Umwelt Bundesamt

TÜVRheinland®
Precisely Right.

CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000059867_03

Certified AMS:	ProCeas LaserCEM for CO, NO, NO_2, SO_2, HCl, HF, NH_3, CH_4, O_2 and H_2O
Manufacturer:	AP2E 110 Avenue Galilée 13593 Aix-en-Provence France
Test Institute:	TÜV Rheinland Energy & Environment GmbH

This is to certify that the AMS has been tested and found to comply with the standards EN 15267-1 (2009), EN 15267-2 (2009), EN 15267-3 (2007) as well as EN 14181 (2014).

Certification is awarded in respect of the conditions stated in this certificate (this certificate contains 16 pages).
The present certificate replaces certificate 0000059867_02 dated 5 September 2023.

TÜVRheinland® CERTIFIED
Suitability Tested
EN 15267
QAL1 Certified
Regular Surveillance
www.tuv.com
ID 0000059867

Publication in the German Federal Gazette (BAnz) of 10 May 2024

German Environment Agency

Dessau, 12 June 2024

Dr. Marcel Langner
Head of Section II 4

This certificate will expire on:
9 May 2029

TÜV Rheinland Energy & Environment GmbH
Cologne, 11 June 2024

ppa. Dr. Peter Wilbring

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TÜV Rheinland Energy & Environment GmbH
Am Grauen Stein
51105 Köln

Test institute accredited to EN ISO/IEC 17025 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:	EuL/21250153/B dated 25 September 2023
Initial certification:	22 July 2019
Expiry date:	9 May 2029
Publication:	BAnz AT 10.05.2024 B7, chapter I No. 5.1

Approved application

The tested AMS is suitable for use at plants according to Directive 2010/75/EC, chapter III (combustion plants / 13th BImSchV:2021), chapter IV (waste incineration plants / 17th BImSchV:2021), Directive 2015/2193/EC (44th BImSchV:2022), 30th BImSchV:2019 and TA Luft:2021. The measured ranges have been selected so as to ensure as broad a field of application as possible.

The suitability of the AMS for this application was evaluated based on laboratory testing and a six-month field test at a waste incinerator and a six-month field test at a power plant with co-incineration of waste.

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 that this AMS is suitable for monitoring the emission limit values and oxygen concentration relevant to the application.

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

Note

The legal regulations mentioned correspond to the current state of legislation during certification. Each user should, if necessary, in consultation with the competent authority, ensure that this AMS meets the legal requirements for the intended use. In addition, it cannot be ruled out that legal regulations governing the use of a measuring device for emission monitoring may change during the lifetime of the certificate.

Basis of the certification

This certification is based on:

- Test report EuL/21250153/B dated 25 September 2023 of TÜV Rheinland Energy 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 AT 10.05.2024 B7, chapter I No. 5.1, Announcement by UBA dated 19 March 2024:

AMS designation:

ProCeas LaserCEM for CO, NO, NH_3, O_2, H_2O, SO_2, HCl, HF, NO_2 and CH_4

Manufacturer: AP2E, Aix-en-Provence, France

Field of application:

Modular measuring system for plants requiring official approval

Measuring ranges during the performance test:

Component/ Modul	Certification range	additional range		Unit
CO	0 - 75	0 - 1.249	-	mg/m³
CO (L)	0 - 30	0 - 250	-	mg/m³
NO	0 - 78	0 - 150	0 - 2.008	mg/m³
NH_3	0 - 15	0 - 45	0 - 76	mg/m³
H_2O	0 - 30	0 - 40	-	Vol.-%
O_2	0 - 21	-	-	Vol.-%
SO_2	0 - 75	0 - 2.858	-	mg/m³
HCl	0 - 15	0 - 98	-	mg/m³
HF	0 - 1,5	0 - 10	-	mg/m³
NO_2	0 - 40	0 - 100	-	mg/m³
CH_4	0 - 5	0 - 20	-	mg/m³

Software version:

1.0.21 (SpectrumAnalyzer) oder 3.0.8.85 (DataAnalyser)

Restrictions:

When using the NO component, the HCl concentration in the waste gas must not exceed 50 mg/m³.

Notes:

1. Wet test gases should be used when testing NH_3, HCl, HF and H_2O.
2. The maintenance interval is three months.
3. The maintenance work must be spread over several days in order to comply with the criteria for downtimes at plants in accordance with the 13th BImSchV and 17th BImSchV.
4. Each measuring component represents a module. Each module bears the name of the component it measures. All modules can be combined as required.
5. Supplementary test (maintenance interval extension, qualification of a new software generation and a QAL3 tool, modification of the rear panel of the cabinet) with regard to the announcements of the Federal Environment Agency of 24 February 2020 (BAnz AT 24.03.2020 B7, Chapter I Number 3.1) and of 5 July 2023 (BAnz AT 02.08.2023 B7, Chapter I Number 3.4).

Test institute:

TÜV Rheinland Energy GmbH, Cologne
Report No.: EuL/21250153/B dated 25 September 2023

Certified product

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

The LaserCEM measuring device is a modular multi-component measuring device that operates at low pressure. The measuring principle is based on infrared laser spectroscopy. This combines a resonator enhanced absorption spectroscopy with optical feedback (OFCEAS; Optical Feedback Cavity Enhanced Absorption Spectroscopy) and a low pressure sampling technique (LPS).

The sample gas preparation consists of a heated CEM probe. Sampling here is via a critical nozzle and a 2-µm filter made of sintered stainless steel. A heated sample gas line equipped with a PTFE core is connected to the probe.

The measuring system tested here consists of:

- Gas sampling probe CEM with critical nozzle and 2 µm filter.
- Heated sample gas line, temperature 80 °C (self-regulating), inner diameter approx. 6 mm, material PFA, length max. 35 m.
- Analytical cabinet with:
    - Analyzer modules LaserCEM,
    - Sample gas hoses,
    - Pump (vacuum),
    - interface module,
    - Measurement outputs and various electrical components.

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With the exception of the heatable gas sampling probe and the heatable sample gas line, all components are located together with the electrical distribution and modules in a lockable measuring cabinet.

The measuring device is available in 2 different versions, which mainly differ in the size of the measuring cabinet. Due to the different heights of the cabinets, adjustments had to be made to the sample gas paths and other arrangements of components such as changeover valves for feeding dry test gases. In addition, the interface module for connecting dry test gases and the switchover options at the front have been expanded for the 38U design.

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 & Environment 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 & Environment 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 & Environment 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: **qal1.de**.

History of documents
Certification of ProCeas LaserCEM 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. 0000059867_00: 5 November 2019
Expiry date of the certificate: 21 July 2024
Test report: 936/21228566/C dated 7 March 2019
TÜV Rheinland Energy GmbH
Publication: BAnz AT 22.07.2019 B8, chapter I number 1.1
UBA announcement dated 28 June 2019

Supplementary testing according to EN 15267
Certificate No. 0000059867_01: 4 June 2020
Expiry date of the certificate: 23 March 2025
Test report: 936/21228566/D dated 20 May 2019
TÜV Rheinland Energy GmbH
Publication: BAnz AT 24.03.2020 B7, chapter I number 3.1
UBA announcement dated 24 February 2020

Notifications
Statement issued by TÜV Rheinland Energy GmbH dated 12 November 2020
Publication: BAnz AT 03.05.2021 B9, chapter III notification 5
UBA announcement dated 31 March 2021
(Software changes)

Supplementary testing according to EN 15267
Certificate No. 0000059867_02: 5 September 2023
Expiry date of the certificate: 1 August 2028
Test report: 936/21250153/A dated 6 February 2023
TÜV Rheinland Energy GmbH
Publication: BAnz AT 02.08.2023 B7, chapter I number 3.4
UBA announcement dated 5 July 2023

Supplementary testing according to EN 15267
Certificate No. 0000059867_03: 12 June 2024
Expiry date of the certificate: 9 May 2029
Test report: EuL/21250153/B dated 25 September 2023
TÜV Rheinland Energy GmbH
Publication: BAnz AT 10.05.2024 B7, chapter I number 5.1
UBA announcement dated 19 March 2024

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system			
Manufacturer	AP2E		
AMS designation	ProCeas LaserCEM		
Serial number of units under test	20200693/20200696		
Measuring principle	Opt. Feedback Cavity Enh. Absorption Spectroscopy		
Test report	EuL/21250153/B		
Test laboratory	TÜV Rheinland		
Measured component	CO		
Certification range	0 - 30	mg/m³	
Evaluation of the cross-sensitivity (CS)			
(system with largest CS)			
Sum of positive CS at zero point	0.00	mg/m³	
Sum of negative CS at zero point	0.00	mg/m³	
Sum of postive CS at span point	0.00	mg/m³	
Sum of negative CS at span point	-0.48	mg/m³	
Maximum sum of cross-sensitivities	-0.48	mg/m³	
Uncertainty of cross-sensitivity	u_i -0.277	mg/m³	

Calculation of the combined standard uncertainty

Tested parameter				u²	
	u_D	0.317	mg/m³	0.100	(mg/m³)²
Lack of fit	u_{lof}	0.081	mg/m³	0.007	(mg/m³)²
Zero drift from field test	$u_{d,z}$	-0.398	mg/m³	0.158	(mg/m³)²
Span drift from field test	$u_{d,s}$	0.364	mg/m³	0.132	(mg/m³)²
Influence of ambient temperature at span	u_t	0.021	mg/m³	0.000	(mg/m³)²
Influence of supply voltage	u_v	0.049	mg/m³	0.002	(mg/m³)²
Cross-sensitivity (interference)	u_i	-0.277	mg/m³	0.077	(mg/m³)²
Influence of sample gas flow	u_p	-0.092	mg/m³	0.008	(mg/m³)²
Uncertainty of reference material at 70% of certification range	u_{rm}	0.242	mg/m³	0.059	(mg/m³)²

* The larger value is used :
"Repeatability standard deviation at set point" or
"Standard deviation from paired measurements under field conditions"

andard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max\,j})^2}$	0.74	mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	1.45	mg/m³

Relative total expanded uncertainty	**U in % of the ELV 20 mg/m³**	**7.23**
Requirement of 2010/75/EU	**U in % of the ELV 20 mg/m³**	**10.00**
Requirement of EN 15267-3	U in % of the ELV 20 mg/m³	7.50

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system				
Manufacturer	AP2E			
AMS designation	ProCeas LaserCEM			
Serial number of units under test	20200693/20200696			
Measuring principle	Opt. Feedback Cavity Enh. Absorption Spectroscopy			
Test report	EuL/21250153/B			
Test laboratory	TÜV Rheinland			
Measured component	CH_4			
Certification range	0 - 5	mg/m³		
Evaluation of the cross-sensitivity (CS)				
(system with largest CS)				
Sum of positive CS at zero point		0.13	mg/m³	
Sum of negative CS at zero point		0.00	mg/m³	
Sum of postive CS at span point		0.10	mg/m³	
Sum of negative CS at span point		-0.03	mg/m³	
Maximum sum of cross-sensitivities		0.13	mg/m³	
Uncertainty of cross-sensitivity	u_i	0.075	mg/m³	

Calculation of the combined standard uncertainty

Tested parameter				u^2	
	u_D	0.058	mg/m³	0.003	(mg/m³)²
Lack of fit	u_{lof}	0.009	mg/m³	0.000	(mg/m³)²
Zero drift from field test	$u_{d,z}$	-0.006	mg/m³	0.000	(mg/m³)²
Span drift from field test	$u_{d,s}$	0.081	mg/m³	0.007	(mg/m³)²
Influence of ambient temperature at span	u_t	0.021	mg/m³	0.000	(mg/m³)²
Influence of supply voltage	u_v	0.002	mg/m³	0.000	(mg/m³)²
Cross-sensitivity (interference)	u_i	0.075	mg/m³	0.006	(mg/m³)²
Influence of sample gas flow	u_p	0.012	mg/m³	0.000	(mg/m³)²
Uncertainty of reference material at 70% of certification range	u_{rm}	0.040	mg/m³	0.002	(mg/m³)²

* The larger value is used :
"Repeatability standard deviation at set point" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max,j})^2}$	0.13	mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	0.26	mg/m³

Relative total expanded uncertainty	**U in % of the range 5 mg/m³**	**5.2**
Requirement of 2010/75/EU	**U in % of the range 5 mg/m³**	**30.0 ****
Requirement of EN 15267-3	U in % of the range 5 mg/m³	22.5

** The EU-directive 2010/75/EC on industrial emissions does not define requirements for this component.
A value of 30.0 % was used instead.

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system					
Manufacturer			AP2E		
AMS designation			ProCeas LaserCEM		
Serial number of units under test			20200693/20200696		
Measuring principle			Opt. Feedback Cavity Enh. Absorption Spectroscopy		
Test report			EuL/21250153/B		
Test laboratory			TÜV Rheinland		
Measured component			HF		
Certification range			0 - 1.5	mg/m³	
Evaluation of the cross-sensitivity (CS)					
(system with largest CS)					
Sum of positive CS at zero point			0.02	mg/m³	
Sum of negative CS at zero point			0.00	mg/m³	
Sum of postive CS at span point			0.06	mg/m³	
Sum of negative CS at span point			-0.03	mg/m³	
Maximum sum of cross-sensitivities			0.06	mg/m³	
Uncertainty of cross-sensitivity		u_i	0.032	mg/m³	

Calculation of the combined standard uncertainty

Tested parameter					u^2	
		u_D	0.004	mg/m³	0.000	(mg/m³)²
Lack of fit		u_{lof}	0.009	mg/m³	0.000	(mg/m³)²
Zero drift from field test		$u_{d,z}$	-0.008	mg/m³	0.000	(mg/m³)²
Span drift from field test		$u_{d,s}$	-0.023	mg/m³	0.001	(mg/m³)²
Influence of ambient temperature at span		u_t	0.015	mg/m³	0.000	(mg/m³)²
Influence of supply voltage		u_v	0.006	mg/m³	0.000	(mg/m³)²
Cross-sensitivity (interference)		u_i	0.032	mg/m³	0.001	(mg/m³)²
Influence of sample gas flow		u_p	0.007	mg/m³	0.000	(mg/m³)²
Uncertainty of reference material at 70% of certification range		u_{rm}	0.012	mg/m³	0.000	(mg/m³)²

* The larger value is used :
"Repeatability standard deviation at set point" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max,j})^2}$	0.05	mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	0.09	mg/m³

Relative total expanded uncertainty	**U in % of the ELV 1 mg/m³**	**9.1**
Requirement of 2010/75/EU	**U in % of the ELV 1 mg/m³**	**40.0**
Requirement of EN 15267-3	U in % of the ELV 1 mg/m³	30.0

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system					
Manufacturer			AP2E		
AMS designation			ProCeas LaserCEM		
Serial number of units under test			20200693/20200696		
Measuring principle			Opt. Feedback Cavity Enh. Absorption Spectroscopy		
Test report			EuL/21250153/B		
Test laboratory			TÜV Rheinland		
Measured component			NO_2		
Certification range			0 - 40	mg/m³	
Evaluation of the cross-sensitivity (CS)					
(system with largest CS)					
Sum of positive CS at zero point			0.25	mg/m³	
Sum of negative CS at zero point			0.00	mg/m³	
Sum of postive CS at span point			0.17	mg/m³	
Sum of negative CS at span point			-1.25	mg/m³	
Maximum sum of cross-sensitivities			-1.25	mg/m³	
Uncertainty of cross-sensitivity	u_i		-0.723	mg/m³	

Calculation of the combined standard uncertainty

Tested parameter				u²	
	u_D	0.170	mg/m³	0.029	(mg/m³)²
Lack of fit	u_{lof}	-0.155	mg/m³	0.024	(mg/m³)²
Zero drift from field test	$u_{d,z}$	-0.162	mg/m³	0.026	(mg/m³)²
Span drift from field test	$u_{d,s}$	-0.370	mg/m³	0.137	(mg/m³)²
Influence of ambient temperature at span	u_t	0.235	mg/m³	0.055	(mg/m³)²
Influence of supply voltage	u_v	0.061	mg/m³	0.004	(mg/m³)²
Cross-sensitivity (interference)	u_i	-0.723	mg/m³	0.523	(mg/m³)²
Influence of sample gas flow	u_p	0.081	mg/m³	0.007	(mg/m³)²
Uncertainty of reference material at 70% of certification range	u_{rm}	0.323	mg/m³	0.105	(mg/m³)²

* The larger value is used :
"Repeatability standard deviation at set point" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max,j})^2}$	0.95	mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	1.87	mg/m³

Relative total expanded uncertainty	**U in % of the ELV 20 mg/m³**	**9.3**
Requirement of 2010/75/EU	**U in % of the ELV 20 mg/m³**	**20.0**
Requirement of EN 15267-3	U in % of the ELV 20 mg/m³	15.0

Umwelt Bundesamt

Certificate:
0000059867_03 / 12 June 2024

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Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system					
Manufacturer		AP2E			
AMS designation		LaserCEM			
Serial number of units under test		SN2015-0120 / SN2015-0125			
Measuring principle		Opt. Feedback Cavity Enh. Absorption Spectroscopy			
Test report		936/21228566/D			
Test laboratory		TÜV Rheinland			
Date of report		2019-05-20			
Measured component		H_2O			
Certification range		0 - 30	Vol.-%		
Evaluation of the cross-sensitivity (CS)					
(system with largest CS)					
Sum of positive CS at zero point		0.00	Vol.-%		
Sum of negative CS at zero point		0.00	Vol.-%		
Sum of postive CS at span point		0.63	Vol.-%		
Sum of negative CS at span point		0.00	Vol.-%		
Maximum sum of cross-sensitivities		0.63	Vol.-%		
Uncertainty of cross-sensitivity	u_i	0.364	Vol.-%		

Calculation of the combined standard uncertainty

Tested parameter				u^2	
Standard deviation from paired measurements under field conditions *	u_D	0.237	Vol.-%	0.056	(Vol.-%)²
Lack of fit	u_{lof}	0.161	Vol.-%	0.026	(Vol.-%)²
Zero drift from field test	$u_{d,z}$	0.121	Vol.-%	0.015	(Vol.-%)²
Span drift from field test	$u_{d,s}$	-0.433	Vol.-%	0.187	(Vol.-%)²
Influence of ambient temperature at span	u_t	0.351	Vol.-%	0.123	(Vol.-%)²
Influence of supply voltage	u_v	0.198	Vol.-%	0.039	(Vol.-%)²
Cross-sensitivity (interference)	u_i	0.364	Vol.-%	0.132	(Vol.-%)²
Influence of sample gas flow	u_n	0.025	Vol.-%	0.001	(Vol.-%)²
Uncertainty of reference material at 70% of certification range	u_{rm}	0.242	Vol.-%	0.059	(Vol.-%)²

* The larger value is used :
"Repeatability standard deviation at set point" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max\ j})^2}$	0.80	Vol.-%
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	1.57	Vol.-%

Relative total expanded uncertainty	**U in % of the range 30 Vol.-%**	**5.2**
Requirement of 2010/75/EU	**U in % of the range 30 Vol.-%**	**10.0 ****
Requirement of EN 15267-3	U in % of the range 30 Vol.-%	7.5

** The EU-directive 2010/75/EC on industrial emissions does not define requirements for this component.
A value of 10.0 % was used instead.

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system					
Manufacturer			AP2E		
AMS designation			LaserCEM		
Serial number of units under test			SN2015-0120 / SN2015-0125		
Measuring principle			Opt. Feedback Cavity Enh. Absorption Spectroscopy		
Test report			936/21228566/D		
Test laboratory			TÜV Rheinland		
Date of report			2019-05-20		
Measured component			HCl		
Certification range			0 - 15	mg/m³	
Evaluation of the cross-sensitivity (CS)					
(system with largest CS)					
Sum of positive CS at zero point			0.07	mg/m³	
Sum of negative CS at zero point			0.00	mg/m³	
Sum of postive CS at span point			0.18	mg/m³	
Sum of negative CS at span point			0.00	mg/m³	
Maximum sum of cross-sensitivities			0.18	mg/m³	
Uncertainty of cross-sensitivity		u_i	0.103	mg/m³	

Calculation of the combined standard uncertainty

Tested parameter				u²	
Standard deviation from paired measurements under field conditions *		u_D	0.058	mg/m³	0.003 (mg/m³)²
Lack of fit		u_{lof}	0.108	mg/m³	0.012 (mg/m³)²
Zero drift from field test		$u_{d,z}$	0.139	mg/m³	0.019 (mg/m³)²
Span drift from field test		$u_{d,s}$	0.208	mg/m³	0.043 (mg/m³)²
Influence of ambient temperature at span		u_t	0.100	mg/m³	0.010 (mg/m³)²
Influence of supply voltage		u_v	0.030	mg/m³	0.001 (mg/m³)²
Cross-sensitivity (interference)		u_i	0.103	mg/m³	0.011 (mg/m³)²
Influence of sample gas flow		u_p	0.025	mg/m³	0.001 (mg/m³)²
Uncertainty of reference material at 70% of certification range		u_{rm}	0.121	mg/m³	0.015 (mg/m³)²

* The larger value is used :
"Repeatability standard deviation at set point" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max,j})^2}$	0.34	mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	0.66	mg/m³

Relative total expanded uncertainty	**U in % of the ELV 10 mg/m³**	**6.6**
Requirement of 2010/75/EU	**U in % of the ELV 10 mg/m³**	**40.0**
Requirement of EN 15267-3	U in % of the ELV 10 mg/m³	30.0

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system					
Manufacturer			AP2E		
AMS designation			LaserCEM		
Serial number of units under test			SN2015-0120 / SN2015-0125		
Measuring principle			Opt. Feedback Cavity Enh. Absorption Spectroscopy		
Test report			936/21228566/D		
Test laboratory			TÜV Rheinland		
Date of report			2019-05-20		
Measured component			NH_3		
Certification range			0 - 15 mg/m³		
Evaluation of the cross-sensitivity (CS)					
(system with largest CS)					
Sum of positive CS at zero point			0.00 mg/m³		
Sum of negative CS at zero point			0.00 mg/m³		
Sum of postive CS at span point			0.22 mg/m³		
Sum of negative CS at span point			-0.19 mg/m³		
Maximum sum of cross-sensitivities			0.22 mg/m³		
Uncertainty of cross-sensitivity		u_i	0.126 mg/m³		

Calculation of the combined standard uncertainty

Tested parameter				u^2	
Repeatability standard deviation at set point *	u_r	0.100	mg/m³	0.010	$(mg/m^3)^2$
Lack of fit	u_{lof}	0.093	mg/m³	0.009	$(mg/m^3)^2$
Zero drift from field test	$u_{d,z}$	-0.156	mg/m³	0.024	$(mg/m^3)^2$
Span drift from field test	$u_{d,s}$	0.217	mg/m³	0.047	$(mg/m^3)^2$
Influence of ambient temperature at span	u_t	0.153	mg/m³	0.023	$(mg/m^3)^2$
Influence of supply voltage	u_v	0.026	mg/m³	0.001	$(mg/m^3)^2$
Cross-sensitivity (interference)	u_i	0.126	mg/m³	0.016	$(mg/m^3)^2$
Influence of sample gas flow	u_p	-0.002	mg/m³	0.000	$(mg/m^3)^2$
Uncertainty of reference material at 70% of certification range	u_{rm}	0.121	mg/m³	0.015	$(mg/m^3)^2$

* The larger value is used :
"Repeatability standard deviation at set point" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max,j})^2}$	0.38	mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	0.75	mg/m³

Relative total expanded uncertainty	**U in % of the ELV 10 mg/m³**	**7.5**
Requirement of 2010/75/EU	**U in % of the ELV 10 mg/m³**	**40.0**
Requirement of EN 15267-3	U in % of the ELV 10 mg/m³	30.0

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system			
Manufacturer	AP2E		
AMS designation	LaserCEM		
Serial number of units under test	SN2015-0120 / SN2015-0125		
Measuring principle	Opt. Feedback Cavity Enh. Absorption Spectroscopy		
Test report	936/21228566/D		
Test laboratory	TÜV Rheinland		
Date of report	2019-05-20		
Measured component	NO		
Certification range	0 - 78	mg/m³	

Evaluation of the cross-sensitivity (CS)			
(system with largest CS)			
Sum of positive CS at zero point	0.42	mg/m³	
Sum of negative CS at zero point	0.00	mg/m³	
Sum of postive CS at span point	0.00	mg/m³	
Sum of negative CS at span point	-1.30	mg/m³	
Maximum sum of cross-sensitivities	-1.30	mg/m³	
Uncertainty of cross-sensitivity	u_i -0.752	mg/m³	

Calculation of the combined standard uncertainty

Tested parameter				u^2	
Standard deviation from paired measurements under field conditions *	u_D	0.721	mg/m³	0.520	(mg/m³)²
Lack of fit	u_{lof}	-0.437	mg/m³	0.191	(mg/m³)²
Zero drift from field test	$u_{d,z}$	0.315	mg/m³	0.099	(mg/m³)²
Span drift from field test	$u_{d,s}$	1.081	mg/m³	1.169	(mg/m³)²
Influence of ambient temperature at span	u_t	0.751	mg/m³	0.564	(mg/m³)²
Influence of supply voltage	u_v	0.347	mg/m³	0.120	(mg/m³)²
Cross-sensitivity (interference)	u_i	-0.752	mg/m³	0.566	(mg/m³)²
Influence of sample gas flow	u_p	0.444	mg/m³	0.197	(mg/m³)²
Uncertainty of reference material at 70% of certification range	u_{rm}	0.630	mg/m³	0.397	(mg/m³)²

* The larger value is used :
"Repeatability standard deviation at set point" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max,j})^2}$	1.96	mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	3.83	mg/m³

Relative total expanded uncertainty	**U in % of the ELV 50 mg/m³**	**7.7**
Requirement of 2010/75/EU	**U in % of the ELV 50 mg/m³**	**20.0**
Requirement of EN 15267-3	U in % of the ELV 50 mg/m³	15.0

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system			
Manufacturer	AP2E		
AMS designation	LaserCEM		
Serial number of units under test	SN2015-0120 / SN2015-0125		
Measuring principle	Opt. Feedback Cavity Enh. Absorption Spectroscopy		
Test report	936/21228566/D		
Test laboratory	TÜV Rheinland		
Date of report	2019-05-20		
Measured component	O_2		
Certification range	0 - 21	Vol.-%	

Evaluation of the cross-sensitivity (CS)

(system with largest CS)			
Sum of positive CS at zero point		0.00	Vol.-%
Sum of negative CS at zero point		0.00	Vol.-%
Sum of postive CS at span point		0.00	Vol.-%
Sum of negative CS at span point		-0.34	Vol.-%
Maximum sum of cross-sensitivities		-0.34	Vol.-%
Uncertainty of cross-sensitivity	u_i	-0.197	Vol.-%

Calculation of the combined standard uncertainty

Tested parameter				u^2	
Standard deviation from paired measurements under field conditions *	u_D	0.091	Vol.-%	0.008	(Vol.-%)²
Lack of fit	u_{lof}	0.058	Vol.-%	0.003	(Vol.-%)²
Zero drift from field test	$u_{d,z}$	0.029	Vol.-%	0.001	(Vol.-%)²
Span drift from field test	$u_{d,s}$	0.069	Vol.-%	0.005	(Vol.-%)²
Influence of ambient temperature at span	u_t	0.107	Vol.-%	0.011	(Vol.-%)²
Influence of supply voltage	u_v	0.012	Vol.-%	0.000	(Vol.-%)²
Cross-sensitivity (interference)	u_i	-0.197	Vol.-%	0.039	(Vol.-%)²
Influence of sample gas flow	u_p	0.023	Vol.-%	0.001	(Vol.-%)²
Uncertainty of reference material at 70% of certification range	u_{rm}	0.170	Vol.-%	0.029	(Vol.-%)²

* The larger value is used :
"Repeatability standard deviation at set point" or
"Standard deviation from paired measurements under field conditions"

$$u_c = \sqrt{\sum (u_{max,j})^2}$$

Combined standard uncertainty (u_C)		0.31	Vol.-%
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	0.61	Vol.-%

Relative total expanded uncertainty	**U in % of the range 21 Vol.-%**	**2.9**
Requirement of 2010/75/EU	**U in % of the range 21 Vol.-%**	**10.0 ****
Requirement of EN 15267-3	U in % of the range 21 Vol.-%	7.5

** The EU-directive 2010/75/EC on industrial emissions does not define requirements for this component.
A value of 10.0 % was used instead.

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system				
Manufacturer		AP2E		
AMS designation		LaserCEM		
Serial number of units under test		SN2015-0120 / SN2015-0125		
Measuring principle		Opt. Feedback Cavity Enh. Absorption Spectroscopy		
Test report		936/21228566/D		
Test laboratory		TÜV Rheinland		
Date of report		2019-03-07		
Measured component		SO_2		
Certification range		0 - 75	mg/m³	
Evaluation of the cross-sensitivity (CS)				
(system with largest CS)				
Sum of positive CS at zero point		0.00	mg/m³	
Sum of negative CS at zero point		0.00	mg/m³	
Sum of postive CS at span point		1.66	mg/m³	
Sum of negative CS at span point		-0.74	mg/m³	
Maximum sum of cross-sensitivities		1.66	mg/m³	
Uncertainty of cross-sensitivity	u_i	0.957	mg/m³	

Calculation of the combined standard uncertainty

Tested parameter				u^2	
Standard deviation from paired measurements under field conditions *	u_D	0.113	mg/m³	0.013	$(mg/m^3)^2$
Lack of fit	u_{lof}	0.866	mg/m³	0.750	$(mg/m^3)^2$
Zero drift from field test	$u_{d,z}$	0.130	mg/m³	0.017	$(mg/m^3)^2$
Span drift from field test	$u_{d,s}$	0.866	mg/m³	0.750	$(mg/m^3)^2$
Influence of ambient temperature at span	u_t	0.850	mg/m³	0.723	$(mg/m^3)^2$
Influence of supply voltage	u_v	0.121	mg/m³	0.015	$(mg/m^3)^2$
Cross-sensitivity (interference)	u_i	0.957	mg/m³	0.916	$(mg/m^3)^2$
Influence of sample gas flow	u_b	0.189	mg/m³	0.036	$(mg/m^3)^2$
Uncertainty of reference material at 70% of certification range	u_{rm}	0.606	mg/m³	0.368	$(mg/m^3)^2$

* The larger value is used :
"Repeatability standard deviation at set point" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max,j})^2}$	1.89	mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	3.71	mg/m³

Relative total expanded uncertainty	**U in % of the ELV 50 mg/m³**	**7.4**
Requirement of 2010/75/EU	**U in % of the ELV 50 mg/m³**	**20.0**
Requirement of EN 15267-3	U in % of the ELV 50 mg/m³	15.0