

# CERTIFICATE

## of Product Conformity (QAL1)

Certificate No.: 0000059867\_01

**AMS designation:** LaserCEM for CO, NO, NH<sub>3</sub>, O<sub>2</sub>, H<sub>2</sub>O, SO<sub>2</sub> and HCl

**Manufacturer:** AP2E  
240 Rue Louis de Broglie  
13290 Aix-en-Provence  
France

**Test Laboratory:** 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)  
and EN 14181 (2014).**

Certification is awarded in respect of the conditions stated in this certificate  
(this certificate contains 12 pages).  
The present certificate replaces certificate 0000059867 of 5 November 2019.



Suitability Tested  
EN 15267  
QAL1 Certified  
Regular Surveillance

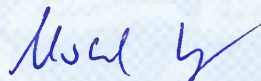
www.tuv.com  
ID 0000059867

Publication in the German Federal Gazette  
(BAnz) of 24 March 2020

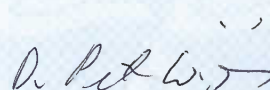
This certificate will expire on:  
23 March 2025

German Federal Environment Agency  
Dessau, 04 June 2020

TÜV Rheinland Energy GmbH  
Cologne, 03 June 2020



Dr. Marcel Langner  
Head of Section II 4.1



ppa. Dr Peter Wilbring

[www.umwelt-tuv.eu](http://www.umwelt-tuv.eu)  
[tre@umwelt-tuv.eu](mailto:tre@umwelt-tuv.eu)  
Phone: + 49 221 806-5200

TÜV Rheinland Energy GmbH  
Am Grauen Stein  
51105 Köln

Test institute accredited to EN ISO/IEC 17025:2005 by DAkkS (German Accreditation Body).  
This accreditation is limited to the accreditation scope defined in the enclosure to certificate D-PL-11120-02-00.

<b>Test Report:</b>	936/21228566/D dated 20 May 2019
<b>Initial certification:</b>	22 July 2019
<b>Expiry date:</b>	23 March 2025
<b>Publication:</b>	BAnz AT 24.03.2020 B7, chapter I number 3.1

### Approved application

The tested AMS is suitable for use at combustion plants according to Directive 2010/75/EU, chapter III (13<sup>th</sup> BImSchV), chapter IV (17<sup>th</sup> BImSchV), 30<sup>th</sup> BImSchV, plants in compliance with TA Luft and plants according to the 27<sup>th</sup> BImSchV. 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 assessed on the basis of a laboratory test and a six-months field test at a municipal waste incineration plant.

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 limit values and oxygen concentrations relevant to the application.

Any potential user should ensure, in consultation with the manufacturer, that this AMS is suitable for the intended purpose.

### Basis of the certification

This certification is based on:

- Test report no. 936/21228566/D dated 20 May 2019 issued by 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 24.03.2020 B7, chapter I number 3.1,  
UBA announcement dated 24 February 2020:

**AMS designation:**

LaserCEM for CO, NO, NH<sub>3</sub>, O<sub>2</sub>, H<sub>2</sub>O, SO<sub>2</sub> and HCl

**Manufacturer:**

AP2E, Aix-en-Provence, France

**Field of application:**

For measurements at plants requiring official approval

**Measuring ranges during performance testing:**

Component	Certification range	supplementary range		Unit
CO	0–75	0–1249	–	mg/m <sup>3</sup>
NO	0–78	0–150	0–2008	mg/m <sup>3</sup>
NH <sub>3</sub>	0–15	0–45	0–76	mg/m <sup>3</sup>
H <sub>2</sub> O	0–30	0–40	–	vol.-%
O <sub>2</sub>	0–21	-	-	vol.-%
SO <sub>2</sub>	0–75	0–2858	–	mg/m <sup>3</sup>
HCl	0–15	0–98	–	mg/m <sup>3</sup>

**Software version:**

3.0.8.24

**Restrictions:**

For the measurement of NO, the HCl concentration present in the waste gas must not exceed 50 mg/m<sup>3</sup>.

**Notes:**

1. The maintenance interval is three months.
2. Wet test gases must be used for testing NH<sub>3</sub> and HCl.
3. Maintenance work must be spread over several days in order to comply with the requirements for outage times specified by the 13<sup>th</sup> BImSchV and 17<sup>th</sup> BImSchV.
4. Supplementary testing (extension of the maintenance interval) as regards Federal Environment Agency (UBA) notice of 28 June 2019 (BAnz AT 22.07.2019 B8, chapter I number 1.1).

**Test Report:**

TÜV Rheinland Energy GmbH, Cologne  
Report no.: 936/21228566/D dated 20 May 2019

### Certified product

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

The LaserCEM is a multi-component measuring system which operates at low pressure and uses infrared laser spectroscopy as its measuring principle. This principle combines absorption spectroscopy enhanced by a cavity with optical feedback (OFCEAS: Optical Feedback Cavity Enhanced Absorption Spectroscopy) and low pressure sampling (LPS).

The sample gas conditioning unit consists of a heated CEM probe which comprises two components: a critical nozzle and a 2 µm filter made of sintered stainless steel. The probe is connected to a heated sample gas line which is equipped with an inner liner made of PTFE.

The AMS tested here comprises the following components:

- CEM sample probe with critical nozzle and 2 µm filter
- Heated sample gas line, temperature 80 °C, inner diameter ~ 6 mm, material PTFE
- Analyser cabinet c/w:
  - 2 LaserCEM analyser modules
  - Sample gas hoses
  - (Vacuum) pump

With the exemption of the heated sampling probe and the heated sample gas line, all other components are installed in a lockable measurement cabinet together with the electronics distribution and the modules.

### General remarks

This certificate is based upon the equipment tested. The manufacturer is responsible for ensuring that on-going production complies with the requirements of the EN 15267. The manufacturer is required to maintain an approved quality management system controlling the manufacturing process for the certified product. Both the product and the quality management systems shall be subject to regular surveillance.

If a product of the current production does not conform to the certified product, TÜV Rheinland Energy GmbH must be notified at the address given on page 1.

A certification mark with an ID-Number that is specific to the certified product is presented on page 1 of this certificate.

This document as well as the certification mark remains property of TÜV Rheinland Energy GmbH. Upon revocation of the publication the certificate loses its validity. After the expiration of the certificate and on request of TÜV Rheinland Energy GmbH this document shall be returned and the certificate mark must no longer be used.

The relevant version of this certificate and its expiration date are also accessible on the internet at [gal1.de](http://gal1.de).

### **Document history**

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

#### **Initial certification according to EN 15267**

Certificate no. 0000059867: 05 November 2019  
Expiry date of the certificate: 21 July 2024  
Test report: 936/21228566/C dated 7 March 2019  
TÜV Rheinland Energy GmbH, Cologne  
Publication: BAnz AT 22.07.2019 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, Cologne  
Publication: BAnz AT 24.03.2020 B7, chapter I number 3.1  
UBA announcement dated 24 February 2020



### 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	TÜV Rheinland
Date of report	2019-05-20

#### Measured component

Certification range	CO	0 - 75 mg/m <sup>3</sup>
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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 <sup>3</sup>
Sum of negative CS at zero point	0.00 mg/m <sup>3</sup>
Sum of positive CS at span point	0.32 mg/m <sup>3</sup>
Sum of negative CS at span point	-1.47 mg/m <sup>3</sup>
Maximum sum of cross-sensitivities	-1.47 mg/m <sup>3</sup>
Uncertainty of cross-sensitivity	$u_i$ -0.849 mg/m <sup>3</sup>

#### Calculation of the combined standard uncertainty

##### Tested parameter

		$u^2$
Repeatability standard deviation at set point *	$u_r$ 0.300 mg/m <sup>3</sup>	0.090 (mg/m <sup>3</sup> ) <sup>2</sup>
Lack of fit	$u_{lof}$ 0.433 mg/m <sup>3</sup>	0.187 (mg/m <sup>3</sup> ) <sup>2</sup>
Zero drift from field test	$u_{d,z}$ 0.260 mg/m <sup>3</sup>	0.068 (mg/m <sup>3</sup> ) <sup>2</sup>
Span drift from field test	$u_{d,s}$ 0.953 mg/m <sup>3</sup>	0.908 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of ambient temperature at span	$u_t$ 0.404 mg/m <sup>3</sup>	0.163 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of supply voltage	$u_v$ 0.104 mg/m <sup>3</sup>	0.011 (mg/m <sup>3</sup> ) <sup>2</sup>
Cross-sensitivity (interference)	$u_i$ -0.849 mg/m <sup>3</sup>	0.721 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of sample gas flow	$u_n$ -0.325 mg/m <sup>3</sup>	0.106 (mg/m <sup>3</sup> ) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	$u_{rm}$ 0.606 mg/m <sup>3</sup>	0.368 (mg/m <sup>3</sup> ) <sup>2</sup>

\* The larger value is used :

"Repeatability standard deviation at set point" or

"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty ( $u_c$ )

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 1.62 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c * k = u_c * 1.96 \quad 3.17 \text{ mg/m}^3$$

#### Relative total expanded uncertainty

##### Requirement of 2010/75/EU

Requirement of EN 15267-3

U in % of the ELV 50 mg/m<sup>3</sup> **6.3**

U in % of the ELV 50 mg/m<sup>3</sup> **10.0**

U in % of the ELV 50 mg/m<sup>3</sup> **7.5**

**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 <sub>2</sub> O	0 - 30 Vol.-%
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**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.-%) <sup>2</sup>
Lack of fit	$u_{lof}$	0.161	Vol.-%	0.026 (Vol.-%) <sup>2</sup>
Zero drift from field test	$u_{d,z}$	0.121	Vol.-%	0.015 (Vol.-%) <sup>2</sup>
Span drift from field test	$u_{d,s}$	-0.433	Vol.-%	0.187 (Vol.-%) <sup>2</sup>
Influence of ambient temperature at span	$u_t$	0.351	Vol.-%	0.123 (Vol.-%) <sup>2</sup>
Influence of supply voltage	$u_v$	0.198	Vol.-%	0.039 (Vol.-%) <sup>2</sup>
Cross-sensitivity (interference)	$u_i$	0.364	Vol.-%	0.132 (Vol.-%) <sup>2</sup>
Influence of sample gas flow	$u_b$	0.025	Vol.-%	0.001 (Vol.-%) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	$u_{rm}$	0.242	Vol.-%	0.059 (Vol.-%) <sup>2</sup>

\* 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**

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

**Calculation of the combined standard uncertainty**

**Tested parameter**

Standard deviation from paired measurements under field conditions *	$u_D$	0.058 mg/m <sup>3</sup>	$u^2$	0.003 (mg/m <sup>3</sup> ) <sup>2</sup>
Lack of fit	$u_{lof}$	0.108 mg/m <sup>3</sup>	0.012	(mg/m <sup>3</sup> ) <sup>2</sup>
Zero drift from field test	$u_{d,z}$	0.139 mg/m <sup>3</sup>	0.019	(mg/m <sup>3</sup> ) <sup>2</sup>
Span drift from field test	$u_{d,s}$	0.208 mg/m <sup>3</sup>	0.043	(mg/m <sup>3</sup> ) <sup>2</sup>
Influence of ambient temperature at span	$u_t$	0.100 mg/m <sup>3</sup>	0.010	(mg/m <sup>3</sup> ) <sup>2</sup>
Influence of supply voltage	$u_v$	0.030 mg/m <sup>3</sup>	0.001	(mg/m <sup>3</sup> ) <sup>2</sup>
Cross-sensitivity (interference)	$u_i$	0.103 mg/m <sup>3</sup>	0.011	(mg/m <sup>3</sup> ) <sup>2</sup>
Influence of sample gas flow	$u_n$	0.025 mg/m <sup>3</sup>	0.001	(mg/m <sup>3</sup> ) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	$u_{rm}$	0.121 mg/m <sup>3</sup>	0.015	(mg/m <sup>3</sup> ) <sup>2</sup>

\* 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

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

**Relative total expanded uncertainty**

Requirement of 2010/75/EU

Requirement of EN 15267-3

**U in % of the ELV 10 mg/m<sup>3</sup> 6.6**

**U in % of the ELV 10 mg/m<sup>3</sup> 40.0**

**U in % of the ELV 10 mg/m<sup>3</sup> 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	NH <sub>3</sub>	0 - 15 mg/m <sup>3</sup>
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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 <sup>3</sup>
Sum of negative CS at zero point	0.00 mg/m <sup>3</sup>
Sum of positive CS at span point	0.22 mg/m <sup>3</sup>
Sum of negative CS at span point	-0.19 mg/m <sup>3</sup>
Maximum sum of cross-sensitivities	0.22 mg/m <sup>3</sup>
Uncertainty of cross-sensitivity	$u_i$ 0.126 mg/m <sup>3</sup>

**Calculation of the combined standard uncertainty**

**Tested parameter**

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

\* 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

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

**Relative total expanded uncertainty**

Requirement of 2010/75/EU

**U in % of the ELV 10 mg/m<sup>3</sup> 7.5**

Requirement of EN 15267-3

**U in % of the ELV 10 mg/m<sup>3</sup> 40.0**

**U in % of the ELV 10 mg/m<sup>3</sup> 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	NO	0 - 78 mg/m <sup>3</sup>
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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 <sup>3</sup>
Sum of negative CS at zero point	0.00 mg/m <sup>3</sup>
Sum of positive CS at span point	0.00 mg/m <sup>3</sup>
Sum of negative CS at span point	-1.30 mg/m <sup>3</sup>
Maximum sum of cross-sensitivities	-1.30 mg/m <sup>3</sup>
Uncertainty of cross-sensitivity	$u_i$ -0.752 mg/m <sup>3</sup>

**Calculation of the combined standard uncertainty**

**Tested parameter**

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

\* 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/m <sup>3</sup>
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	3.83 mg/m <sup>3</sup>

**Relative total expanded uncertainty**

Requirement of 2010/75/EU	<b>U in % of the ELV 50 mg/m<sup>3</sup></b>	<b>7.7</b>
Requirement of EN 15267-3	<b>U in % of the ELV 50 mg/m<sup>3</sup></b>	<b>20.0</b>
	<b>U in % of the ELV 50 mg/m<sup>3</sup></b>	<b>15.0</b>



**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 <sub>2</sub>	0 - 21 Vol.-%
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**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 <sub>i</sub>	-0.197 Vol.-%

**Calculation of the combined standard uncertainty**

**Tested parameter**

			u <sup>2</sup>
Standard deviation from paired measurements under field conditions *	u <sub>D</sub>	0.091 Vol.-%	0.008 (Vol.-%) <sup>2</sup>
Lack of fit	u <sub>lof</sub>	0.058 Vol.-%	0.003 (Vol.-%) <sup>2</sup>
Zero drift from field test	u <sub>d,z</sub>	0.029 Vol.-%	0.001 (Vol.-%) <sup>2</sup>
Span drift from field test	u <sub>d,s</sub>	0.069 Vol.-%	0.005 (Vol.-%) <sup>2</sup>
Influence of ambient temperature at span	u <sub>t</sub>	0.107 Vol.-%	0.011 (Vol.-%) <sup>2</sup>
Influence of supply voltage	u <sub>v</sub>	0.012 Vol.-%	0.000 (Vol.-%) <sup>2</sup>
Cross-sensitivity (interference)	u <sub>i</sub>	-0.197 Vol.-%	0.039 (Vol.-%) <sup>2</sup>
Influence of sample gas flow	u <sub>b</sub>	0.023 Vol.-%	0.001 (Vol.-%) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	u <sub>rm</sub>	0.170 Vol.-%	0.029 (Vol.-%) <sup>2</sup>

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

Combined standard uncertainty (u <sub>c</sub> )	$u_c = \sqrt{\sum (u_{max,j})^2}$	0.31	Vol.-%
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	0.61	Vol.-%

**Relative total expanded uncertainty**

<b>Requirement of 2010/75/EU</b>	<b>U in % of the range 21 Vol.-%</b>	<b>2.9</b>
Requirement of EN 15267-3	U in % of the range 21 Vol.-%	10.0 **
	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	OFCEAS

**Test report**

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

**Measured component**

Certification range	SO <sub>2</sub> 0 - 75 mg/m <sup>3</sup>
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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 <sup>3</sup>
Sum of negative CS at zero point	0.00 mg/m <sup>3</sup>
Sum of positive CS at span point	1.66 mg/m <sup>3</sup>
Sum of negative CS at span point	-0.74 mg/m <sup>3</sup>
Maximum sum of cross-sensitivities	1.66 mg/m <sup>3</sup>
Uncertainty of cross-sensitivity	u <sub>i</sub> 0.957 mg/m <sup>3</sup>

**Calculation of the combined standard uncertainty**

**Tested parameter**

			u <sup>2</sup>
Standard deviation from paired measurements under field conditions *	u <sub>D</sub> 0.113 mg/m <sup>3</sup>		0.013 (mg/m <sup>3</sup> ) <sup>2</sup>
Lack of fit	u <sub>inf</sub> 0.866 mg/m <sup>3</sup>		0.750 (mg/m <sup>3</sup> ) <sup>2</sup>
Zero drift from field test	u <sub>d,z</sub> 0.130 mg/m <sup>3</sup>		0.017 (mg/m <sup>3</sup> ) <sup>2</sup>
Span drift from field test	u <sub>d,s</sub> 0.866 mg/m <sup>3</sup>		0.750 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of ambient temperature at span	u <sub>t</sub> 0.850 mg/m <sup>3</sup>		0.723 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of supply voltage	u <sub>v</sub> 0.121 mg/m <sup>3</sup>		0.015 (mg/m <sup>3</sup> ) <sup>2</sup>
Cross-sensitivity (interference)	u <sub>i</sub> 0.957 mg/m <sup>3</sup>		0.916 (mg/m <sup>3</sup> ) <sup>2</sup>
Influence of sample gas flow	u <sub>n</sub> 0.189 mg/m <sup>3</sup>		0.036 (mg/m <sup>3</sup> ) <sup>2</sup>
Uncertainty of reference material at 70% of certification range	u <sub>rm</sub> 0.606 mg/m <sup>3</sup>		0.368 (mg/m <sup>3</sup> ) <sup>2</sup>

\* The larger value is used :

"Repeatability standard deviation at set point" or

"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u<sub>c</sub>)

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

Total expanded uncertainty

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

**Relative total expanded uncertainty**

Requirement of 2010/75/EU

**U in % of the ELV 50 mg/m<sup>3</sup> 7.4**

Requirement of EN 15267-3

**U in % of the ELV 50 mg/m<sup>3</sup> 20.0**

U in % of the ELV 50 mg/m<sup>3</sup> 15.0