 2014
- Suitability publication by the Umweltbundesamt as responsible body
- Monitoring of the product and the manufacturing process
- Publication in the German Federal Gazette (BAnz AT 2nd April 2015 B5, chapter I, no. 4.1 and chapter IV 43. Notification, UBA publication from 25th February 2015).

AMS:	Set CEM CERT 7MB1957 monitoring CO, NO, NO_x, SO_2 and O_2
Manufacturer:	Siemens AG, Karlsruhe
Suitability:	Modular measuring system for plants in compliance with the 13th and 27th BImSchV and plants in compliance with TA Luft

Measurement ranges in the suitability test:

Ultramat 23-7MB2355 module				
Component	**Certification range**	**Additional measurement range**		**Unit**
CO	0 – 200	0 – 1250	-	mg/m³
NO_x	0 – 150 [1)] 0 – 230 [2)]	0 – 750 [1)] 0 – 1150 [2)]	0 – 2000 [1)] 0 – 3067 [2)]	mg/m³ mg/m³
SO_2	0 – 400	0 – 2000	0 – 7000	mg/m³
$O_{2\ paramagnetic}$	0 – 25	-	-	Vol.-%
$O_{2\ electrochemical}$	0 – 25	-	-	Vol.-%
Ultramat 23-7MB2357 module				
CO	0 – 200	0 – 1250	-	mg/m³
NO_x	0 – 150 [1)] 0 – 230 [2)]	0 – 750 [1)] 0 – 1150 [2)]	0 – 2000 [1)] 0 – 3067 [2)]	mg/m³ mg/m³
SO_2	0 – 400	0 – 2000	0 – 7000	mg/m³
$O_{2\ paramagnetic}$	0 – 25	-	-	Vol.-%
$O_{2\ electrochemical}$	0 – 25	-	-	Vol.-%
Ultramat 23-7MB2358 module				
CO	0 – 250	0 – 1250	-	mg/m³
NO_x	0 – 400 [1)] 0 – 613 [2)]	0 – 2000 [1)] 0 – 3067 [2)]	- -	mg/m³ mg/m³
SO_2	0 – 400	0 – 2000	0 – 7000	mg/m³
$O_{2\ paramagnetic}$	0 – 25	-	-	Vol.-%
$O_{2\ electrochemical}$	0 – 25	-	-	Vol.-%

[1)] stated as NO
[2)] stated as NO_2

Measurement ranges for the modular system Set CEM CERT 7MB1957 in the suitability test:

Component	Module variation	Certification range	Additional measurement range		Unit
CO	Ultramat 23-7MB2355 – Z – T13	0 – 200	0 – 1250	-	mg/m³
	Ultramat 23-7MB2357 – Z – T13	0 – 200	0 – 1250	-	mg/m³
	Ultramat 23-7MB2358 – Z – T13	0 – 250	0 – 1250	-	mg/m³
	Ultramat 23-7MB2355 – Z – T23	0 – 200	0 – 1250	-	mg/m³
	Ultramat 23-7MB2357 – Z – T23	0 – 200	0 – 1250	-	mg/m³
	Ultramat 23-7MB2358 – Z – T23	0 – 250	0 – 1250	-	mg/m³
	Ultramat 23-7MB2355 – Z – T33	0 – 200	0 – 1250	-	mg/m³
	Ultramat 23-7MB2357 – Z – T33	0 – 200	0 – 1250	-	mg/m³
NO_x	Ultramat 23-7MB2355 – Z – T13	0 – 150 [1] 0 – 230 [2]	0 – 750 [1] 0 – 1150 [2]	0 – 2000 [1] 0 – 3067 [2]	mg/m³
	Ultramat 23-7MB2357 – Z – T13	0 – 150 [1] 0 – 230 [2]	0 – 750 [1] 0 – 1150 [2]	0 – 2000 [1] 0 – 3067 [2]	mg/m³
	Ultramat 23-7MB2358 – Z – T13	0 – 400 [1] 0 – 613 [2]	0 – 2000 [1] 0 – 3067 [2]	-	mg/m³
	Ultramat 23-7MB2355 – Z – T23	0 – 150 [1] 0 – 230 [2]	0 – 750 [1] 0 – 1150 [2]	0 – 2000 [1] 0 – 3067 [2]	mg/m³
	Ultramat 23-7MB2357 – Z – T23	0 – 150 [1] 0 – 230 [2]	0 – 750 [1] 0 – 1150 [2]	0 – 2000 [1] 0 – 3067 [2]	mg/m³
	Ultramat 23-7MB2358 – Z – T23	0 – 400 [1] 0 – 613 [2]	0 – 2000 [1] 0 – 3067 [2]	-	mg/m³
	Ultramat 23-7MB2355 – Z – T33	0 – 150 [1] 0 – 230 [2]	0 – 750 [1] 0 – 1150 [2]	0 – 2000 [1] 0 – 3067 [2]	mg/m³
	Ultramat 23-7MB2357 – Z – T33	0 – 150 [1] 0 – 230 [2]	0 – 750 [1] 0 – 1150 [2]	0 – 2000 [1] 0 – 3067 [2]	mg/m³
SO_2	Ultramat 23-7MB2355 – Z – T13	0 – 400	0 – 2000	0 – 7000	mg/m³
	Ultramat 23-7MB2357 – Z – T13	0 – 400	0 – 2000	0 – 7000	mg/m³
	Ultramat 23-7MB2358 – Z – T13	0 – 400	0 – 2000	0 – 7000	mg/m³
	Ultramat 23-7MB2355 – Z – T23	0 – 400	0 – 2000	0 – 7000	mg/m³
	Ultramat 23-7MB2357 – Z – T23	0 – 400	0 – 2000	0 – 7000	mg/m³
	Ultramat 23-7MB2358 – Z – T23	0 – 400	0 – 2000	0 – 7000	mg/m³
	Ultramat 23-7MB2355 – Z – T33	0 – 400	0 – 2000	0 – 7000	mg/m³
	Ultramat 23-7MB2357 – Z – T33	0 – 400	0 – 2000	0 – 7000	mg/m³
O_2 paramagnetic	Ultramat 23-7MB2355 – Z – T13	0 – 25	-	-	
	Ultramat 23-7MB2357 – Z – T13	0 – 25	-	-	
	Ultramat 23-7MB2358 – Z – T13	0 – 25	-	-	
O_2 electrochemical	Ultramat 23-7MB2355 – Z – T23	0 – 25	-	-	
	Ultramat 23-7MB2357 – Z – T23	0 – 25	-	-	
	Ultramat 23-7MB2358 – Z – T23	0 – 25	-	-	

[1] stated as NO
[2] stated as NO_2

The suitability test of the system Set CEM CERT 7 MB1957 covers three modules that are equipped to measure the following components respectively:

Module variation	Component 1	Component 2	Component 3	Component 4
Ultramat 23-7MB2355 – Z – T13 [1]	CO	NO	SO_2	O_2 paramagnetic
Ultramat 23-7MB2355 – Z – T23 [1]	CO	NO	SO_2	O_2 electrochemical
Ultramat 23-7MB2355 – Z – T33 [1]	CO	NO	SO_2	-
Ultramat 23-7MB2357 – Z – T13 [2]	CO	NO	SO_2	O_2 paramagnetic
Ultramat 23-7MB2357 – Z – T23 [2]	CO	NO	SO_2	O_2 electrochemical
Ultramat 23-7MB2357 – Z – T33 [2]	CO	NO	SO_2	-
Ultramat 23-7MB2358 – Z – T13 [3]	CO	NO	SO_2	O_2 paramagnetic
Ultramat 23-7MB2358 – Z – T23 [3]	CO	NO	SO_2	O_2 electrochemical

[1] one component from 1 to 3 respectively
[2] two components from 1 to 3 respectively
[3] all three components from 1 to 3 respectively

Software versions:

Ultramat 23-7MB2355:	2.15.00
Ultramat 23-7MB2357:	2.15.00
Ultramat 23-7MB2358:	2.15.05
SPS:	Set CEM CERT Rev. 1.0

Restrictions:

1. The requirement for total uncertainty in the suitability test according to DIN EN 15267 was not fulfilled for the component CO and only partly fulfilled for the component SO_2.
2. The protection provided by enclosure class is only IP 20. If the operating conditions require a higher class the analysis module shall be incorporated into an analysis cabinet with the relevant protection class.

Notes:

1. The AMS should be operated at an interval of 24 h for automatic alignment.
2. To optimise the cross-sensitivity at the measurement channel CO with CO_2, the Ultramat 23-7MB2355, Ultramat 23-7MB2357 and Ultramat 23-7MB2358 modules from the Set CEM CERT 7MB1957 AMS will be operated with a modified CO receiver from the production month April 2014, identified with the series number from E4 onwards in the central block.
3. The analyser should be operated with the activated thermo-AUTOCAL-function.
4. The modular measurement system Set CEM CERT 7MB1957 can alternatively be fitted with a measurement gas sampling probe (SP2000-H) from M&C TechGroup Germany GmbH and a measurement gas cooler (EGK 2-19) from Bühler Technologies GmbH.
5. The modular measurement system Set CEM CERT 7MB1957 is fitted with a NO_x-converter from M&C TechGroup Germany GmbH, type gas converter CG-2, for detecting NO_x.
6. The maintenance interval for the Ultramat 23-7MB2358 module is three months. In the case of an extension of the Set CEM CERT 7MB1957 by adding additional modules the functionality of the respective compilation of the modules should be tested within the framework of the test for proper installation and the maintenance interval should be set.

7. The maintenance interval for the Ultramat 23-7MB2355 and Ultramat 23-7MB2357 modules is four weeks. In the case of an extension of the Set CEM CERT 7MB1957 by adding additional modules the functionality of the respective compilation of the modules should be tested within the framework of the test for proper installation and the maintenance interval should be set.

8. Supplementary test to the publication by the Umweltbundesamt from 17th July 2014 (BAnz AT 05.08.2014 B11, chapter I number 5.3 and 5.4 as well as chapter V 3. Notification).

Test report:	TÜV SÜD Industrie Service GmbH, Munich Report-No.: 1797266 from 18th September 2014

Notification on the publication from the Umweltbundesamt dated 17th July 2014 (BAnz AT 05.08.2014 B11, chapter I number 5.3 and 5.4 and chapter V 3. Notification)

43	The current software-version for the Ultramat 23-7MB2358 module from the modular AMS Set CEM CERT 7MB1957 for CO, NO, NO_x, SO_2 and O_2 from Siemens AG is 2.15.05. TÜV Süd Industrie Service GmbH statement from 18th September 2014

Certified product

The certificate applies to AMS that comply with the following description:

The entire tested modular AMS consists of a heated sample gas extraction probe, heated sample hose, a dual-level measurement gas cooler, a measurement gas feeder pump and of a maximum of two analyser modules Ultramat 23-7MB2355, Ultramat 23-7MB2357 and Ultramat 23-7MB2358. The modular AMS measures CO, NO, SO_2 and O_2 according to the principle of non-dispersive-infrared-absorption (NDIR procedure). Either an electrochemical or paramagnetic oxygen measurement cell can be used to measure O_2.

To regulate measurement gas flow there is a measurement gas pipe with integrated gas recirculation between the first and second cooler level. In the cooler casing there is another fine filter for separating fine dust. After the measurement gas cooler the gas path separates into two pipe sections, each supplying one analyser module with measurement gas. In each of these pipe section currents there is a condensation filter directly before the analyser module, which closes the gas path on penetration of any humidity, to protect the analyser. The (heated) converter is switched on before the condensation filter to measure NO_x. To regulate zero/sample gas there is a three way valve between the first and second cooler level, which can be switched on to automatically align the analyser or can be time controlled using programmable logic controller (PLC).

The entire system is made up of the following components:

Probe		
Manufacturer:	Bühler Technologies GmbH, D - 40880 Ratingen	
Type:	GAS 222.20-Cal-twin with ceramic filter	
Alternative Probe		
Manufacturer:	M&C TechGroup Germany GmbH, D - 40885 Ratingen	
Type:	SP2000-H with ceramic filter	
Controller:	M&C TechGroup Germany GmbH, D - 40885 Ratingen	
Heated sampling hose		
Manufacturer:	Winkler GmbH, D-69126 Heidelberg	
Heated temperature:	180 °C, 2 PTFE connection (ID: 4 mm), heated to 180 °C, length in the suitability test 35 m	
Controller		
Manufacturer:	Siemens AG	
Type:	SIRIUS, PT 100	
Compressor cooler		
Manufacturer:	M&C TechGroup Germany GmbH, D - 40885 Ratingen	
Type:	CSS V1-S	
Alternative compressor cooler		
Manufacturer:	Bühler Technologies GmbH, D-40880 Ratingen	
Type:	EGK 2-19	
Measurement gas feeder pump		
Manufacturer:	Bühler Technologies GmbH, D-40880 Ratingen	
Type:	P 2.3	
NO_x converter		
Manufacturer:	M&C TechGroup Germany GmbH, D - 40885 Ratingen	
Type:	Gas converter CG-2	
Analyser	Ultramat 23-7MB2355	
	Software version	2.15.00
	Ultramat 23-7MB2357	
	Software version	2.15.00
	Ultramat 23-7MB2358	
	Software version	2.15.05
	Software version SPS	Set CEM CERT Rev. 1.0

General comments

This certificate is based on the analyser tested. The manufacturer is responsible for the continuous compliance of the production to the DIN EN 15267 requirements. The manufacturer is obliged to maintain a tested quality management system to control the manufacture of the certified product. Regular monitoring must be conducted on both the product and the quality management systems.

Should the product from the current production series no longer comply with the certified product, the Environmental Service Department of TÜV SÜD Industrie Service GmbH should be informed (Address see footnote).

The certification mark, which appears on the certified product or is used in advertising materials, is presented on page 1 of this certificate.

This document and the certification mark shall remain the property of TÜV SÜD Industrie Service GmbH.

Should the publication be revoked, this certificate will become invalid. This document must be returned when the period of validity has elapsed and at the request of TÜV SÜD Industrie Service GmbH and the certification mark may no longer be used.

The current version of the certificate and its validity can also be viewed on the internet page: **qal1.de**.

The certification of the modular measuring system Set CEM CERT 7MB1957 is based on the following documents and the regular continuous monitoring of the manufacturer's quality management system:

Initial certification to DIN EN 15267:

Certificate No. 1630664-ts	5th March 2013
Certificate validity until	4th March 2018 (5 years)

Test report: 1630664 from 15th September 2012,
TÜV SÜD Industrie Service GmbH
Publication: BAnz AT 05.03.2013 B10, chapter I no. 6.1
UBA publication from 12th February 2013

Supplementary test to DIN EN 15267:

Certificate No. 1630664.2-ts	23rd July 2013
Certificate validity until	4th March 2018 (5 years)

Test report: 1630664-2 from 15th March 2013,
TÜV SÜD Industrie Service GmbH
Publication: BAnz AT 23.07.2013 B4, chapter I, no. 4.1
UBA publication from 3rd July 2013

Supplementary test to DIN EN 15267:

Certificate No. 1630664.3-ts	1st April 2014
Certificate validity until	4th March 2018 (5 years)

Test report: 1630664-3 from 18th December 2013,
TÜV SÜD Industrie Service GmbH
Publication: BAnz AT 01.04.2014 B12, chapter I, no. 4.2
UBA publication from 27th February 2014

Supplementary test to DIN EN 15267:

Certificate No. 1630664.4a-ts	5th August 2014
Certificate validity until	4th March 2018 (5 years)

Test report: 1630664-4a from 28th February 2014,
TÜV SÜD Industrie Service GmbH
Publication: BAnz AT 05.08.2014 B11, chapter I, no. 5.3
UBA publication from 17th July 2014

Supplementary test to DIN EN 15267:

Certificate No. 1630664.4b-ts	5th August 2014
Certificate validity until	4th March 2018 (5 years)

Test report: 1630664-4b from 28th February 2014,
TÜV SÜD Industrie Service GmbH
Publication: BAnz AT 05.08.2014 B11, chapter I, no. 5.4
UBA publication from 17th July 2014

Supplementary test to DIN EN 15267:

Certificate No. 1797266-ts	14th April 2015
Certificate validity until	4th March 2018 (5 years)

Test report: 1797266 from 18th September 2014,
TÜV SÜD Industrie Service GmbH
Publication: BAnz AT 02.04.2015 B5, chapter I, no. 4.1
UBA publication from 25th February 2015

Notifications:

TÜV Süd Industrie Service GmbH statement from 17th March 2013
Publication: BAnz AT 23.07.2013 B4, chapter V, notification 26 (new software)
UBA publication from 3rd July 2013

TÜV Süd Industrie Service GmbH statement from19th March 2014
Publication: BAnz AT 05.08.2014 B11, chapter V, notification 3 (new software)
UBA publication from 17th July 2014

TÜV Süd Industrie Service GmbH statement from 18th September 2015
Publication: BAnz AT 02.04.2015 B5, chapter IV, notification 43 (new software)
UBA publication from 25th February 2015

Calculation of total uncertainty for QAL1 testing to DIN EN 14181 and DIN EN 15267-3 for the Ultramat 23-7MB2358 module

Total uncertainty for the measurement component CO in the measurement range 0-250 mg/m³ for modules 1/ 2

Performance characteristic	*Uncertainty*	*Value of standard uncertainty in mg/m³*	*Square sum of standard uncertainty in (mg/m³)²*
Lack-of-fit	u_{lof}	0,678	0,4597
Zero point drift	$u_{d,z}$	1,443	2,0822
Span point drift	$u_{d,s}$	1,443	2,0822
Influence of ambient temperature at span point	u_t	0,781	0,61
Influence of sample gas pressure	u_p		
Influence of sample gas flow	u_f	-0,217	0,0471
Influence of voltage	u_v	1,392	1,9377
Cross-sensitivity	u_i	2,165	4,6872
Repeatability standard deviation at span point	$u_r = s_r$	0,094	ur < du
Standard deviation from paired measurements	$u_d = s_d$	1,656	2,7423
Uncertainty of the test gas (2% at 70% CR)	u_{rm}	2,0207	4,0832
Excursion of measurement beam	u_{mb}		
Converter efficiency for NOx	u_{ce}		
Response factors (TOC)	u_{rf}		
		Sum	18,7316
Combined standard uncertainty	$u_c = \sqrt{\sum (u_i)^2}$	4,328	mg/m³
Expanded uncertainty	$U_{0,95} = 1,96 \times u_c$	8,4829	mg/m³
Relative expanded uncertainty	U	8,5	%ELV
Demanded uncertainty according to EN 15267-3	(at ELV 100 mg/m³)	7,5	%ELV
Requirement concerning uncertainty fulfilled		no	concerning to EN 15267-3
Demanded uncertainty 13. / 17. BImSchV	(at ELV 100 mg/m³)	10	%ELV
Requirement concerning uncertainty fulfilled		yes	concerning to 13. / 17. BImSchV

Total uncertainty for the measurement component NO in the measurement range 0-400 mg/m³ for modules 1/ 2

Performance characteristic	*Uncertainty*	*Value of standard uncertainty in mg/m³*	*Square sum of standard uncertainty in (mg/m³)²*
Lack-of-fit	u_{lof}	-0,393	0,1544
Zero point drift	$u_{d,z}$	3,233	10,4523
Span point drift	$u_{d,s}$	3,695	13,653
Influence of ambient temperature at span point	u_t	2,177	4,7393
Influence of sample gas pressure	u_p		
Influence of sample gas flow	u_f	0,277	0,0767
Influence of voltage	u_v	1,688	2,8493
Cross-sensitivity	u_i	-6,928	47,9972
Repeatability standard deviation at span point	$u_r = s_r$	0,232	ur < du
Standard deviation from paired measurements	$u_d = s_d$	1,750	3,0625
Uncertainty of the test gas (2% at 70% CR)	u_{rm}	3,233	10,4536
Excursion of measurement beam	u_{mb}		
Converter efficiency for NOx	u_{ce}		
Response factors (TOC)	u_{rf}		
		Sum	93,4383
Combined standard uncertainty	$u_c = \sqrt{\sum (u_i)^2}$	9,6663	mg/m³
Expanded uncertainty	$U_{0,95} = 1,96 \times u_c$	18,9459	mg/m³
Relative expanded uncertainty	U	**14,5**	%ELV
Demanded uncertainty according to EN 15267-3	(at ELV 130,4 mg/m³)	**15**	%ELV
Requirement concerning uncertainty fulfilled		**yes**	concerning to EN 15267-3
Demanded uncertainty 13. / 17. BImSchV	(at ELV 130,4 mg/m³)	**20**	%ELV
Requirement concerning uncertainty fulfilled		**yes**	concerning to 13. / 17. BImSchV

Total uncertainty for the measurement component SO_2 in the measurement range 0-400 mg/m³ for modules 1/ 2

Performance characteristic	*Uncertainty*	*Value of standard uncertainty in mg/m³*	*Square sum of standard uncertainty in (mg/m³)²*
Lack-of-fit	u_{lof}	2,102	4,4184
Zero point drift	$u_{d,z}$	6,235	38,8752
Span point drift	$u_{d,s}$	4,85	23,5225
Influence of ambient temperature at span point	u_t	6,498	42,224
Influence of sample gas pressure	u_p		
Influence of sample gas flow	u_f	-2,215	4,9062
Influence of voltage	u_v	2,217	4,9151
Cross-sensitivity	u_i	-6,928	47,9972
Repeatability standard deviation at span point	$u_r = s_r$	0,794	ur < du
Standard deviation from paired measurements	$u_d = s_d$	2,475	6,1256
Uncertainty of the test gas (2% at 70% CR)	u_{rm}	3,2332	10,4536
Excursion of measurement beam	u_{mb}		
Converter efficiency for NOx	u_{ce}		
Response factors (TOC)	u_{rf}		
		Sum	183,4378
Combined standard uncertainty	$u_c = \sqrt{\sum (u_i)^2}$	13,5439	mg/m³
Expanded uncertainty	$U_{0,95} = 1,96 \times u_c$	26,546	mg/m³
Relative expanded uncertainty	U	13,3	%ELV
Demanded uncertainty according to EN 15267-3	(at ELV 200 mg/m³)	15	%ELV
Requirement concerning uncertainty fulfilled		yes	concerning to EN 15267-3
Demanded uncertainty 13. / 17. BImSchV	(at ELV 200 mg/m³)	20	%ELV
Requirement concerning uncertainty fulfilled		yes	concerning to 13. / 17. BImSchV

Total uncertainty for the measurement component O_2 in the measurement range 0-25 Vol.-% (in the version with paramagnetic oxygen measurement) for modules 1 / 2

Performance characteristic	*Uncertainty*	*Value of standard uncertainty in mg/m³*	*Square sum of standard uncertainty in (mg/m³)²*
Lack-of-fit	u_{lof}	0,017	0,0003
Zero point drift	$u_{d,z}$	-0,092	0,0085
Span point drift	$u_{d,s}$	-0,081	0,0066
Influence of ambient temperature at span point	u_t	0,044	0,0019
Influence of sample gas pressure	u_p		
Influence of sample gas flow	u_f	-0,017	0,0003
Influence of voltage	u_v	0,051	0,0026
Cross-sensitivity	u_i	0,162	0,0262
Repeatability standard deviation at span point	$u_r = s_r$	0,012	ur < du
Standard deviation from paired measurements	$u_d = s_d$	0,081	0,0066
Uncertainty of the test gas (2% at 70% CR)	u_{rm}	0,230	0,0529
Excursion of measurement beam	u_{mb}		
Converter efficiency for NOx	u_{ce}		
Response factors (TOC)	u_{rf}		
		Sum	0,1059
Combined standard uncertainty	$u_c = \sqrt{\sum (u_i)^2}$	0,3254	Vol.%
Expanded uncertainty	$U_{0,95} = 1,96 \times u_c$	0,6378	Vol.%
Relative expanded uncertainty	U	2,6	%ELV
Demanded uncertainty according to EN 15267-3	(at ELV 25 Vol.%)	7,5	%ELV
Requirement concerning uncertainty fulfilled		yes	concerning to EN 15267-3
Demanded uncertainty 13. / 17. BImSchV	(at ELV 25 Vol.%)	10	%ELV
Requirement concerning uncertainty fulfilled		yes	concerning to 13. / 17. BImSchV

Total uncertainty for the measurement component CO in the measurement range 0-250 mg/m³ for modules 3/ 4

Performance characteristic	*Uncertainty*	*Value of standard uncertainty in mg/m³*	*Square sum of standard uncertainty in (mg/m³)²*
Lack-of-fit	u_{lof}	0,678	0,4597
Zero point drift	$u_{d,z}$	1,443	2,0822
Span point drift	$u_{d,s}$	1,443	2,0822
Influence of ambient temperature at span point	u_t	1,285	1,6512
Influence of sample gas pressure	u_p		
Influence of sample gas flow	u_f	-0,303	0,0918
Influence of voltage	u_v	1,568	2,4586
Cross-sensitivity	u_i	2,165	4,6872
Repeatability standard deviation at span point	$u_r = s_r$	0,094	ur < du
Standard deviation from paired measurements	$u_d = s_d$	1,656	2,7423
Uncertainty of the test gas (2% at 70% CR)	u_{rm}	2,0207	4,0832
Excursion of measurement beam	u_{mb}		
Converter efficiency for NOx	u_{ce}		
Response factors (TOC)	u_{rf}		
		Sum	20,3384
Combined standard uncertainty	$u_c = \sqrt{\sum (u_i)^2}$	4,5098	mg/m³
Expanded uncertainty	$U_{0,95} = 1,96 \times u_c$	8,8392	mg/m³
Relative expanded uncertainty	U	8,8	%ELV
Demanded uncertainty according to EN 15267-3	(at ELV 100 mg/m³)	7,5	%ELV
Requirement concerning uncertainty fulfilled		no	concerning to EN 15267-3
Demanded uncertainty 13. / 17. BImSchV	(at ELV 100 mg/m³)	10	%ELV
Requirement concerning uncertainty fulfilled		yes	concerning to 13. / 17. BImSchV

Total uncertainty for the measurement component NO in the measurement range 0-400 mg/m³ for modules 3/ 4

Performance characteristic	*Uncertainty*	*Value of standard uncertainty in mg/m³*	*Square sum of standard uncertainty in (mg/m³)²*
Lack-of-fit	u_{lof}	-0,393	0,1544
Zero point drift	$u_{d,z}$	3,233	10,4523
Span point drift	$u_{d,s}$	3,695	13,653
Influence of ambient temperature at span point	u_t	1,712	2,9309
Influence of sample gas pressure	u_p		
Influence of sample gas flow	u_f	0,531	0,282
Influence of voltage	u_v	2,824	7,975
Cross-sensitivity	u_i	-6,928	47,9972
Repeatability standard deviation at span point	$u_r = s_r$	0,232	ur < du
Standard deviation from paired measurements	$u_d = s_d$	1,750	3,0625
Uncertainty of the test gas (2% at 70% CR)	u_{rm}	3,233	10,4536
Excursion of measurement beam	u_{mb}		
Converter efficiency for NOx	u_{ce}		
Response factors (TOC)	u_{rf}		
		Sum	96,9609
Combined standard uncertainty	$u_c = \sqrt{\sum (u_i)^2}$	9,8469	mg/m³
Expanded uncertainty	$U_{0,95} = 1,96 \times u_c$	19,2999	mg/m³
Relative expanded uncertainty	U	**14,8**	%ELV
Demanded uncertainty according to EN 15267-3	(at ELV 130,4 mg/m³)	**15**	%ELV
Requirement concerning uncertainty fulfilled		**yes**	concerning to EN 15267-3
Demanded uncertainty 13. / 17. BImSchV	(at ELV 130,4 mg/m³)	**20**	%ELV
Requirement concerning uncertainty fulfilled		**yes**	concerning to 13. / 17. BImSchV

Total uncertainty for the measurement component SO_2 in the measurement range 0-400 mg/m³ for modules 3/ 4

Performance characteristic	*Uncertainty*	*Value of standard uncertainty in mg/m³*	*Square sum of standard uncertainty in (mg/m³)²*
Lack-of-fit	u_{lof}	2,102	4,4184
Zero point drift	$u_{d,z}$	6,235	38,8752
Span point drift	$u_{d,s}$	4,85	23,5225
Influence of ambient temperature at span point	u_t	9,96	99,2016
Influence of sample gas pressure	u_p		
Influence of sample gas flow	u_f	-2,215	4,9062
Influence of voltage	u_v	2,564	6,5741
Cross-sensitivity	u_i	-6,928	47,9972
Repeatability standard deviation at span point	$u_r = s_r$	0,794	ur < du
Standard deviation from paired measurements	$u_d = s_d$	2,475	6,1256
Uncertainty of the test gas (2% at 70% CR)	u_{rm}	3,2332	10,4536
Excursion of measurement beam	u_{mb}		
Converter efficiency for NOx	u_{ce}		
Response factors (TOC)	u_{rf}		
		Sum	242,0744
Combined standard uncertainty	$u_c = \sqrt{\sum (u_i)^2}$	15,5587	mg/m³
Expanded uncertainty	$U_{0,95} = 1,96 \times u_c$	30,4951	mg/m³
Relative expanded uncertainty	U	15,2	%ELV
Demanded uncertainty according to EN 15267-3	(at ELV 200 mg/m³)	15	%ELV
Requirement concerning uncertainty fulfilled		no	concerning to EN 15267-3
Demanded uncertainty 13. / 17. BImSchV	(at ELV 200 mg/m³)	20	%ELV
Requirement concerning uncertainty fulfilled		yes	concerning to 13. / 17. BImSchV

Total uncertainty for the measurement component O_2 in the measurement range 0-25 Vol.-% (in the version with electrochemical oxygen measurement) for modules 3/ 4

Performance characteristic	*Uncertainty*	*Value of standard uncertainty in mg/m³*	*Square sum of standard uncertainty in (mg/m³)²*
Lack-of-fit	u_{lof}	0,035	0,0012
Zero point drift	$u_{d,z}$	0,167	0,0279
Span point drift	$u_{d,s}$	0,098	0,0096
Influence of ambient temperature at span point	u_t	0,021	0,0004
Influence of sample gas pressure	u_p		
Influence of sample gas flow	u_f	-0,029	0,0008
Influence of voltage	u_v	0,009	0,0001
Cross-sensitivity	u_i	0,167	0,0279
Repeatability standard deviation at span point	$u_r = s_r$	0,016	ur < du
Standard deviation from paired measurements	$u_d = s_d$	0,056	0,0031
Uncertainty of the test gas (2% at 70% CR)	u_{rm}	0,230	0,0529
Excursion of measurement beam	u_{mb}		
Converter efficiency for NOx	u_{ce}		
Response factors (TOC)	u_{rf}		
		Sum	0,1239
Combined standard uncertainty	$u_c = \sqrt{\sum (u_i)^2}$	0,352	Vol.%
Expanded uncertainty	$U_{0,95} = 1,96 \times u_c$	0,6899	Vol.%
Relative expanded uncertainty	U	2,8	%ELV
Demanded uncertainty according to EN 15267-3	(at ELV 25 Vol.%)	7,5	%ELV
Requirement concerning uncertainty fulfilled		yes	concerning to EN 15267-3
Demanded uncertainty 13. / 17. BImSchV	(at ELV 25 Vol.%)	10	%ELV
Requirement concerning uncertainty fulfilled		yes	concerning to 13. / 17. BImSchV

Calculation of total uncertainty for QAL1 testing to DIN EN 14181 and DIN EN 15267-3 for the Ultramat 23-7MB2355 and Ultramat 23-7MB 2357 modules

Total uncertainty for the measurement component CO in the measurement range 0-200 mg/m³

Performance characteristic	*Uncertainty*	*Value of standard uncertainty in mg/m³*	*Square sum of standard uncertainty in (mg/m³)²*
Lack-of-fit	u_{lof}	-0,254	0,0645
Zero point drift	$u_{d,z}$	1,155	1,334
Span point drift	$u_{d,s}$	1,27	1,6129
Influence of ambient temperature at span point	u_t	0,578	0,3341
Influence of sample gas pressure	u_p		
Influence of sample gas flow	u_f	-0,107	0,0114
Influence of voltage	u_v	0,484	0,2343
Cross-sensitivity	u_i	1,998	3,992
Repeatability standard deviation at span point	$u_r = s_r$	0,107	ur < du
Standard deviation from paired measurements	$u_d = s_d$	0,588	0,3457
Uncertainty of the test gas (2% at 70% CR)	u_{rm}	1,6166	2,6134
Excursion of measurement beam	u_{mb}		
Converter efficiency for NOx	u_{ce}		
Response factors (TOC)	u_{rf}		
		Sum	10,5423
Combined standard uncertainty	$u_c = \sqrt{\sum (u_i)^2}$	3,2469	mg/m³
Expanded uncertainty	$U_{0,95} = 1,96 \times u_c$	6,3639	mg/m³
Relative expanded uncertainty	U	**6,4**	%ELV
Demanded uncertainty according to EN 15267-3	(at ELV 100 mg/m³)	**7,5**	%ELV
Requirement concerning uncertainty fulfilled		**yes**	concerning to EN 15267-3
Demanded uncertainty 13. / 17. BImSchV	(at ELV 100 mg/m³)	**10**	%ELV
Requirement concerning uncertainty fulfilled		**yes**	concerning to 13. / 17. BImSchV

Total uncertainty for the measurement component NO in the measurement range 0-150 mg/m³

Performance characteristic	*Uncertainty*	*Value of standard uncertainty in mg/m³*	*Square sum of standard uncertainty in (mg/m³)²*
Lack-of-fit	u_{lof}	-0,719	0,517
Zero point drift	$u_{d,z}$	0,779	0,6068
Span point drift	$u_{d,s}$	2,252	5,0715
Influence of ambient temperature at span point	u_t	0,585	0,3422
Influence of sample gas pressure	u_p		
Influence of sample gas flow	u_f	0,381	0,1452
Influence of voltage	u_v	1,108	1,2277
Cross-sensitivity	u_i	-3,464	11,9993
Repeatability standard deviation at span point	$u_r = s_r$	0,335	ur < du
Standard deviation from paired measurements	$u_d = s_d$	0,619	0,3832
Uncertainty of the test gas (2% at 70% CR)	u_{rm}	1,212	1,4699
Excursion of measurement beam	u_{mb}		
Converter efficiency for NOx	u_{ce}		
Response factors (TOC)	u_{rf}		
		Sum	21,7628
Combined standard uncertainty	$u_c = \sqrt{\sum (u_i)^2}$	4,6651	mg/m³
Expanded uncertainty	$U_{0,95} = 1,96 \times u_c$	9,1436	mg/m³
Relative expanded uncertainty	U	**14,0**	%ELV
Demanded uncertainty according to EN 15267-3	(at ELV 65,2 mg/m³)	**15**	%ELV
Requirement concerning uncertainty fulfilled		**yes**	concerning to EN 15267-3
Demanded uncertainty 13. / 17. BImSchV	(at ELV 65,2 mg/m³)	**20**	%ELV
Requirement concerning uncertainty fulfilled		**yes**	concerning to 13. / 17. BImSchV

Total uncertainty for the measurement component O_2 in the measurement range 0-25 Vol.-% (in the version with paramagnetic oxygen measurement)

Performance characteristic	*Uncertainty*	*Value of standard uncertainty in mg/m³*	*Square sum of standard uncertainty in (mg/m³)²*
Lack-of-fit	u_{lof}	0,017	0,0003
Zero point drift	$u_{d,z}$	-0,092	0,0085
Span point drift	$u_{d,s}$	-0,081	0,0066
Influence of ambient temperature at span point	u_t	0,044	0,0019
Influence of sample gas pressure	u_p		
Influence of sample gas flow	u_f	-0,017	0,0003
Influence of voltage	u_v	0,051	0,0026
Cross-sensitivity	u_i	0,162	0,0262
Repeatability standard deviation at span point	$u_r = s_r$	0,012	ur < du
Standard deviation from paired measurements	$u_d = s_d$	0,081	0,0066
Uncertainty of the test gas (2% at 70% CR)	u_{rm}	0,230	0,0529
Excursion of measurement beam	u_{mb}		
Converter efficiency for NOx	u_{ce}		
Response factors (TOC)	u_{rf}		
		Sum	0,1059
Combined standard uncertainty	$u_c = \sqrt{\sum (u_i)^2}$	0,3254	Vol.%
Expanded uncertainty	$U_{0,95} = 1,96 \times u_c$	0,6378	Vol.%
Relative expanded uncertainty	U	2,6	%ELV
Demanded uncertainty according to EN 15267-3	(at ELV 25 Vol.%)	7,5	%ELV
Requirement concerning uncertainty fulfilled		yes	concerning to EN 15267-3
Demanded uncertainty 13. / 17. BImSchV	(at ELV 25 Vol.%)	10	%ELV
Requirement concerning uncertainty fulfilled		yes	concerning to 13. / 17. BImSchV

Total uncertainty for the measurement component O_2 in the measurement range 0-25 Vol.-% (in the version with electrochemical oxygen measurement)

Performance characteristic	*Uncertainty*	*Value of standard uncertainty in mg/m³*	*Square sum of standard uncertainty in (mg/m³)²*
Lack-of-fit	u_{lof}	0,035	0,0012
Zero point drift	$u_{d,z}$	0,167	0,0279
Span point drift	$u_{d,s}$	0,098	0,0096
Influence of ambient temperature at span point	u_t	0,021	0,0004
Influence of sample gas pressure	u_p		
Influence of sample gas flow	u_f	-0,029	0,0008
Influence of voltage	u_v	0,009	0,0001
Cross-sensitivity	u_i	0,167	0,0279
Repeatability standard deviation at span point	$u_r = s_r$	0,016	ur < du
Standard deviation from paired measurements	$u_d = s_d$	0,056	0,0031
Uncertainty of the test gas (2% at 70% CR)	u_{rm}	0,230	0,0529
Excursion of measurement beam	u_{mb}		
Converter efficiency for NOx	u_{ce}		
Response factors (TOC)	u_{rf}		
		Sum	0,1239
Combined standard uncertainty	$u_c = \sqrt{\sum (u_i)^2}$	0,352	Vol.%
Expanded uncertainty	$U_{0,95} = 1,96 \times u_c$	0,6899	Vol.%
Relative expanded uncertainty	U	**2,8**	%ELV
Demanded uncertainty according to EN 15267-3	(at ELV 25 Vol.%)	**7,5**	%ELV
Requirement concerning uncertainty fulfilled		**yes**	concerning to EN 15267-3
Demanded uncertainty 13. / 17. BImSchV	(at ELV 25 Vol.%)	**10**	%ELV
Requirement concerning uncertainty fulfilled		**yes**	concerning to 13. / 17. BImSchV