

# CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000025931\_02

Certified AMS:	ZRE and ZRE/ZFK7 for CO, NO, SO <sub>2</sub> and O <sub>2</sub>
Manufacturer:	Fuji Electric Co., Ltd. No. 1, Fuji-machi, Hino-city Tokyo 191-8502 Japan
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) and EN 14181 (2004).

Certification is awarded in respect of the conditions stated in this certificate (this certificate contains 12 pages).

The present certificate replaces certificate 0000025931\_01 of 02 February 2015.



Publication in the German Federal Gazette (BAnz.) of 12 February 2010

German Federal Environment Agency Dessau, 12 February 2020

Moul 4

Dr. Marcel Langner Head of Section II 4.1

www.umwelt-tuv.eu tre@umwelt-tuv.eu Tel. + 49 221 806-5200 This certificate will expire on: 11 February 2025

TÜV Rheinland Energy GmbH Cologne, 11 February 2020

OPto.r

ppa. Dr. Peter Wilbring

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 the certificate D-PL-11120-02-00.





Test report: Initial certification: Expiry date: Certificate: Publication: 936/21210059/A of 21 October 2009 12 February 2010 11 February 2025 renewal (previous 0000025931\_01 dated 02 February 2015 with validity up to the 11 February 2020) BAnz. 12 February 2010, no. 24, p. 552, chapter I no. 1.1

#### Approved application

The tested AMS is suitable for use at large combustion plants according to Directive 2001/80/EC and the German Technical Instruction on Air Quality Control as long as the daily mean values for carbon monoxide, sulphur dioxide and nitrogen oxide that shall be monitored do not fall below 120 / 230 / 125 mg/m<sup>3</sup>. The instrument cannot be used at plants where N<sub>2</sub>O concentrations higher than 30 mg/m<sup>3</sup> are to be expected.

The suitability of the AMS for this application was assessed on the basis of a laboratory test and a 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 valid at the time of performance testing. As changes in legal regulations are possible, any potential user should ensure that this AMS is suitable for monitoring the limit values 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.

#### **Basis of the certification**

This certification is based on:

- test report 936/21210059/A of 21 October 2009 of TÜV Rheinland Immissionsschutz und Energiesysteme GmbH
- suitability announced by the German Federal Environment Agency (UBA) as the relevant body
- the ongoing surveillance of the product and the manufacturing process

Certificate: 0000025931\_02 / 12 February 2020



Publication in the German Federal Gazette: BAnz. 12 February 2010, no. 24, p. 552, chapter I, no. 1.1, Announcement by UBA from 25 January 2010:

#### AMS designation:

ZRE and ZRE/ZFK7 for NO, SO<sub>2</sub>, CO and O<sub>2</sub>

#### Manufacturer:

Fuji Electric Systems Co., Ltd., Tokyo, Japan

#### Field of application:

For plants according to Directive 2001/80/EC and the German Technical Instruction on Air Quality Control

#### Measuring ranges during the performance test:

Component	Certification- range	Supplementary range	Unit
CO	0 - 125	0 - 1250	mg/m <sup>3</sup>
NO	0 - 268	0 - 2680	mg/m <sup>3</sup>
SO <sub>2</sub>	0 - 571	0 - 5710	mg/m <sup>3</sup>
O <sub>2</sub> (Pa.*)	0 - 25	0 - 10	Vol%
O <sub>2</sub> (Zi.**)	0 - 25	0 - 10	Vol%

\* Pa. = paramagnetic

\*\* Zi. = zirconium oxide

#### Software version:

1.02

#### **Restrictions:**

- 1. The requirements with regard to measurement uncertainty in accordance with EN 15267-3 are fulfilled for a daily average limit value of 120 mg/m<sup>3</sup> for CO.
- 2. The requirements with regard to measurement uncertainty in accordance with EN 15267-3 are fulfilled for a daily average limit value of 230 mg/m<sup>3</sup> for SO<sub>2</sub>.
- 3. The requirements with regard to measurement uncertainty in accordance with EN 15267-3 are fulfilled for a daily average limit value of 125 mg/m<sup>3</sup> for NO.
- 4. The measuring system is not suitable for plants where N<sub>2</sub>O concentrations in the stack gas exceed 30 mg/m<sup>3</sup>.

#### Notes:

- 1. Either the paramagnetic or the zirconia oxygen sensor may be used for measuring O<sub>2</sub>: Version ZRE: NO, SO<sub>2</sub>, CO and O<sub>2</sub> (Pa)
  - Version ZRE/ZFK7: NO, SO<sub>2</sub>, CO and O<sub>2</sub> (Zi)
- 2. The maintenance interval is four weeks.
- 3. An automatic zero point calibration must be carried out at least once every 24 h.
- 4. Test gases shall be fed via the dynamic injector at least once every three months (control of the gas line and gas processing).
- 5. An AMS of identical design is also distributed by the company ETA, Rue Einstein, BP60129, 62220 Carvin, France.

#### **Test report:**

TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, Cologne Report No.: 936/21210059/A of 21 October 2009

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Publication in the German Federal Gazette: Banz. 29 July 2011, no. 113, p. 2725, chapter III notification 9, Announcement by UBA from 15 July 2011:

9 Notification as regards Federal Environment Agency notices of 25 January 2010 (BAnz. p. 552, chapter I, no. 1.1)

The current software version of the measuring system ZRE und ZRE/ZFK7 manufactured by Fuji Electric Systems Co., Ltd. is:

1.03

Statement of TÜV Rheinland Energie und Umwelt GmbH of 24 March 2011

Publication in the German Federal Gazette: BAnz. 2 March 2012, no. 36, p. 920, chapter V notification 7, Announcement by UBA from 23 February 2012:

Notification as regards Federal Environment Agency notices of 25 January 2010 (Federal Gazette (BAnz.) p. 552, chapter I, no. 1.1) and 15 July 2011 (Federal Gazette (BAnz.) p. 2725, chapter III, 9<sup>th</sup> notification)

The company Fuji Electric Systems Co., Ltd., manufacturer of the ZRE and ZRE/ZFK7 measuring system for NO, SO<sub>2</sub>, CO and O<sub>2</sub>, was renamed. The new company name is:

Fuji Electric Co., Ltd.

Statement of TÜV Rheinland Energie und Umwelt GmbH of 26 September 2011

Publication in the German Federal Gazette: BAnz AT 05.08.2014 B11, chapter V notification 7, Announcement by UBA from 17 July 2014:

7 Notification as regards Federal Environmental Agency notices of 25 January 2010 (Federal Gazette (BAnz.) p. 552, chapter I, no. 1.1) and of 23 February 2012 (Federal Gazette (BAnz.) p. 920, chapter V, 7<sup>th</sup> notification)

The ZRE and ZRE/ZFK7 measuring systems for monitoring CO, NO, SO<sub>2</sub> and O<sub>2</sub> manufactured by Fuji Electric Co., Ltd. will hereafter be distributed with the P1.1E pump manufactured by Bühler Technologies GmbH.

Statement of TÜV Rheinland Energie und Umwelt GmbH of 12 March 2014





Publication in the German Federal Gazette: BAnz AT 22.07.2019 B8, chapter V notification 5, Announcement by UBA from 28 June 2019:

5 Notification as regards Federal Environment Agency (UBA) notices of 25 January 2010 (BAnz. p. 552, chapter I number 1.1 and of 7 July 2014 (BAnz AT 05.08.2014 B11, chapter V 7<sup>th</sup> notification)

A new display has been introduced to the multi-component ZRE/ZFK7 measuring system manufactured by Fuji Electric. The software of the AMS has been changed accordingly. The latest software version of the ZRE/ZFK7 measuring system is 3.00. In addition, software version 2.00 is also up-to-date.

Statement issued by TÜV Rheinland Energy GmbH dated 6 March 2019

#### **Certified product**

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

The AMS is a non-dispersive infrared gas analyser (NDIR analyser) based on the singlebeam principle for the determination of CO,  $SO_2$  and NO. A paramagnetic sensor or, alternatively, a zirconia cell (ZFK7) may be installed for the determination of  $O_2$ .

The ZRE option consists of a NDIR analyser and a paramagnetic  $O_2$  analyser. The sample gas is divided into three partial flows: one flow passes through the converters and the optical bench for NO detection, another partial flow passes the optical bench for CO and SO<sub>2</sub> detection, and the third partial flow passes through the paramagnetic sensor.

The ZRE/ZFK7 option consists of the NDIR analyser and a zirconium sensor for detecting  $O_2$ . Here, the measuring gas is divided into two partial gas flows: one flow passes through the converters and the optical bench for NO detection and the other one passes through the optical bench for CO and SO<sub>2</sub> detection, followed by the zirconium oxygen sensor.

The ZFK7 analyser is connected to the ZRE analyser in a way that allows operation, parameterisation and output of all measured values via the ZRE analyser.

The systems are equipped with a probe manufactured by TECNOVA HT PERO-MI (type AGP04), a cooler manufactured by M&C, type ECM-2 G/SR 25.2, ZDL021 converters manufactured by Fuji Electric Systems Co., Ltd., Japan, and, as an option if the measuring gas contains  $NH_3$ , with a scrubber of the AS-series manufactured by Permapure. The cabinet is equipped with a cooling unit.





#### **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 ZRE and ZRE/ZFK7 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. 0000025931\_00: 10 March 2010 Expiry date of the certificate: 11 February 2015 Test report 936/21210059/A dated 21 October 2009 TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, Cologne Publication: BAnz. 12 February 2010, no. 24, p. 552, chapter I, no. 1.1 Announcement by UBA dated 25 January 2010

#### Notifications according to EN 15267

Statement of TÜV Rheinland Energy GmbH dated 24 March 2011 Publication: Banz. 29 July 2011, no. 113, p. 2725, chapter III notification 9 Announcement by UBA dated 15 July 2011 (software changes)

Statement of TÜV Rheinland Energy GmbH dated 26 September 2011 Publication: BAnz. 2 March 2012, no. 36, p. 920, chapter V notification 7 Announcement by UBA dated 23 February 2012 (change of manufacturer name)

Statement of TÜV Rheinland Energy GmbH dated 12 March 2014 Publication: BAnz AT 05.08.2014 B11, chapter V notification 7 Announcement by UBA dated 17 July 2014 (hardware changes)

#### **Renewal of the certificate**

Certificate No. 0000025931\_01: Expiry date of the certificate: 02 February 2015 11 February 2020

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Certificate: 0000025931\_02 / 12 February 2020



Statement of TÜV Rheinland Energy GmbH dated 06 March 2019 Publication: BAnz AT 22.07.2019 B8, chapter V notification 5 Announcement by UBA dated 28 June 2019 (software and hardware changes)

#### Renewal of the certificate

Certificate No. 0000025931\_02: Expiry date of the certificate: 12 February 2020 11 February 2025





## Calculation of overall uncertainty for QAL1 in EN 14181 and EN 15267-3

Manufacturer data Manufacturer		Fuji Elec	tric Systems C	co., Ltd		
Name of measuring system		ZRE				
Serial Number		100AC0	1 / 100AC02			
Measuring Principle		NDIR				
TÜV Data						
Approval Report		936/212	10059/A / 2009	9-10-21		
Editor		Steinhag	gen			
Date		2009-10	-19			
Measurement Component		SO2				
Certificated range		571	mg/m³			
Evaluation of the cross sensitivity (CS)						
Sum of positive CS at zero point		3.60	mg/m³			
Sum of negative CS at zero point		0.00	mg/m³			
Sum of postive CS at reference point		19.87	mg/m³			
Sum of negative CS at reference point		-2.97	mg/m³			
Maximum sum of cross sensitivities		19.87	mg/m³			
Uncertainty of cross sensitivity		11.47	mg/m³			
Calculation of the combined standard uncertainty						
Test Value		u		U <sup>2</sup>		
Standard deviation from paired measurements under field conditions *	u <sub>D</sub>	2.108	mg/m <sup>3</sup>	4.444 (mg/m <sup>3</sup> ) <sup>2</sup>		
Lack of fit	Ulof	0.635	mg/m <sup>3</sup>	0.403 (mg/m <sup>3</sup> ) <sup>2</sup>		
Zero drift from field test	u <sub>d,z</sub>	-2.670	mg/m <sup>3</sup>	7.129 (mg/m <sup>3</sup> ) <sup>2</sup>		
Span drift from field test	U <sub>d.s</sub>	-7.810	mg/m <sup>3</sup>	60.996 (mg/m <sup>3</sup> ) <sup>2</sup>		
Influence of ambient temperature at span	ut	8.307	mg/m <sup>3</sup>	69.006 (mg/m <sup>3</sup> ) <sup>2</sup>		
Influence of supply voltage	uv	0.500	mg/m <sup>3</sup>	0.250 (mg/m <sup>3</sup> ) <sup>2</sup>		
Cross sensitivity (interference)	u <sub>i</sub>	11.4/2	mg/m <sup>3</sup>	131.616 (mg/m <sup>3</sup> ) <sup>2</sup>		
Influence of sample gas flow	up	-1./1/	mg/m <sup>3</sup>	2.948 (mg/m <sup>3</sup> ) <sup>2</sup>		
Uncertainty of reference material at 70% of certification range	u <sub>rm</sub>	4.015	mg/m <sup>3</sup>	21.301 (mg/m <sup>3</sup> ) <sup>2</sup>		
The bigger value of: "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"						
Combined standard uncertainty (u.)	u. = 1	$\sum (u_{max})$	<u>)</u> <sup>2</sup>	17 27 mg/m <sup>3</sup>		
Total expanded uncertainty	U = u	* k = u *	1 96	33.84 mg/m <sup>3</sup>		
		un unc		oo.or mg/m		
Relative total expanded uncertainty	U in %	6 of the EL	.V 230 mg/m <sup>3</sup>	14.7		
Requirement of 2000/76/EC and 2001/80/EC		of the EL	V 230 mg/m <sup>3</sup>	20.0		
Requirement of EN 15267-3	U in % of the ELV 230 mg/m <sup>3</sup> 15.0					

Certificate: 0000025931\_02 / 12 February 2020



## Calculation of overall uncertainty for QAL1 in EN 14181 and EN 15267-3

Manufacturer data							
Manufacturer			Fuji Electric Systems Co., Ltd				
Name of measuring system			ZRE				
Serial Number		100AC	01 / 100AC02				
Measuring Principle		NDIR					
TÜV Data							
Approval Report		936/21	210059/A / 2009	-10-21			
Applotantopoli		500/21	21000001112000	10 21			
Editor		Steinha	agen				
Date		2009-1	0-19				
Measurement Component		0.0					
Certificated range		125	ma/m <sup>3</sup>				
Continuated range		120	ing, in				
Evaluation of the cross sensitivity (CS)							
Sum of positive CS at zero point		2.15	mg/m³				
Sum of negative CS at zero point		0.00	mg/m <sup>3</sup>				
Sum of postive CS at reference point		3.86	mg/m³				
Sum of negative CS at reference point		-0.63	mg/m <sup>3</sup>				
Maximum sum of cross sensitivities		3.86	mg/m <sup>3</sup>				
Uncertainty of cross sensitivity		2.23	mg/m³				
Calculation of the combined standard uncertainty							
Test Value		u		U <sup>2</sup>			
Standard deviation from paired measurements under field conditions *	un	1.604	mg/m <sup>3</sup>	2.573 (mg/m <sup>3</sup> ) <sup>2</sup>			
Lack of fit	ulof	0.289	mg/m <sup>3</sup>	0.084 (mg/m <sup>3</sup> ) <sup>2</sup>			
Zero drift from field test	U <sub>d.z</sub>	-0.274	mg/m <sup>3</sup>	0.075 (mg/m <sup>3</sup> ) <sup>2</sup>			
Span drift from field test	U <sub>d.s</sub>	-1.667	mg/m <sup>3</sup>	2.779 (mg/m <sup>3</sup> ) <sup>2</sup>			
Influence of ambient temperature at span	ut	2.498	mg/m <sup>3</sup>	6.240 (mg/m <sup>3</sup> ) <sup>2</sup>			
Influence of supply voltage	uv	0.346	mg/m <sup>3</sup>	0.120 (mg/m <sup>3</sup> ) <sup>2</sup>			
Cross sensitivity (interference)	u	2.230	mg/m³	4.973 (mg/m <sup>3</sup> ) <sup>2</sup>			
Influence of sample gas flow	up	-0.361	mg/m³	0.130 (mg/m <sup>3</sup> ) <sup>2</sup>			
Uncertainty of reference material at 70% of certification range	u <sub>rm</sub>	1.010	mg/m³	1.021 (mg/m <sup>3</sup> ) <sup>2</sup>			
* The bigger value of: "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"							
Combined standard uncertainty (u.)	u _ = 1	Σ (u	( ) <sup>2</sup>	4.24 mg/m <sup>3</sup>			
Total expanded uncertainty	U = u.	*k = u.	*196	8.31 mg/m <sup>3</sup>			
	u uc	a ac		o.or mg/m			
Relative total expanded uncertainty	U in %	of the E	LV 120 mg/m <sup>3</sup>	6.9			
Requirement of 2000/76/EC and 2001/80/EC	U in %	of the E	LV 120 mg/m <sup>3</sup>	10.0			
Requirement of EN 15267-3	U in % of the ELV 120 mg/m <sup>3</sup> 7.5						

Certificate: 0000025931\_02 / 12 February 2020



## Calculation of overall uncertainty for QAL1 in EN 14181 and EN 15267-3

ManufacturerFuji Electric Systems Co., Ltd ZREName of measuring systemZRESerial Number100AC01 / 100AC02Measuring PrincipleNDIRTÜV Data Approval ReportApproval Report936/21210059/A / 2009-10-21EditorSteinhagen 2009-10-19Date2009-10-19Measurement ComponentNO Certificated rangeCatificated range268Sum of positive CS at zero point3.59Sum of negative CS at zero point2.17Sum of negative CS at reference point2.17Sum of negative CS at reference point2.17Sum of negative CS at reference point2.06Sum of negative CS at reference point2.07Sum of negative CS at reference point2.07Sum of negative CS at reference point2.06Sum of negative CS at reference point2.06Sum of negative CS at reference point2.07Sum of negative CS at reference point2.06Sum of the combined standard uncertaintyuUncertainty of cross sensitivities3.59Sup of fituUncertainty of tross sensitivityuUncertainty of the combined standard uncertaintyUncertainty of the combined standard uncertaintyuUncertainty of reference point1.324 mg/m³Sup of fit from field testuUncertai	Manufacturer data							
Name of measuring systemZRE 100AC01 / 100AC02 Measuring PrincipleSerial Number100AC01 / 100AC02 MDIRTÜV Data Approval Report936/21210059/A / 2009-10-21Editor DateSteinhagen 2009-10-19Measurement Component Certificated rangeNO RSum of positive CS at zero point3.59 mg/m³ Sum of negative CS at zero pointSum of negative CS at zero point2.17 mg/m³ Sum of negative CS at reference pointSum of negative CS at reference point2.17 mg/m³ 2.007 mg/m³Calculation of the combined standard uncertainty Uncertainty of cross sensitivityuUncertainty of the sensitivity (SS)1.324 mg/m³ 2.07 mg/m³Calculation of the combined standard uncertainty Uncertainty of cross sensitivities3.59 mg/m³ 2.007 mg/m³Calculation of the combined standard uncertainty Test Valueuu² u 4.2.07 mg/m³Calculation of the combined standard uncertainty Test ValueuuUncertainty of reference point 3.59 mg/m³1.753 (mg/m³)² 2.326 (mg/m³)²Influence of ambient temperature at span Influence of supply voltage Cores sensitivity (inference) Uncertainty of reference materiai at 70% of certification range u <b< td=""><td colspan="3">Manufacturer</td><td colspan="5">Fuji Electric Systems Co., Ltd</td></b<>	Manufacturer			Fuji Electric Systems Co., Ltd				
Serial Number100AC01 / 100AC02 NDRMeasuring PrincipleNDRTÜV Data Approval Report936/21210059/A / 2009-10-21Editor DateSteinhagen 2009-10-19Measurement Component DateNO 268 mg/m³Certificated range268 mg/m³Evaluation of the cross sensitivity (CS)Steinhagen 2009-10-19Sum of positive CS at zero point-1.96 mg/m³ 3.000 fnegative CS at zero pointSum of negative CS at zero point-1.96 mg/m³ 3.000 fnegative CS at reference pointSum of negative CS at reference point-2.06 mg/m³ 4.000 mg/m³Sum of negative CS at reference point-2.06 mg/m³ 4.000 mg/m³Standard deviation from paired measurements under field conditions * uper durit from field testuper durit form field test 4.35 durit from field tes	Name of measuring system			ZRE				
Measuring PrincipleNDIR <b>TÜV Data</b> Approval Report936/21210059/A / 2009-10-21Editor DateSteinhagen 2009-10-19Measurement Component DateNO 268 mg/m³Certificated rangeNO 268 mg/m³Evaluation of the cross sensitivity (CS) Sum of positive CS at zero pointNO 3.59 mg/m³ Sum of positive CS at zero pointSum of positive CS at zero point-1.96 mg/m³ Sum of positive CS at reference point-2.06 mg/m³ Maximum sum of cross sensitivityCalculation of the combined standard uncertainty Test Valueuu² uCalculation of the combined standard uncertainty Iffuence of ambient temperature at span Influence of supply voltage Cross sensitivity iffuerference)uuU0.462 mg/m³ 0.213 (mg/m³)² 1.145 (	Serial Number	1(	100AC01 / 100AC02					
TÚV Data Approval Report936/21210059/A / 2009-10-21Editor DateSteinhagen 2009-10-19Measurement Component Certificated rangeNO 268 mg/m³Evaluation of the cross sensitivity (CS)Steinhagen gym³Sum of positive CS at zero point $3.59 mg/m³$ $2.17 mg/m³$ Sum of positive CS at reference point $2.17 mg/m³$ $2.07 mg/m³$ Sum of negative CS at reference point $2.17 mg/m³$ $2.07 mg/m³$ Calculation of the combined standard uncertainty Test ValueuTest Valueuu² $4.350 mg/m³$ $1.145 (mg/m³)^2$ $2.680 mg/m³$ Influence of supply voltage Cross sensitivity (the fference)u $0.242 mg/m³$ $1.145 (mg/m³)^2$ $1.145 (mg/m³)^2$	Measuring Principle	N	DIR					
TUP bata         Approval Report       936/21210059/A / 2009-10-21         Editor       Steinhagen         Date       2009-10-19         Measurement Component       NO         Certificated range       268         Evaluation of the cross sensitivity (CS)       Sum of positive CS at zero point         Sum of positive CS at zero point       3.59         Sum of negative CS at zero point       -1.96         Sum of negative CS at reference point       -2.06         Maximum sum of cross sensitivity       2.07         Sum of of the combined standard uncertainty       -2.06         Test Value       u       u <sup>2</sup> Standard deviation from paired measurements under field conditions *       up       1.324 mg/m <sup>3</sup> Lack of fit       u_ds       1.324 mg/m <sup>3</sup> 1.753 (mg/m <sup>3</sup> ) <sup>2</sup> Zero drift from field test       u_ds       4.350 mg/m <sup>3</sup> 1.455 (mg/m <sup>3</sup> ) <sup>2</sup> Influence of ambient temperature at span       u_t       5.689 mg/m <sup>3</sup> 3.2365 (mg/m <sup>3</sup> ) <sup>2</sup> Influence of supply voltage       u_y       0.462 mg/m <sup>3</sup> 0.213 (mg/m <sup>3</sup> ) <sup>2</sup> Cross sensitivity (interference)       u_y       0.097 mg/m <sup>3</sup> 2.299 (mg/m <sup>3</sup> ) <sup>2</sup> Influence of supply voltage       u_y								
Approval Report936/21210059/A / 2009-10-21Editor DateSteinhagen 2009-10-19Measurement Component Certificated rangeNO 268 mg/m³Evaluation of the cross sensitivity (CS) Sum of positive CS at zero point $3.59$ mg/m³ $-1.96$ mg/m³Sum of positive CS at zero point $-1.96$ mg/m³ $-2.06$ mg/m³Sum of negative CS at reference point $2.17$ mg/m³ $-2.06$ mg/m³Maximum sum of cross sensitivity $2.07$ mg/m³Calculation of the combined standard uncertainty Test Valueuu² $u_{cr}$ Calculation from paired measurements under field conditions * $u_{dr}$ $u_{D}$ $1.324$ mg/m³ $1.753$ (mg/m³)² $1.456$ (	TUV Data							
Editor Date Steinhagen 2009-10-19 Measurement Component NO Certificated range 268 mg/m <sup>3</sup> Evaluation of the cross sensitivity (CS) Sum of positive CS at zero point 3.59 mg/m <sup>3</sup> Sum of negative CS at zero point -1.96 mg/m <sup>3</sup> Sum of negative CS at reference point 2.17 mg/m <sup>3</sup> Sum of negative CS at reference point 2.17 mg/m <sup>3</sup> Sum of negative CS at reference point 2.17 mg/m <sup>3</sup> Sum of cross sensitivities 3.59 mg/m <sup>3</sup> Uncertainty of cross sensitivity 2.07 mg/m <sup>3</sup> Calculation of the combined standard uncertainty 2.07 mg/m <sup>3</sup> Eack of fit 2.170 mg/m <sup>3</sup> 1.753 (mg/m <sup>3</sup> ) <sup>2</sup> Lack of fit $u_{dx}$ 1.070 mg/m <sup>3</sup> 1.145 (mg/m <sup>3</sup> ) <sup>2</sup> Influence of ambient temperature at span $u_t$ 5.689 mg/m <sup>3</sup> 32.365 (mg/m <sup>3</sup> ) <sup>2</sup> Influence of supply voltage $u_v$ 0.462 mg/m <sup>3</sup> 0.213 (mg/m <sup>3</sup> ) <sup>2</sup> Cross sensitivity (interference) $u_t$ 2.073 mg/m <sup>3</sup> 4.299 (mg/m <sup>3</sup> ) <sup>2</sup> Influence of supply voltage $u_v$ 0.462 mg/m <sup>3</sup> 0.013 (mg/m <sup>3</sup> ) <sup>2</sup> Cross sensitivity of reference material at 70% of certification range $u_m$ 2.166 mg/m <sup>3</sup> 4.693 (mg/m <sup>3</sup> ) <sup>2</sup> Combined standard uncertainty $(u_c)$ $U_c = \sqrt{\sum (u_{max})^2}$ 7.97 mg/m <sup>3</sup>	Approval Report	936/21210059/A / 2009-10-21						
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Lack of fit Lack	Standard deviation from paired measurements under field conditions *	Ц. 1	324	m a/m <sup>3</sup>	1 753	$(m \alpha / m^{3})^{2}$		
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Span drift from field test $u_{d,s}$ $4.350 \text{ mg/m}^3$ $18.923 \text{ (mg/m}^3)^2$ Influence of ambient temperature at span $u_t$ $5.689 \text{ mg/m}^3$ $32.365 \text{ (mg/m}^3)^2$ Influence of supply voltage $u_v$ $0.462 \text{ mg/m}^3$ $0.213 \text{ (mg/m}^3)^2$ Cross sensitivity (interference) $u_i$ $2.073 \text{ mg/m}^3$ $4.299 \text{ (mg/m}^3)^2$ Influence of sample gas flow $u_p$ $0.097 \text{ mg/m}^3$ $0.009 \text{ (mg/m}^3)^2$ Uncertainty of reference material at 70% of certification range $u_m$ $2.166 \text{ mg/m}^3$ $4.693 \text{ (mg/m}^3)^2$ * The bigger value of: "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions" $u_c = \sqrt{\sum (u_{max,j})^2}$ $7.97 \text{ mg/m}^3$ Combined standard uncertainty ( $u_c$ ) $u_c = \sqrt{\sum (u_{max,j})^2}$ $7.97 \text{ mg/m}^3$ Total expanded uncertainty $15.61 \text{ mg/m}^3$	Zero drift from field test	U	.070	ma/m <sup>3</sup>	1.145	$(mg/m^3)^2$		
Influence of ambient temperature at span Influence of ambient temperature at span Influence of supply voltage Cross sensitivity (interference) Influence of sample gas flow Uncertainty of reference material at 70% of certification range The bigger value of: "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions" Combined standard uncertainty (u <sub>c</sub> ) Total expanded uncertainty (u <sub>c</sub> ) Line and the standard uncertainty (u <sub>c</sub> ) Total expanded uncertainty (u <sub>c</sub> ) Line and the standard uncertainty (u <sub>c</sub> ) Line and the standard uncertainty (u <sub>c</sub> ) Combined standard uncertainty (u <sub>c</sub> ) Line and the standard uncertainty (u <sub>c</sub> )	Span drift from field test	Ude 4	.350	ma/m <sup>3</sup>	18.923	(mg/m <sup>3</sup> ) <sup>2</sup>		
Influence of supply voltage $u_v$ 0.462 mg/m <sup>3</sup> 0.213 (mg/m <sup>3</sup> ) <sup>2</sup> Cross sensitivity (interference) $u_i$ 2.073 mg/m <sup>3</sup> 4.299 (mg/m <sup>3</sup> ) <sup>2</sup> Influence of sample gas flow $u_p$ 0.097 mg/m <sup>3</sup> 0.009 (mg/m <sup>3</sup> ) <sup>2</sup> Uncertainty of reference material at 70% of certification range $u_m$ 2.166 mg/m <sup>3</sup> 4.693 (mg/m <sup>3</sup> ) <sup>2</sup> * The bigger value of: "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions" Combined standard uncertainty ( $u_c$ ) $u_c = \sqrt{\sum (u_{max,j})^2}$ 7.97 mg/m <sup>3</sup> Total expanded uncertainty ( $u_c$ ) 15.61 mg/m <sup>3</sup>	Influence of ambient temperature at span	u, 5	6.689	mg/m <sup>3</sup>	32.365	(mg/m <sup>3</sup> ) <sup>2</sup>		
Cross sensitivity (interference) $u_i$ $2.073 \text{ mg/m}^3$ $4.299 \text{ (mg/m}^3)^2$ Influence of sample gas flow $u_p$ $0.097 \text{ mg/m}^3$ $0.009 \text{ (mg/m}^3)^2$ Uncertainty of reference material at 70% of certification range $u_m$ $2.166 \text{ mg/m}^3$ $4.693 \text{ (mg/m}^3)^2$ * The bigger value of: "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions" $u_c = \sqrt{\sum (u_{max,j})^2}$ $7.97 \text{ mg/m}^3$ Combined standard uncertainty ( $u_c$ ) $u_c = \sqrt{\sum (u_{max,j})^2}$ $7.97 \text{ mg/m}^3$ $15.61 \text{ mg/m}^3$	Influence of supply voltage	u <sub>v</sub> (	.462	mg/m <sup>3</sup>	0.213	(mg/m <sup>3</sup> ) <sup>2</sup>		
Influence of sample gas flow $u_p = 0.097 \text{ mg/m}^3 = 0.009 (\text{mg/m}^3)^2$ Uncertainty of reference material at 70% of certification range $u_m = 2.166 \text{ mg/m}^3 = 4.693 (\text{mg/m}^3)^2$ * The bigger value of: "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions" Combined standard uncertainty (u <sub>c</sub> ) $u_c = \sqrt{\sum (u_{max,j})^2} = 7.97 \text{ mg/m}^3$ Total expanded uncertainty (u <sub>c</sub> ) 15.61 mg/m^3	Cross sensitivity (interference)	u <sub>i</sub> 2	.073	mg/m <sup>3</sup>	4.299	(mg/m <sup>3</sup> ) <sup>2</sup>		
Uncertainty of reference material at 70% of certification range $u_m = 2.166 \text{ mg/m}^3 = 4.693 (\text{mg/m}^3)^2$ * The bigger value of: "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions" Combined standard uncertainty (u <sub>c</sub> ) $u_c = \sqrt{\sum (u_{max,j})^2} = 7.97 \text{ mg/m}^3$ Total expanded uncertainty (u <sub>c</sub> ) 15.61 mg/m <sup>3</sup>	Influence of sample gas flow	u <sub>p</sub> (	.097	mg/m³	0.009	(mg/m <sup>3</sup> ) <sup>2</sup>		
* The bigger value of: "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions" Combined standard uncertainty (u <sub>c</sub> ) Total expanded uncertainty $u_{c} = \sqrt{\sum_{k} (u_{max, j})^{2}} \qquad 7.97 \text{ mg/m}^{3}$	Uncertainty of reference material at 70% of certification range	u <sub>m</sub> 2	.166	mg/m³	4.693	(mg/m <sup>3</sup> ) <sup>2</sup>		
"Standard deviation from paired measurements under field conditions" Combined standard uncertainty (u <sub>c</sub> ) $U_c = \sqrt{\sum (u_{max,j})^2}$ 7.97 mg/m <sup>3</sup> Total expanded uncertainty 15.61 mg/m <sup>3</sup>	* The bigger value of: "Repeatability standard deviation at span" or							
Combined standard uncertainty (u <sub>c</sub> ) $u_{c} = \sqrt{\sum_{k} (u_{max,j})^{2}} $ Total expanded uncertainty (u <sub>c</sub> ) 7.97 mg/m <sup>3</sup>	"Standard deviation from paired measurements under field conditions"							
$ \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} $	Combined standard uncertainty (u.)	$u_{a} = \sqrt{\Sigma}$	(u	$(x^{2})^{2}$	7 97	m a /m <sup>3</sup>		
$U = 0, N = 0, L_{2}U = 0, U = 0, L_{2}U $	Total expanded uncertainty	$U = u_* k$	= 11.	* 1 96	15.61	ma/m <sup>3</sup>		
			-c					
Relative total expanded uncertainty U in % of the ELV 125 mg/m <sup>3</sup> 12.5	Relative total expanded uncertainty	U in % of	the E	LV 125 mg/m <sup>3</sup>		12.5		
Requirement of 2000/76/EC and 2001/80/EC U in % of the ELV 125 mg/m <sup>3</sup> 20.0	Requirement of 2000/76/EC and 2001/80/EC		the E	LV 125 mg/m <sup>3</sup>		20.0		
Requirement of EN 15267-3         U in % of the ELV 125 mg/m³         15.0	Requirement of EN 15267-3	U in % of t	he E	LV 125 mg/m³		15.0		

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## Calculation of overall uncertainty for QAL1 in EN 14181 and EN 15267-3

Manufacturer data Manufacturer Name of measuring system Serial Number Measuring Principle TÜV Data Approval Report		Fuji El ZRE 100AC Param 936/21	ectric Systems C 01 / 100AC02 agnetism 210059/A / 2009-	o., Ltd 10-21	
Editor		Stoiph	0000		
Date		2009-1	0-19		
Measurement Component		02			
Certificated range		25	Vol%		
Evaluation of the cross sensitivity (CS)					
Sum of positive CS at zero point		0.00	Vol %		
Sum of pegative CS at zero point		0.00	Vol%		
Sum of nostive CS at reference point		0.14	Vol -%		
Sum of negative CS at reference point		0.00	Vol -%		
Maximum sum of cross sensitivities		0.14	Vol -%		
Uncertainty of cross sensitivity		0.08	Vol%		
Calculation of the combined standard uncertainty Test Value		u		U <sup>2</sup>	
Standard deviation from paired measurements under field conditions *	Up.	0.058	Vol%	0.003 (Vol%	)²
Lack of fit	Ulof	0.040	Vol%	0.002 (Vol%	)2
Zero drift from field test	Ud a	-0.064	Vol%	0.004 (Vol%	)²
Span drift from field test	U.Z.	0.110	Vol%	0.012 (Vol%	)2
Influence of ambient temperature at span	U.5	0.184	Vol%	0.034 (Vol%	)²
Influence of supply voltage	u <sub>v</sub>	0.020	Vol%	0.000 (Vol%	)²
Cross sensitivity (interference)	ui	0.081	Vol%	0.007 (Vol%	)²
Influence of sample gas flow	up	0.075	Vol%	0.006 (Vol%	)²
Uncertainty of reference material at 70% of certification range	u <sub>rm</sub>	0.202	Vol%	0.041 (Vol%	)²
* The bigger value of: "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"					
Combined standard uncertainty (u <sub>c</sub> )	$u_c = $	$\sum (u_{ma})$	x i) <sup>2</sup>	0.33 Vol%	
Total expanded uncertainty	U = u <sub>c</sub>	* k = u	c*1.96	0.65 Vol%	
Relative total expanded uncertainty	Uin %	of the	range 25 Vol%	2	6
Requirement of 2000//b/EC and 2001/80/EC	Uin %	of the	range 25 Vol%	10	.0 *
Requirement OFEN 15207-3	U in %	of the ra	ange 25 Vol%	1	.э

\*\* For this component no requirements in the EC-directives 2001/80/EC und 2000/76/EC are given. A value of 10 % was used for this.

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### Calculation of overall uncertainty for QAL1 in EN 14181 and EN 15267-3

Manufacturer data					
Manufacturer	Fuji Electric Systems Co., Ltd				
Name of measuring system		ZFK7			
Serial Number		100AC	01 / 100AC02		
Measuring Principle		zirconi	а		
Approval Report		026/24	210050/4 / 2000	10.21	
		930/21	210059/A / 2009-	10-21	
Editor		Steinh	agen		
Date		2009-1	0-19		
Massurement Component		0.			
Certificated range		25	Vol %		
Certificated lange		25	V 0176		
Evaluation of the cross sensitivity (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 reference point		0.25	Vol%		
Sum of negative CS at reference point		0.00	Vol%		
Maximum sum of cross sensitivities		0.25	Vol%		
Uncertainty of cross sensitivity		0.14	Vol%		
Calculation of the combined standard uncertainty					
Test Value				U <sup>2</sup>	
Standard deviation from paired measurements under field conditions *	lla	0.051	Vol -%	0.003 (	Vol -%)2
Lack of fit		-0.040	Vol%	0.002 (	Vol%) <sup>2</sup>
Zero drift from field test		-0.052	Vol%	0.003 (	Vol%) <sup>2</sup>
Span drift from field test	Ma,2	0.098	Vol%	0.010 (	Vol%) <sup>2</sup>
Influence of ambient temperature at span	ua,s	0.231	Vol%	0.053 (	Vol%) <sup>2</sup>
Influence of supply voltage	Ц.	0.023	Vol%	0.001 (	Vol%) <sup>2</sup>
Cross sensitivity (interference)	U;	0.144	Vol%	0.021 (	Vol%) <sup>2</sup>
Influence of sample gas flow	Un	0.063	Vol%	0.004 (	Vol%)2
Uncertainty of reference material at 70% of certification range	Urm	0.202	Vol%	0.041 (	Vol%)2
* The bigger value of: "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"				,	,
Combined standard uncertainty (v. )	u =.	$\sum (u)$	.)2	0.071	(a) 0/
Combined standard uncertainty (u <sub>C</sub> )		/ (ª ma	x, j /	0.37 V	/01%
lotal expanded uncertainty	U = u <sub>c</sub>	; ~ K = U,	<sub>c</sub> ^ 1.96	0.72 \	/01%
Relative total expanded uncertainty	ll in 9	of the	range 25 Vol -%		29
Requirement of 2000/76/EC and 2001/80/EC	U in % of the range 25 Vol%				10.0 *
Requirement of FN 15267-3	Ll in %	of the r	ange 25 Vol -%		7.5
	0 11 /		ango 20 V 0170		1.5

 $^{**}$  For this component no requirements in the EC-directives 2001/80/EC und 2000/76/EC are given. A value of 10 % was used for this.