

CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000059867_02

Certified AMS: ProCeas LaserCEM for CO, NO, NO₂, SO₂, HCl, HF, NH₃, CH₄, O₂ and H₂O

Manufacturer: AP2E
 240 Rue Louis de Broglie
 13593 Aix-en-Provence
 France

Test Institute: TÜV Rheinland Energy 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_01 dated 04 June 2020.



Suitability Tested
 EN 15267
 QAL1 Certified
 Regular
 Surveillance

www.tuv.com
 ID 0000059867

Publication in the German Federal Gazette
 (BAZ) of 02 August 2023

This certificate will expire on:
 01 August 2028

German Environment Agency
 Dessau, 05 September 2023

TÜV Rheinland Energy GmbH
 Cologne, 04 September 2023



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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:	936/21250153/A dated 06 February 2023
Initial certification:	22 July 2019
Expiry date:	01 August 2028
Publication:	BAnz AT 02.08.2023 B7, chapter I No. 3.4

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 three-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 936/21250153/A dated 06 February 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 02.08.2023 B7, chapter I No. 3.4,
Announcement by UBA dated 05 July 2023:

AMS designation:

ProCeas LaserCEM for CO, NO, NH₃, O₂, H₂O, SO₂, HCl, HF, NO₂ and CH₄

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	Maintenance interval
CO	0 - 75	0 - 1,249	-	mg/m ³	3 months
CO(L)	0 - 30	0 - 250	-	mg/m ³	1 month
NO	0 - 78	0 - 150	0 - 2,008	mg/m ³	3 months
NH ₃	0 - 15	0 - 45	0 - 76	mg/m ³	3 months
H ₂ O	0 - 30	0 - 40	-	Vol.-%	3 months
O ₂	0 - 21	-	-	Vol.-%	3 months
SO ₂	0 - 75	0 - 2,858	-	mg/m ³	3 months
HCl	0 - 15	0 - 98	-	mg/m ³	3 months
HF	0 - 1,5	0 - 10	-	mg/m ³	1 month
NO ₂	0 - 40	0 - 100	-	mg/m ³	1 month
CH ₄	0 - 5	0 - 20	-	mg/m ³	1 month

Software version: 3.0.8

Restrictions:

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

Notes:

1. Wet test gases must be used when testing NH₃, HCl, HF and H₂O.
2. The maintenance interval shall be determined depending on the module configuration.
3. The maintenance work is to be distributed over several days in order to comply with the criteria for downtimes at plants according to the 13th BImSchV and 17th BImSchV.
4. The name of the measuring system has been changed from LaserCEM to ProCeas LaserCEM.
5. Each measured component represents a module. Each module bears the name of the component measured with it. All modules can be combined in any way.
6. Supplementary test (approval of further components) with regard to the announcements of the Federal Environment Agency (UBA) of 24 February 2020 (BAnz AT 24.03.2020 B7, chapter I number 3.1) and of 31 March 2021 (BAnz AT 03.05.2021 B9, chapter III notification 5).

Test institute: TÜV Rheinland Energy GmbH, Cologne
Report No.: 936/21250153/A dated 6 February 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

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 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 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: 05 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: 04 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: 05 September 2023

Expiry date of the certificate: 01 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

Berechnung der Gesamtunsicherheit nach DIN EN 14181 und DIN EN 15267-3

Messeinrichtung

Hersteller	AP2E
Bezeichnung der Messeinrichtung	ProCeas LaserCEM
Seriennummer der Prüflinge	20200693/20200696
Messprinzip	Resonatorverstärkte Abs.-spektr. mit opt. Feedback

Prüfbericht

Prüfinstitut	936/21250153/A TÜV Rheinland
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Messkomponente

Zertifizierungsbereich ZB	CO	0 - 30 mg/m ³
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Bewertung der Querempfindlichkeiten (QE)

(System mit größter QE)

Summe positive QE am Null-Punkt	0.00 mg/m ³
Summe negative QE am Null-Punkt	0.00 mg/m ³
Summe positive QE am Ref.-Punkt	0.00 mg/m ³
Summe negative QE am Ref.-Punkt	-0.48 mg/m ³
Maximale Summe von Querempfindlichkeiten	-0.48 mg/m ³
Messunsicherheit der Querempfindlichkeit	u_i -0.277 mg/m ³

Berechnung der erweiterten Messunsicherheit

Prüfgröße

		u^2
Standardabweichung aus Doppelbestimmungen *	u_D 0.317 mg/m ³	0.100 (mg/m ³) ²
Linearität / Lack-of-fit	u_{inf} 0.081 mg/m ³	0.007 (mg/m ³) ²
Nullpunktdrift aus Feldtest	$u_{d,z}$ -0.398 mg/m ³	0.158 (mg/m ³) ²
Referenzpunktdrift aus Feldtest	$u_{r,s}$ 0.364 mg/m ³	0.132 (mg/m ³) ²
Einfluss der Umgebungstemperatur am Referenzpunkt	u_t 0.021 mg/m ³	0.000 (mg/m ³) ²
Einfluss der Netzspannung	u_v 0.049 mg/m ³	0.002 (mg/m ³) ²
Querempfindlichkeit	u_i -0.277 mg/m ³	0.077 (mg/m ³) ²
Einfluss des Probengasvolumenstrom	u_b -0.092 mg/m ³	0.008 (mg/m ³) ²
Unsicherheit des Referenzmaterials bei 70% des ZB	u_{rm} 0.242 mg/m ³	0.059 (mg/m ³) ²

* Der größere der Werte wird verwendet:
"Wiederholstandardabweichung am Referenzpunkt" oder
"Standardabweichung aus Doppelbestimmungen"

Kombinierte Standardunsicherheit (u_c)	$u_c = \sqrt{\sum (u_{max,j})^2}$	0.74 mg/m ³
Erweiterte Unsicherheit	$U = u_c * k = u_c * 1,96$	1.45 mg/m ³

Relative erweiterte Messunsicherheit

Anforderung nach 2010/75/EU	U in % vom Grenzwert 20 mg/m³	7,23
Anforderung nach DIN EN 15267-3	U in % vom Grenzwert 20 mg/m³	10,00
	U in % vom Grenzwert 20 mg/m ³	7,50

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

Measuring system

Manufacturer	AP2E
AMS designation	ProCeam LaserCEM
Serial number of units under test	20200693/20200696
Measuring principle	Resonatorverstärkte Abs.-spektr. mit opt. Feedback

Test report

Test laboratory	936/21250153/A TÜV Rheinland
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Measured component

Certification range	CH ₄ 0 - 5 mg/m ³
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Evaluation of the cross-sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	0.13 mg/m ³
Sum of negative CS at zero point	0.00 mg/m ³
Sum of positive CS at span point	0.10 mg/m ³
Sum of negative CS at span point	-0.03 mg/m ³
Maximum sum of cross-sensitivities	0.13 mg/m ³
Uncertainty of cross-sensitivity	u_i 0.075 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

		u^2
Lack of fit	u_D 0.058 mg/m ³	0.003 (mg/m ³) ²
Zero drift from field test	u_{lof} 0.009 mg/m ³	0.000 (mg/m ³) ²
Span drift from field test	$u_{d,z}$ -0.006 mg/m ³	0.000 (mg/m ³) ²
Influence of ambient temperature at span	$u_{d,s}$ 0.046 mg/m ³	0.002 (mg/m ³) ²
Influence of supply voltage	u_t 0.021 mg/m ³	0.000 (mg/m ³) ²
Cross-sensitivity (interference)	u_v 0.002 mg/m ³	0.000 (mg/m ³) ²
Influence of sample gas flow	u_i 0.075 mg/m ³	0.006 (mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u_b 0.012 mg/m ³	0.000 (mg/m ³) ²
	u_{rm} 0.040 mg/m ³	0.002 (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)	$u_c = \sqrt{\sum (u_{max,j})^2}$	0.12 mg/m ³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	0.23 mg/m ³

Relative total expanded uncertainty

Requirement of 2010/75/EU	U in % of the range 5 mg/m³	4,5
Requirement of EN 15267-3	U in % of the range 5 mg/m³	30,0 **
	U in % of the range 5 mg/m ³	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.

Berechnung der Gesamtunsicherheit nach DIN EN 14181 und DIN EN 15267-3

Messeinrichtung

Hersteller	AP2E
Bezeichnung der Messeinrichtung	ProCeas LaserCEM
Seriennummer der Prüflinge	20200693/20200696
Messprinzip	Resonatorverstärkte Abs.-spektr. mit opt. Feedback

Prüfbericht

Prüfinstitut	936/21250153/A TÜV Rheinland
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Messkomponente

Zertifizierungsbereich ZB	HF 0 - 1.5 mg/m ³
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Bewertung der Querempfindlichkeiten (QE)

(System mit größter QE)

Summe positive QE am Null-Punkt	0.02 mg/m ³
Summe negative QE am Null-Punkt	0.00 mg/m ³
Summe positive QE am Ref.-Punkt	0.06 mg/m ³
Summe negative QE am Ref.-Punkt	-0.03 mg/m ³
Maximale Summe von Querempfindlichkeiten	0.06 mg/m ³
Messunsicherheit der Querempfindlichkeit	u_i 0.032 mg/m ³

Berechnung der erweiterten Messunsicherheit

Prüfgröße

		u^2
Standardabweichung aus Doppelbestimmungen *	u_D 0.004 mg/m ³	0.000 (mg/m ³) ²
Linearität / Lack-of-fit	u_{lin} 0.009 mg/m ³	0.000 (mg/m ³) ²
Nullpunktdrift aus Feldtest	$u_{t,z}$ -0.008 mg/m ³	0.000 (mg/m ³) ²
Referenzpunktdrift aus Feldtest	$u_{t,s}$ 0.018 mg/m ³	0.000 (mg/m ³) ²
Einfluss der Umgebungstemperatur am Referenzpunkt	u_t 0.015 mg/m ³	0.000 (mg/m ³) ²
Einfluss der Netzspannung	u_v 0.006 mg/m ³	0.000 (mg/m ³) ²
Querempfindlichkeit	u_i 0.032 mg/m ³	0.001 (mg/m ³) ²
Einfluss des Probengasvolumenstrom	u_n 0.007 mg/m ³	0.000 (mg/m ³) ²
Unsicherheit des Referenzmaterials bei 70% des ZB	u_m 0.012 mg/m ³	0.000 (mg/m ³) ²

* Der größere der Werte wird verwendet:

"Wiederholstandardabweichung am Referenzpunkt" oder
"Standardabweichung aus Doppelbestimmungen"

Kombinierte Standardunsicherheit (u_c)

$$u_c = \sqrt{\sum (u_{max, j})^2} \quad 0.04 \text{ mg/m}^3$$

Erweiterte Unsicherheit

$$U = u_c \cdot k = u_c \cdot 1,96 \quad 0.09 \text{ mg/m}^3$$

Relative erweiterte Messunsicherheit

Anforderung nach 2010/75/EU

U in % vom Grenzwert 1 mg/m³ 8,7

Anforderung nach DIN EN 15267-3

U in % vom Grenzwert 1 mg/m³ 40,0

U in % vom Grenzwert 1 mg/m³ 30,0

Berechnung der Gesamtunsicherheit nach DIN EN 14181 und DIN EN 15267-3

Messeinrichtung

Hersteller	AP2E
Bezeichnung der Messeinrichtung	ProCeas LaserCEM
Seriennummer der Prüflinge	20200693/20200696
Messprinzip	Resonatorverstärkte Abs.-spektr. mit opt. Feedback

Prüfbericht

Prüfinstitut	936/21250153/A TÜV Rheinland
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Messkomponente

Zertifizierungsbereich ZB	NO ₂ 0 - 40 mg/m ³
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Bewertung der Querempfindlichkeiten (QE)

(System mit größter QE)

Summe positive QE am Null-Punkt	0.25 mg/m ³
Summe negative QE am Null-Punkt	0.00 mg/m ³
Summe positive QE am Ref.-Punkt	0.17 mg/m ³
Summe negative QE am Ref.-Punkt	-1.25 mg/m ³
Maximale Summe von Querempfindlichkeiten	-1.25 mg/m ³
Messunsicherheit der Querempfindlichkeit	u_i -0.723 mg/m ³

Berechnung der erweiterten Messunsicherheit

Prüfgröße

		u^2
Standardabweichung aus Doppelbestimmungen *	u_D 0.170 mg/m ³	0.029 (mg/m ³) ²
Linearität / Lack-of-fit	u_{inf} -0.155 mg/m ³	0.024 (mg/m ³) ²
Nullpunktdrift aus Feldtest	$u_{d,z}$ -0.162 mg/m ³	0.026 (mg/m ³) ²
Referenzpunktdrift aus Feldtest	$u_{r,s}$ -0.370 mg/m ³	0.137 (mg/m ³) ²
Einfluss der Umgebungstemperatur am Referenzpunkt	u_t 0.235 mg/m ³	0.055 (mg/m ³) ²
Einfluss der Netzspannung	u_v 0.061 mg/m ³	0.004 (mg/m ³) ²
Querempfindlichkeit	u_i -0.723 mg/m ³	0.523 (mg/m ³) ²
Einfluss des Probengasvolumenstrom	u_b 0.081 mg/m ³	0.007 (mg/m ³) ²
Unsicherheit des Referenzmaterials bei 70% des ZB	u_{rm} 0.323 mg/m ³	0.105 (mg/m ³) ²

* Der größere der Werte wird verwendet:
"Wiederholstandardabweichung am Referenzpunkt" oder
"Standardabweichung aus Doppelbestimmungen"

Kombinierte Standardunsicherheit (u_c)	$u_c = \sqrt{\sum (u_{max,j})^2}$	0.95 mg/m ³
Erweiterte Unsicherheit	$U = u_c * k = u_c * 1,96$	1.87 mg/m ³

Relative erweiterte Messunsicherheit

Anforderung nach 2010/75/EU	U in % vom Grenzwert 20 mg/m³	9,3
Anforderung nach DIN EN 15267-3	U in % vom Grenzwert 20 mg/m³	20,0
	U in % vom Grenzwert 20 mg/m ³	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	OFCEAS

Test report

Test laboratory	936/21228566/D
Date of report	TÜV Rheinland
	2019-05-20

Measured component

Certification range	H ₂ O
	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 positive 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_{of}	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_b	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)

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 0.80 \text{ Vol.-%}$$

Total expanded uncertainty

$$U = u_c * k = u_c * 1.96 \quad 1.57 \text{ Vol.-%}$$

Relative total expanded uncertainty

Requirement of 2010/75/EU

Requirement of EN 15267-3

U in % of the range 30 Vol.-%

U in % of the range 30 Vol.-%

U in % of the range 30 Vol.-%

5.2

10.0 **

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	OFCEAS

Test report

Test laboratory	936/21228566/D TÜV Rheinland
Date of report	2019-05-20

Measured component

Certification range	HCl 0 - 15 mg/m ³
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Evaluation of the cross-sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	0.07 mg/m ³
Sum of negative CS at zero point	0.00 mg/m ³
Sum of positive CS at span point	0.18 mg/m ³
Sum of negative CS at span point	0.00 mg/m ³
Maximum sum of cross-sensitivities	0.18 mg/m ³
Uncertainty of cross-sensitivity	u_i 0.103 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

		u^2	
Standard deviation from paired measurements under field conditions *	u_D 0.058 mg/m ³	0.003	(mg/m ³) ²
Lack of fit	u_{lof} 0.108 mg/m ³	0.012	(mg/m ³) ²
Zero drift from field test	$u_{d,z}$ 0.139 mg/m ³	0.019	(mg/m ³) ²
Span drift from field test	$u_{d,s}$ 0.208 mg/m ³	0.043	(mg/m ³) ²
Influence of ambient temperature at span	u_t 0.100 mg/m ³	0.010	(mg/m ³) ²
Influence of supply voltage	u_v 0.030 mg/m ³	0.001	(mg/m ³) ²
Cross-sensitivity (interference)	u_i 0.103 mg/m ³	0.011	(mg/m ³) ²
Influence of sample gas flow	u_b 0.025 mg/m ³	0.001	(mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u_{rm} 0.121 mg/m ³	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)

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 0.34 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c * k = u_c * 1.96 \quad 0.66 \text{ mg/m}^3$$

Relative total expanded uncertainty

Requirement of 2010/75/EU

Requirement of EN 15267-3

U in % of the ELV 10 mg/m³ 6.6

U in % of the ELV 10 mg/m³ 40.0

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	OFCEAS

Test report

Test laboratory	936/21228566/D TÜV Rheinland
Date of report	2019-05-20

Measured component

Certification range	NH ₃ 0 - 15 mg/m ³
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Evaluation of the cross-sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	0.00 mg/m ³
Sum of negative CS at zero point	0.00 mg/m ³
Sum of positive CS at span point	0.22 mg/m ³
Sum of negative CS at span point	-0.19 mg/m ³
Maximum sum of cross-sensitivities	0.22 mg/m ³
Uncertainty of cross-sensitivity	u_i 0.126 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

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

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 0.38 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c \cdot k = u_c \cdot 1.96 \quad 0.75 \text{ mg/m}^3$$

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	OFCEAS

Test report

Test laboratory	936/21228566/D
Date of report	TÜV Rheinland
	2019-05-20

Measured component

Certification range	O ₂
	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 positive 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_b	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"

Combined standard uncertainty (u_c)

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 0.31 \text{ Vol.-%}$$

Total expanded uncertainty

$$U = u_c * k = u_c * 1.96 \quad 0.61 \text{ Vol.-%}$$

Relative total expanded uncertainty

Requirement of 2010/75/EU

Requirement of EN 15267-3

U in % of the range 21 Vol.-%

U in % of the range 21 Vol.-%

U in % of the range 21 Vol.-%

2.9

10.0 **

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	OFCEAS

Test report

Test laboratory	936/21228566/D TÜV Rheinland
Date of report	2019-05-20

Measured component

Certification range	SO ₂ 0 - 75 mg/m ³
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Evaluation of the cross-sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	0.00 mg/m ³
Sum of negative CS at zero point	0.00 mg/m ³
Sum of positive CS at span point	1.66 mg/m ³
Sum of negative CS at span point	-0.74 mg/m ³
Maximum sum of cross-sensitivities	1.66 mg/m ³
Uncertainty of cross-sensitivity	u _i 0.957 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

			u ²
Standard deviation from paired measurements under field conditions *	u _D	0.113 mg/m ³	0.013 (mg/m ³) ²
Lack of fit	u _{lof}	0.866 mg/m ³	0.750 (mg/m ³) ²
Zero drift from field test	u _{d.z}	0.130 mg/m ³	0.017 (mg/m ³) ²
Span drift from field test	u _{d.s}	0.866 mg/m ³	0.750 (mg/m ³) ²
Influence of ambient temperature at span	u _t	0.850 mg/m ³	0.723 (mg/m ³) ²
Influence of supply voltage	u _v	0.121 mg/m ³	0.015 (mg/m ³) ²
Cross-sensitivity (interference)	u _i	0.957 mg/m ³	0.916 (mg/m ³) ²
Influence of sample gas flow	u _b	0.189 mg/m ³	0.036 (mg/m ³) ²
Uncertainty of reference material at 70% of certification range	u _{rm}	0.606 mg/m ³	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)

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 1.89 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c * k = u_c * 1.96 \quad 3.71 \text{ mg/m}^3$$

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

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	OFCEAS

Test report

Test laboratory	936/21228566/D TÜV Rheinland
Date of report	2019-05-20

Measured component

Certification range	NO 0 - 78 mg/m ³
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Evaluation of the cross-sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	0.42 mg/m ³
Sum of negative CS at zero point	0.00 mg/m ³
Sum of positive CS at span point	0.00 mg/m ³
Sum of negative CS at span point	-1.30 mg/m ³
Maximum sum of cross-sensitivities	-1.30 mg/m ³
Uncertainty of cross-sensitivity	u_i -0.752 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

			u^2
Standard deviation from paired measurements under field conditions *	u_D 0.721 mg/m ³	0.520 (mg/m ³) ²	
Lack of fit	u_{lof} -0.437 mg/m ³	0.191 (mg/m ³) ²	
Zero drift from field test	$u_{d.z}$ 0.315 mg/m ³	0.099 (mg/m ³) ²	
Span drift from field test	$u_{d.s}$ 1.081 mg/m ³	1.169 (mg/m ³) ²	
Influence of ambient temperature at span	u_t 0.751 mg/m ³	0.564 (mg/m ³) ²	
Influence of supply voltage	u_v 0.347 mg/m ³	0.120 (mg/m ³) ²	
Cross-sensitivity (interference)	u_i -0.752 mg/m ³	0.566 (mg/m ³) ²	
Influence of sample gas flow	u_b 0.444 mg/m ³	0.197 (mg/m ³) ²	
Uncertainty of reference material at 70% of certification range	u_{rm} 0.630 mg/m ³	0.397 (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)

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 1.96 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c \cdot k = u_c \cdot 1.96 \quad 3.83 \text{ mg/m}^3$$

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