

CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000040210_03

AMS designation: Smart CEMS for CO, NO, NO₂, NO_x, SO₂, CO₂ and O₂

Manufacturer: Kontram Oy
Tuupakantie 32 a
01740 Vantaa
Finland

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 (2004)

invalid since

Certification is awarded in respect of the conditions stated in this certificate
(this certificate contains 17 pages).
The present certificate replaces certificate 0000040210_01 of 01 April 2019.

2022-12-30



Suitability tested
EN 15267
QAL1 Certified
Regular Surveillance

www.tuv.com
ID 0000040210

Publication in the German Federal Gazette
(BAnz) of 01 April 2014

This certificate will expire on:
30 June 2025

German Federal Environment Agency
Dessau, 01 July 2020

TÜV Rheinland Energy GmbH
Cologne, 30 June 2020

Dr. Marcel Langner
Head of Section II 4.1

ppa. Dr. Peter Wilbring

www.umwelt-tuv.eu
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 by DAkkS (German Accreditation Body).
This accreditation is limited to the accreditation scope defined in the enclosure to certificate D-PL-11120-02-00.

Test Report:	936/21218430/B dated 2 April 2014
Initial certification:	01 April 2014
Expiry date:	30 June 2025
Certificate:	Renewal (of previous certificate 0000040210_01 dated 01 April 2019 valid until 30 June 2020)
Publication:	BAnz AT 05.08.2014 B11, chapter I number 5.1

Approved application

The tested AMS is suitable for use at combustion plants according to Directive 2010/75/EU, chapter III (13th 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 five-months field test at a municipal waste incinerator.

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 936/21218430/B dated 2 April 2014 issued by TÜV Rheinland Energie und Umwelt GmbH
- Suitability announced by the German Federal Environment Agency (UBA) as the relevant body
- The ongoing surveillance of the product and the manufacturing process

6. Supplementary testing (extension to include the component O₂ for T60i and S4900 as well as an extension to include to a second type of gas sampling probe) as regards Federal Environment Agency notices of 27 February 2014 (BAnz AT 01.04.2014 B12, chapter I number 4.1).

Test Report:

TÜV Rheinland Energie und Umwelt GmbH, Cologne
Report no.: 936/21218430/B dated 2 April 2014

Publication in the German Federal Gazette: BAnz AT 14.03.2016 B7, chapter V notification 24, UBA announcement dated 18 February 2016:

24 Notification as regards Federal Environment Agency (UBA) notice of 17 July 2014 (BAnz AT 05.08.2014 B11, chapter I number 5.1).

The CEMS measuring system for CO, NO, NO₂, NO_x, SO₂, CO₂ and O₂ manufactured by Kontram Oy has been revised technically. For the new version, the front door with an integrated control display has replaced the original transparent front door.

This display serves as the central control unit for the temperature of gas conditioning and applying test gases. A type 18112 pressure control manufactured by Fairchild has replaced the type 16232 by the same manufacturer which had previously been used. The reed or pump for the purge air of the purification dryer was relocated to the SC unit. If the CEMS T60i measurement unit is built-in, an external humidity sensor is not required in that case the internal humidity sensor of the CEMS T60i module is used to protect the system from drops of water.

The new version of the measuring system has been renamed "Smart CEMS" instead of "CEMS".

The new software version of the analyser module CEMS T60i is: 02.02.08. 02.02.08.

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 23 October 2015

Publication in the German Federal Gazette: BAnz AT 24.03.2020 B7, chapter IV notification 56, UBA announcement dated 24 February 2020:

56 Notification as regards Federal Environment Agency (UBA) notices of 17 February 2014 (BAnz AT 05.08.2014 B11, chapter I number 5.1) and of 18 July 2016 (BAnz AT 14.03.2016 B7, chapter V 24th notification)

The latest software version of the CEMS T60i measuring module in the Smart CEMS measuring system for CO, NO, NO₂, NO_x, SO₂, CO₂ and O₂ manufactured by Kontram Oy is:
02.02.09

Statement issued by TÜV Rheinland Energy GmbH dated 23 September 2019

Certified product

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

The AMS is a modular measuring system comprised of up to two different analysers T60i and/or S4900.

The tested AMS consist of:

- Heated sample gas probe
 - JCT, type JES301 with gas filter element (SiC 2 µm) or
 - Bühler TYP GAS 222.20 with gas filter element (ceramic 3 µm)
- 50 m heated sampling hose in the field test, 180 °C, 6 mm PTFE gas tubing (a heated 5 m sampling hose was used in the laboratory)
- Measuring cabinet CEMS with sample gas pump (ejection pump)
Permeation dryer (PD-100T-24MSS, Permapure)
Flow volume regulator
- Up to two analyser modules T60i, T60i + S4900 or 2 x S4900

Analyser module T60i

The T60i module measures exhaust gas components using a non-dispersive infra-red analyser (NDIR) (this means that the measuring system uses optical band-pass filters rather than diffraction gratings or prisms).

For oxygen a paramagnetic oxygen measuring cell is used.

Analyser module S4900

A separate measuring cell with single-beam measurement with gas filter correlation is used for carbon monoxide, nitrogen monoxide and sulphur dioxide.

For oxygen, a paramagnetic oxygen measuring cell is used.

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 qal1.de.

invalid since
2022-12-30

Document history

Certification of the Smart CEMS 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. 0000040210: 29 April 2014
Expiry date of the certificate: 31 March 2019
Test report no.: 936/21218430/A dated 8 October 2013
TÜV Rheinland Energie und Umwelt GmbH, Cologne
Publication: BAnz AT 01.04.2014 B12, chapter I number 4.1
UBA announcement dated 27 February 2014

Supplementary testing according to EN 15267

Certificate no. 0000040210_01: 09 September 2014
Expiry date of the certificate: 31 March 2019
Test report no.: 936/21218430/B dated 2 April 2014
TÜV Rheinland Energie und Umwelt GmbH, Cologne
Publication: BAnz AT 05.08.2014 B11, chapter I number 5.1
UBA announcement dated 17 July 2014

Notifications in accordance with EN 15267

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 23 October 2015
Publication: BAnz AT 14.03.2016 B7, chapter V notification 24
UBA announcement dated 18 February 2016
(Software and design changes and renaming of the AMS)

Renewal of the certificate

Certificate no. 0000040210_02: 01 April 2019
Expiry date of the certificate: 30 June 2020

Notifications in accordance with EN 15267

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 23 September 2019
Publication: BAnz AT 24.03.2020 B7, chapter V notification 56
UBA announcement dated 24 February 2020
(software updates)

Renewal of the certificate

Certificate no. 0000040210_03: 01 July 2020
Expiry date of the certificate: 30 June 2025

invalid since
2022-12-30

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

Measuring system

Manufacturer	Kontram Oy
AMS designation	CEMS_S4900
Serial number of units under test	CEMS 1 / CEMS 2
Measuring principle	IR-Spectroscopy

Test report

Test laboratory	936/21218430/B
Date of report	TÜV Rheinland
	2014-04-02

Measured component

Certification range	CO
	0 - 125 mg/m³

Evaluation of the cross-sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	1.10 mg/m³
Sum of negative CS at zero point	0.00 mg/m³
Sum of positive CS at span point	-1.60 mg/m³
Sum of negative CS at span point	-2.70 mg/m³
Maximum sum of cross-sensitivities	-2.70 mg/m³
Uncertainty of cross-sensitivity	-1.55 mg/m³

Calculation of the combined standard uncertainty

Tested parameter

Tested parameter		u²
Standard deviation from paired measurements under field conditions *	u _D 0.613 mg/m³	0.376 (mg/m³)²
Lack of fit	u _L 0.577 mg/m³	0.333 (mg/m³)²
Zero drift from field test	u _{d,z} -0.869 mg/m³	0.755 (mg/m³)²
Span drift from field test	u _{d,s} 2.983 mg/m³	8.898 (mg/m³)²
Influence of ambient temperature at span	u _t 1.274 mg/m³	1.623 (mg/m³)²
Influence of supply voltage	u _v 0.611 mg/m³	0.373 (mg/m³)²
Cross-sensitivity (interference)	u _i -1.559 mg/m³	2.430 (mg/m³)²
Influence of sample gas flow	u _p -0.150 mg/m³	0.023 (mg/m³)²
Uncertainty of reference material at 70% of certification range	u _{rm} 1.010 mg/m³	1.021 (mg/m³)²

* The larger value is used :

"Repeatability standard deviation at span" or

"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_c)

$$u_c = \sqrt{\sum (u_{\max, j})^2} \quad 3.98 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c * k = u_c * 1.96 \quad 7.80 \text{ mg/m}^3$$

Relative total expanded uncertainty

U in % of the ELV 110 mg/m³ **7.1**

Requirement of 2010/75/EU

U in % of the ELV 110 mg/m³ **10.0**

Requirement of EN 15267-3

U in % of the ELV 110 mg/m³ **7.5**

**invalid since
2022-12-30**

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

Measuring system

Manufacturer	Kontram Oy
AMS designation	CEMS_S4900
Serial number of units under test	CEMS 1 / CEMS 2
Measuring principle	IR-Spectroscopy

Test report

Test laboratory	936/21218430/B
Date of report	TÜV Rheinland
	2014-04-02

Measured component

Certification range	NO	0 - 121 mg/m³
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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	-1.45 mg/m³
Sum of positive CS at span point	0.80 mg/m³
Sum of negative CS at span point	-3.00 mg/m³
Maximum sum of cross-sensitivities	-3.00 mg/m³
Uncertainty of cross-sensitivity	-1.732 mg/m³

Calculation of the combined standard uncertainty

Tested parameter

Standard deviation from paired measurements under field conditions *	u_{df}	1.657 mg/m³	3.488 (mg/m³)²
Lack of fit	u_{lof}	-0.629 mg/m³	0.396 (mg/m³)²
Zero drift from field test	$u_{d,z}$	-1.707 mg/m³	2.914 (mg/m³)²
Span drift from field test	$u_{d,s}$	-2.096 mg/m³	4.393 (mg/m³)²
Influence of ambient temperature at span	u_t	2.095 mg/m³	4.388 (mg/m³)²
Influence of supply voltage	u_v	0.407 mg/m³	0.166 (mg/m³)²
Cross-sensitivity (interference)	u_i	-1.332 mg/m³	1.774 (mg/m³)²
Influence of sample gas flow	u_p	-0.332 mg/m³	0.110 (mg/m³)²
Uncertainty of reference material at 50% of certification range	u_{ref}	0.078 mg/m³	0.006 (mg/m³)²

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

Combined standard uncertainty (u_c)	$u_c = \sqrt{\sum (u_{max, j})^2}$	4.45 mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	8.72 mg/m³

Relative total expanded uncertainty

Requirement of 2010/75/EU	U in % of the ELV 60 mg/m³	14.5
Requirement of EN 15267-3	U in % of the ELV 60 mg/m³	20.0
	U in % of the ELV 60 mg/m³	15.0

invalid since
2022-12-30

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

Measuring system

Manufacturer	Kontram Oy
AMS designation	CEMS_S4900
Serial number of units under test	CEMS 1 / CEMS 2
Measuring principle	Paramagnetic

Test report

Test laboratory	936/21218430/B
Date of report	TÜV Rheinland
	2014-04-02

Measured component

Certification range	O ₂	0 - 25 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	-0.37	Vol.-%
Maximum sum of cross-sensitivities	-0.37	Vol.-%
Uncertainty of cross-sensitivity	-0.214	Vol.-%

Calculation of the combined standard uncertainty

Tested parameter

Standard deviation from paired measurements under field conditions *	u_p	0.100	Vol.-%	0.010 (Vol.-%) ²
Lack of fit	u_{lof}	0.058	Vol.-%	0.003 (Vol.-%) ²
Zero drift from field test	$u_{d,z}$	-0.081	Vol.-%	0.007 (Vol.-%) ²
Span drift from field test	$u_{d,s}$	0.098	Vol.-%	0.010 (Vol.-%) ²
Influence of ambient temperature at span	u_t	0.118	Vol.-%	0.014 (Vol.-%) ²
Influence of supply voltage	u_v	0.017	Vol.-%	0.000 (Vol.-%) ²
Cross-sensitivity (interference)	u_i	-0.214	Vol.-%	0.046 (Vol.-%) ²
Influence of sample gas flow	u_p	-0.057	Vol.-%	0.003 (Vol.-%) ²
Uncertainty of reference material at 25% of certification range	u_{ref}	0.022	Vol.-%	0.001 (Vol.-%) ²

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

Combined standard uncertainty (u_c)	$u_c = \sqrt{\sum (u_{max,i})^2}$	0.37	Vol.-%
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	0.72	Vol.-%

Relative total expanded uncertainty

Requirement of 2010/75/EU	U in % of the range 25 Vol.-%	2.9
Requirement of EN 15267-3	U in % of the range 25 Vol.-%	10.0 **
	U in % of the range 25 Vol.-%	7.5

** The EU-directive 2010/75/EU on industrial emissions provides no requirements for this component.
The chosen value is recommended by the certification body.

invalid since
2022-12-30

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

Measuring system

Manufacturer	Kontram Oy
AMS designation	CEMS_S4900
Serial number of units under test	CEMS 1 / CEMS 2
Measuring principle	IR-Spectroscopy

Test report

Test laboratory	TÜV Rheinland
Date of report	2014-04-02

Measured component

Certification range	SO ₂	0 - 486 mg/m ³
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Evaluation of the cross-sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	2.29 mg/m ³
Sum of negative CS at zero point	-2.99 mg/m ³
Sum of positive CS at span point	12.50 mg/m ³
Sum of negative CS at span point	-19.37 mg/m ³
Maximum sum of cross-sensitivities	-19.37 mg/m ³
Uncertainty of cross-sensitivity	-11.785 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

Standard deviation from paired measurements under field conditions *	$u_{d,p}$	4.190 mg/m ³	20.161 (mg/m ³) ²
Lack of fit	u_{lof}	2.296 mg/m ³	5.272 (mg/m ³) ²
Zero drift from field test	$u_{d,z}$	-4.186 mg/m ³	17.523 (mg/m ³) ²
Span drift from field test	$u_{d,s}$	8.418 mg/m ³	70.863 (mg/m ³) ²
Influence of ambient temperature at span	u_t	0.784 mg/m ³	7.741 (mg/m ³) ²
Influence of supply voltage	u_v	2.150 mg/m ³	9.563 (mg/m ³) ²
Cross-sensitivity (interference)	u_i	-11.785 mg/m ³	15.104 (mg/m ³) ²
Influence of sample gas flow	u_p	1.169 mg/m ³	1.367 (mg/m ³) ²
Uncertainty of reference material at 100% of certification range	u_{rm}	3.928 mg/m ³	15.431 (mg/m ³) ²

* The larger value is used :

"Repeatability standard deviation at span" or

"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_c)

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 16.46 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c \cdot k = u_c \cdot 1.96 \quad 32.27 \text{ mg/m}^3$$

Relative total expanded uncertainty

U in % of the ELV 250 mg/m³ **12.9**

Requirement of 2010/75/EU

U in % of the ELV 250 mg/m³ **20.0**

Requirement of EN 15267-3

U in % of the ELV 250 mg/m³ 15.0

invalid since
2022-12-30

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

Measuring system

Manufacturer	Kontram Oy
AMS designation	CEMS_T60i
Serial number of units under test	CEMS 1 / CEMS 2
Measuring principle	IR-Spectroscopy

Test report

Test laboratory	936/21218430/B
Date of report	TÜV Rheinland
	2014-04-02

Measured component

Certification range	CO	0 - 250 mg/m³
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Evaluation of the cross-sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	1.20 mg/m³
Sum of negative CS at zero point	0.00 mg/m³
Sum of positive CS at span point	9.60 mg/m³
Sum of negative CS at span point	-8.30 mg/m³
Maximum sum of cross-sensitivities	9.60 mg/m³
Uncertainty of cross-sensitivity	5.543 mg/m³

Calculation of the combined standard uncertainty

Tested parameter

Repeatability standard deviation at span point*	u_r	1.006 mg/m³	1.012 (mg/m³)²
Lack of fit	u_{lof}	1.155 mg/m³	1.334 (mg/m³)²
Zero drift from field test	$u_{d,z}$	0.239 mg/m³	0.057 (mg/m³)²
Span drift from field test	$u_{d,s}$	1.465 mg/m³	2.146 (mg/m³)²
Influence of ambient temperature at span	u_t	1.053 mg/m³	1.109 (mg/m³)²
Influence of supply voltage	u_v	1.319 mg/m³	1.741 (mg/m³)²
Cross-sensitivity (interference)	u_i	5.043 mg/m³	25.725 (mg/m³)²
Influence of sample gas flow	u_p	1.293 mg/m³	1.672 (mg/m³)²
Uncertainty of reference material at 90% of certification range	u_{ref}	0.991 mg/m³	0.982 (mg/m³)²

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

Combined standard uncertainty (u_c)	$u_c = \sqrt{\sum (u_{max,i})^2}$	6.70 mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	13.13 mg/m³

Relative total expanded uncertainty

Requirement of 2010/75/EU	U in % of the ELV 175 mg/m³	7.5
Requirement of EN 15267-3	U in % of the ELV 175 mg/m³	10.0
	U in % of the ELV 175 mg/m³	7.5

**invalid since
2022-12-30**

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

Measuring system

Manufacturer	Kontram Oy
AMS designation	CEMS_T60i
Serial number of units under test	CEMS 1 / CEMS 2
Measuring principle	IR-Spectroscopy

Test report

Test laboratory	936/21218430/B
Date of report	TÜV Rheinland
	2014-04-02

Measured component

Certification range	CO ₂	0 - 25 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	0.20	Vol.-%
Sum of negative CS at span point	-0.80	Vol.-%
Maximum sum of cross-sensitivities	-0.80	Vol.-%
Uncertainty of cross-sensitivity	-0.462	Vol.-%

Calculation of the combined standard uncertainty

Tested parameter

Standard deviation from paired measurements under field conditions *	u_p	0.132	Vol.-%	0.035	(Vol.-%) ²
Lack of fit	u_{lof}	0.058	Vol.-%	0.003	(Vol.-%) ²
Zero drift from field test	$u_{d,z}$	-0.075	Vol.-%	0.006	(Vol.-%) ²
Span drift from field test	$u_{d,s}$	0.294	Vol.-%	0.086	(Vol.-%) ²
Influence of ambient temperature at span	u_t	0.008	Vol.-%	0.048	(Vol.-%) ²
Influence of supply voltage	u_v	0.001	Vol.-%	0.003	(Vol.-%) ²
Cross-sensitivity (interference)	u_i	-0.162	Vol.-%	0.213	(Vol.-%) ²
Influence of sample gas flow	u_p	0.078	Vol.-%	0.006	(Vol.-%) ²
Uncertainty of reference material at 25% of certification range	u_{ref}	0.002	Vol.-%	0.004	(Vol.-%) ²

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

Combined standard uncertainty (u_c)	$u_c = \sqrt{\sum (u_{max, j})^2}$	0.66	Vol.-%
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	1.29	Vol.-%

Relative total expanded uncertainty

Requirement of 2010/75/EU	U in % of the range 25 Vol.-%	5.2
Requirement of EN 15267-3	U in % of the range 25 Vol.-%	10.0 **
	U in % of the range 25 Vol.-%	7.5

** The EU-directive 2010/75/EU on industrial emissions provides no requirements for this component.
The chosen value is recommended by the certification body.

invalid since
2022-12-30

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

Measuring system

Manufacturer	Kontram Oy
AMS designation	CEMS_T60i
Serial number of units under test	CEMS 1 / CEMS 2
Measuring principle	IR-Spectroscopy

Test report

Test laboratory	936/21218430/B
Date of report	TÜV Rheinland
	2014-04-02

Measured component

Certification range	NO	0 - 121 mg/m³
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Evaluation of the cross-sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	0.64 mg/m³
Sum of negative CS at zero point	-2.11 mg/m³
Sum of positive CS at span point	2.90 mg/m³
Sum of negative CS at span point	-1.50 mg/m³
Maximum sum of cross-sensitivities	2.90 mg/m³
Uncertainty of cross-sensitivity	1.677 mg/m³

Calculation of the combined standard uncertainty

Tested parameter

Standard deviation from paired measurements under field conditions *	u_p	1.662 mg/m³	2.762 (mg/m³)²
Lack of fit	u_{lof}	-0.692 mg/m³	0.479 (mg/m³)²
Zero drift from field test	$u_{d,z}$	1.648 mg/m³	2.716 (mg/m³)²
Span drift from field test	$u_{d,s}$	2.096 mg/m³	4.393 (mg/m³)²
Influence of ambient temperature at span	u_t	1.134 mg/m³	1.285 (mg/m³)²
Influence of supply voltage	u_v	0.404 mg/m³	0.163 (mg/m³)²
Cross-sensitivity (interference)	u_i	1.577 mg/m³	2.812 (mg/m³)²
Influence of sample gas flow	u_p	0.568 mg/m³	0.323 (mg/m³)²
Uncertainty of reference material at 90% of certification range	u_{ref}	0.278 mg/m³	0.077 (mg/m³)²

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

Combined standard uncertainty (u_c)	$u_c = \sqrt{\sum (u_{max,i})^2}$	4.02 mg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	7.87 mg/m³

Relative total expanded uncertainty

Requirement of 2010/75/EU	U in % of the ELV 55 mg/m³	14.3
Requirement of EN 15267-3	U in % of the ELV 55 mg/m³	20.0
	U in % of the ELV 55 mg/m³	15.0

invalid since
2022-12-30

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

Measuring system

Manufacturer	Kontram Oy
AMS designation	CEMS_T60i
Serial number of units under test	CEMS 1 / CEMS 2
Measuring principle	IR-Spectroscopy

Test report

Test laboratory	936/21218430/B
Date of report	TÜV Rheinland
	2014-04-02

Measured component

Certification range	NO ₂
	0 - 185 mg/m ³

Evaluation of the cross-sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	2.06 mg/m ³
Sum of negative CS at zero point	0.00 mg/m ³
Sum of positive CS at span point	3.02 mg/m ³
Sum of negative CS at span point	-6.11 mg/m ³
Maximum sum of cross-sensitivities	-6.11 mg/m ³
Uncertainty of cross-sensitivity	-3.527 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

Repeatability standard deviation at span point*	u_r	0.156 mg/m ³	0.581 (mg/m ³) ²
Lack of fit	u_{lof}	-1.186 mg/m ³	1.407 (mg/m ³) ²
Zero drift from field test	$u_{d,z}$	2.601 mg/m ³	6.765 (mg/m ³) ²
Span drift from field test	$u_{d,s}$	3.031 mg/m ³	9.187 (mg/m ³) ²
Influence of ambient temperature at span	u_t	1.082 mg/m ³	7.925 (mg/m ³) ²
Influence of supply voltage	u_v	0.911 mg/m ³	0.962 (mg/m ³) ²
Cross-sensitivity (interference)	u_i	-7.927 mg/m ³	2.440 (mg/m ³) ²
Influence of sample gas flow	u_p	1.743 mg/m ³	3.038 (mg/m ³) ²
Uncertainty of reference material at 50% of certification range	u_m	1.195 mg/m ³	2.926 (mg/m ³) ²

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

Combined standard uncertainty (u_c)	$u_c = \sqrt{\sum (u_{max, j})^2}$	6.28 mg/m ³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	12.31 mg/m ³

Relative total expanded uncertainty

Requirement of 2010/75/EU	U in % of the ELV 85 mg/m³	14.5
Requirement of EN 15267-3	U in % of the ELV 85 mg/m³	20.0
	U in % of the ELV 85 mg/m³	15.0

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2022-12-30

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

Measuring system

Manufacturer	Kontram Oy
AMS designation	CEMS_T60i
Serial number of units under test	CEMS 1 / CEMS 2
Measuring principle	Paramagnetic

Test report

Test laboratory	936/21218430/B
Date of report	TÜV Rheinland
	2014-04-02

Measured component

Certification range	O ₂	0 - 25 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	-0.33	Vol.-%
Maximum sum of cross-sensitivities	-0.33	Vol.-%
Uncertainty of cross-sensitivity	-0.191	Vol.-%

Calculation of the combined standard uncertainty

Tested parameter

Standard deviation from paired measurements under field conditions *	u_p	0.101	Vol.-%	0.010 (Vol.-%) ²
Lack of fit	u_{lof}	0.052	Vol.-%	0.003 (Vol.-%) ²
Zero drift from field test	$u_{d,z}$	-0.087	Vol.-%	0.008 (Vol.-%) ²
Span drift from field test	$u_{d,s}$	0.115	Vol.-%	0.013 (Vol.-%) ²
Influence of ambient temperature at span	u_t	0.076	Vol.-%	0.006 (Vol.-%) ²
Influence of supply voltage	u_v	0.011	Vol.-%	0.000 (Vol.-%) ²
Cross-sensitivity (interference)	u_i	-0.191	Vol.-%	0.036 (Vol.-%) ²
Influence of sample gas flow	u_p	0.021	Vol.-%	0.000 (Vol.-%) ²
Uncertainty of reference material at 25% of certification range	u_{ref}	0.002	Vol.-%	0.000 (Vol.-%) ²

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

Combined standard uncertainty (u_c)	$u_c = \sqrt{\sum (u_{max,i})^2}$	0.34	Vol.-%
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	0.67	Vol.-%

Relative total expanded uncertainty

Requirement of 2010/75/EU	U in % of the range 25 Vol.-%	2.7
Requirement of EN 15267-3	U in % of the range 25 Vol.-%	10.0 **
	U in % of the range 25 Vol.-%	7.5

** The EU-directive 2010/75/EU on industrial emissions provides no requirements for this component.
The chosen value is recommended by the certification body.

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

Measuring system

Manufacturer	Kontram Oy
AMS designation	CEMS_T60i
Serial number of units under test	CEMS 1 / CEMS 2
Measuring principle	IR-Spectroscopy

Test report

Test laboratory	936/21218430/B
Date of report	TÜV Rheinland
	2014-04-02

Measured component

Certification range	SO ₂	0 - 486 mg/m ³
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Evaluation of the cross-sensitivity (CS)

(system with largest CS)

Sum of positive CS at zero point	4.03 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	-11.25 mg/m ³
Maximum sum of cross-sensitivities	-11.25 mg/m ³
Uncertainty of cross-sensitivity	-6.498 mg/m ³

Calculation of the combined standard uncertainty

Tested parameter

Standard deviation from paired measurements under field conditions *	u_{df}	3.173 mg/m ³	10.065 (mg/m ³) ²
Lack of fit	u_{lof}	-2.296 mg/m ³	5.272 (mg/m ³) ²
Zero drift from field test	$u_{d,z}$	-0.982 mg/m ³	0.964 (mg/m ³) ²
Span drift from field test	$u_{d,s}$	8.418 mg/m ³	70.863 (mg/m ³) ²
Influence of ambient temperature at span	u_t	1.953 mg/m ³	3.813 (mg/m ³) ²
Influence of supply voltage	u_v	1.215 mg/m ³	1.476 (mg/m ³) ²
Cross-sensitivity (interference)	u_i	-6.498 mg/m ³	42.224 (mg/m ³) ²
Influence of sample gas flow	u_p	-1.052 mg/m ³	1.107 (mg/m ³) ²
Uncertainty of reference material at 50% of certification range	u_m	0.998 mg/m ³	1.000 (mg/m ³) ²

* The larger value is used:

"Repeatability standard deviation at span" or

"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_c)

$$u_c = \sqrt{\sum (u_{max,j})^2} \quad 12.23 \text{ mg/m}^3$$

Total expanded uncertainty

$$U = u_c * k = u_c * 1.96 \quad 23.96 \text{ mg/m}^3$$

Relative total expanded uncertainty

U in % of the ELV 160 mg/m³ **15.0**

Requirement of 2010/75/EU

U in % of the ELV 160 mg/m³ **20.0**

Requirement of EN 15267-3

U in % of the ELV 160 mg/m³ **15.0**

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