

# CERTIFICATE

## of Product Conformity (QAL1)

Certificate No.: 0000037051\_01

**Certified AMS:** GM32 In-Situ-Gasanalysator model Cross Duct for NO and SO<sub>2</sub>

**Manufacturer:** SICK AG  
Nimburger Str. 11  
76276 Reute  
Germany

**Test Institute:** TÜV Rheinland Energy GmbH

This is to certify that the AMS has been tested and certified  
according to 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 16 pages).



Suitability Tested  
EN 15267  
QAL1 Certified  
Regular  
Surveillance

www.tuv.com  
ID 0000037051

Publication in the German Federal Gazette  
(BAnz.) of 25 August 2009

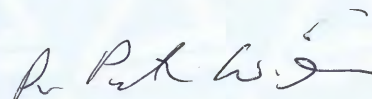
German Federal Environment Agency  
Dessau, 18 July 2017



Dr. Marcel Langner  
Head of Section II 4.1

This certificate will expire on:  
19 July 2022

TÜV Rheinland Energy GmbH  
Cologne, 17 July 2017



ppa. Dr. Peter Wilbring

[www.umwelt-tuv.eu](http://www.umwelt-tuv.eu)  
tre@umwelt-tuv.eu  
Tel. + 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 the certificate D-PL-11120-02-00.

**Certificate:**  
0000037051\_01 / 18 July 2017

**Test report:** 936/21209185/C of 6 March 2009  
**Initial certification:** 20 July 2012  
**Expiry date:** 19 July 2022  
**Certificate:** renewal (previous certificate 0000037051 dated from 20 August 2012 with validity up to the 19 July 2017)  
**Publication:** BAnz. 25 August 2009, No. 125, p. 2929, chapter I no. 3.2

### **Approved application**

The tested AMS is suitable for use at combustion plants according to Directive 2010/75/EU, chapter III (13. BImSchV), at waste incineration plants according to Directive 2010/75/EU, chapter IV (17. BImSchV), at plants according to the 27. BImSchV and other plants requiring official approval. The measured ranges have been selected considering the wide application range of the AMS.

The suitability of the AMS for this application was assessed on the basis of a laboratory test and a seven months field test at fluidised bed combustion main material mineral coal.

The AMS is approved for an ambient temperature range of -20 °C to +50 °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 value 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 936/21209185/C of 6 March 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

Publication in the German Federal Gazette: BAnz. 25 August 2009, No. 125, p. 2929, chapter I no. 3.2,  
Announcement by UBA from 03 August 2009:

**AMS name:**

GM32 In-Situ Gas Analyser Model Cross Duct for NO and SO<sub>2</sub>

**Manufacturer:**

SICK MAIHAK GmbH, Reute

**Approval:**

For measurements at plants requiring official approval and plants according to 27<sup>th</sup> BImSchV

**Measuring ranges during the suitability test:**

Component	CR 1	CR 2	Unit
NO	0 - 70*	0 - 700*	mg/m <sup>3</sup>
SO <sub>2</sub>	0 - 75*	0 - 1000*	mg/m <sup>3</sup>

CR = Certification range

\* With an active measuring path length of 1.86m

Or

Component	CR 1	CR 2	Unit
NO	0 - 130,2*	0 - 1302*	mg/m <sup>3</sup>
SO <sub>2</sub>	0 - 139,5*	0 - 1860*	mg/m <sup>3</sup>

CR = Certification range

\* With an active measuring path length of 1.00m

**Software versions:**

GM32: 9125967 SL36

SOPAS ET: 02.20

**Remarks:**

1. A three-month period has been specified as maintenance interval.
2. The device variant "Comfort" has been tested. In terms of hardware and software, the device variant "Pro" is completely identical to the configuration tested. However, it contains only 1 instead of 2 separately calibrated measuring ranges per component. In accordance with the type coding, variant "Comfort" is identified by "C", and variant "Pro" by "P".
3. Within the context of the manufacturer's quality assurance according to QAL 3 of Directive DIN EN 14181, the signals of the internal check cycle can be used for regular checks of the zero and span points. If any values exceed specified limits, the measuring system is then checked – similarly to the annual surveillance test (AST) – by means of a filter box and a zero path adapted to on-site conditions.
4. Performance testing includes the following device variants (measured components):

Device designation according to type code	NO	SO <sub>2</sub>
C1 or P1		x
C2 or P2	x	x
C4 or P4	x	

"C" = device variant "Comfort"

"P" = device variant "Pro"

5. Complementary test to the announcement of the German Federal Environmental Agency of 19 February 2009 (BAnz. p. 901).

**Test report:**

TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, Cologne  
Report No.: 936/21209185/C of 6 March 2009

Publication in the German Federal Gazette: BAnz. 12 February 2010, No. 24, p. 552, chapter IV notification 8,  
Announcement by UBA from 25 January 2010:

**8 Notification as regards Federal Environmental Agency notices of 03 August 2009 (Federal Gazette (BAnz.), p. 2931)**

The current software version implemented in the emission measuring system GM 32 in-situ gas analyser by the company SICK MAIHAK GmbH, in its cross-duct and GMP measuring probe versions is:

GM32: 9125967 T473

Statement of TÜV Rheinland Immissionsschutz und Energiesysteme GmbH of 9 October 2009

Publication in the German Federal Gazette: BAnz. 26 January 2011, No. 14, p. 294,  
chapter IV notification 1  
Announcement by UBA from 10 January 2011:

**1 Notification as regards Federal Environmental Agency notices of 3 August 2009 (Federal Journal (BAnz. p. 2929, chapter I no. 3.2 and 3.3) and of 25 January 2010 (BAnz. p. 552, chapter IV notification 8)**

The current software version of the emission measuring system GM 32 In-situ Analyser in its cross duct and GMP measuring probe versions by SICK Maihak GmbH is:

GM32: 9125967 U727

Effective immediately, the GMP probe version's cladding tube of the probe is extended to 45 mm. The reflector in its clamp is repositioned by the same distance in relation to the measurement slit.

Statement of TÜV Rheinland Energie und Umwelt GmbH of 4 October 2010

Publication in the German Federal Gazette: BAnz. 26 January 2011, No. 14, p. 294,  
chapter IV notification 30  
Announcement by UBA from 10 January 2011:

**30 Notification as regards Federal Environmental Agency notices referring to suitability-tested AMS manufactured by SICK Engineering GmbH and SICK MAIHAK GmbH (Excerpt)**

No.	AMS manufacturer	Notice	Notification	Opinion of the test institute
...	...	...	...	...
8	GM 32 In-Situ Analysator in its Cross Duct version and in its GMP probe version/ SICK MAIHAK GmbH	as regards notification 1 of this notice	The current software version of the SOPAS ET platform, which controls the AMS is, SOPAS ET 2.32	TÜV Rheinland Energie und Umwelt GmbH of 08 November 2010
...	...	...	...	...

Publication in the German Federal Gazette: BAnz. 29 July 2011, No. 113, p. 2725,  
chapter III notification 16,  
Announcement by UBA from 15 July 2011:

**16 Notification as regards Federal Environmental Agency notices of 3 August 2009 (Federal Journal (BAnz.) p. 2929, chapter I no. 3.2 and 3.3) and of 10 January 2011 (Federal Journal (BAnz.) p. 294, chapter IV notification 1 and 30)**

The tracking mirror which has so far been used for the GM 32 In-Situ Gas analyser, in its Cross Duct and GMP probe version for NO and SO<sub>2</sub> manufactured by SICK MAIHAK GmbH may be replaced by an alternative tracking module.

The current software version is: GM32: 9125967 V113

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

Publication in the German Federal Gazette: BAnz AT 20.07.2012 B11, chapter IV  
notification 22,  
Announcement by UBA from 06 July 2012:

**22 Notification as regards Federal Environmental Agency notices of 3. August 2009 (BAnz. S. 2929, chapter I no. 3.2 und 3.3) and of 15 July 2011 (Federal Journal (BAnz.) p. 2725, chapter III notification 16)**

The GM 32 In-Situ Gas analyser in its GMP probe and Cross Duct versions for NO and SO<sub>2</sub> manufactured by SICK MAIHAK GmbH as well as the production process and the quality management system for this measuring system meet the requirements of DIN EN 15267.

Statement of TÜV Rheinland Energie und Umwelt GmbH of 20 March 2012

Publication in the German Federal Gazette: BAnz AT 05.03.2013 B10, chapter V notification 17,

Announcement by UBA from 12 February 2013:

**17 Notification as regards Federal Environmental Agency notices of 3 August 2009 (Federal Gazette (BAnz.) p 2929, chapter I no. 3.2) and of 6 July 2012 (Federal Gazette BAnz AT 20.07.2012 B11, chapter IV notification 22)**

The GM 32 in-situ gas analyser for measuring NO and SO<sub>2</sub> emissions in its cross-duct version manufactured by SICK MAIHAK GmbH is also available as flameproof type for installation at hazardous areas of the classification Zone 1 (category 2G) and Zone 2 (category 3G).

The GM 32 in-situ gas analyser for measuring NO and SO<sub>2</sub> emissions in its cross-duct version manufactured by SICK MAIHAK GmbH can also be equipped with the new TX25 processor.

The current software version of the GM 32 in-situ gas analyser for measuring NO and SO<sub>2</sub> emissions in its cross-duct version manufactured by SICK MAIHAK GmbH is:

GM32: 9125967 W051 (former processor)

or

GM32: 9171698 0000 (new processor)

The current software version of the purge air attachment of the GM 32 in-situ gas analyser for measuring NO and SO<sub>2</sub> emissions in its cross-duct version manufactured by SICK MAIHAK GmbH is:

9091948 WJ24

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 2 October 2012

Publication in the German Federal Gazette: BAnz AT 23.07.2013 B4, chapter V notification 12,  
Announcement by UBA from 03 July 2013:

**12 Notification as regards Federal Environmental Agency notices regarding performance tested AMS manufactured by SICK MAIHAK GmbH (Excerpt)**

No.	AMS manufacturer	Notice	Notification	Opinion of the test institute
...	...	...	...	...
7	GM 32 In-Situ Analysator in its Cross Duct version and in its GMP probe version/ SICK AG	of 3 August 2009 Federal Gazette (BAnz. p. 2929, chapter II no. 3.2 and 3.3) and 12 February 2013 Federal Gazette (BAnz AT 5 March 2013 B10, chapter V notification 17 and 18)	SICK MAIHAK GmbH merged with its parent company SICK AG as of 1 January 2013. The manufacturer is now registered as SICK AG.	TÜV Rheinland Energie und Umwelt GmbH of 25 March 2013
...	...	...	...	...

Publication in the German Federal Gazette: BAnz AT 23.07.2013 B4, chapter V notification 13,  
Announcement by UBA from 03 July 2013:

**13 Notification as regards Federal Environmental Agency notices referring to suitability-tested AMS manufactured by SICK Engineering GmbH and SICK AG (Excerpt)**

No.	AMS manufacturer	Notice	Notification	Opinion of the test institute
...	...	...	...	...
8	GM 32 In-Situ Analysator in its Cross Duct version and in its GMP probe version/ SICK AG	as regards notification 13 (serial number 7) of this notice	The current software version of the SOPAS ET platform, which controls the AMS is, SOPAS ET 2.38	TÜV Rheinland Energie und Umwelt GmbH of 25 March 2013
...	...	...	...	...



Publication in the German Federal Gazette: BAnz AT 01.04.2014 B12, chapter VI notification 15,  
Announcement by UBA from 27 February 2014:

**15 Notification on the announcements of the Federal Environment Agency of 3 August 2009 (BAnz. p. 2929, chapter I number 3.2) and of 3 July 2013 (BAnz AT 23.07.2013 B4, chapter V notification 12 [no. 7] and notification 13 [no. 8])**

The current firmware versions of the GM 32 in-situ gas analyser emission measuring system in the cross-duct version for NO and SO<sub>2</sub> by SICK AG are:

Firmware version with old processor card (CPU PXA255):	9125967 X938
Firmware version with new processor card (CPU TX25):	9171698 X938

Statement of TÜV Rheinland Energie und Umwelt GmbH of 10 October 2013

Publication in the German Federal Gazette: BAnz AT 26.08.2015 B4, chapter V notification 35,  
Announcement by UBA from 22 July 2015:

**35 Notification as regards Federal Environment Agency (UBA) notices of 3 August 2009 (Federal Gazette (BAnz.) p. 2929, chapter I number 3.2) and of 27 February 2014 (Federal Gazette BAnz AT 01.04.2014 B12, chapter VI notification 15)**

The sensitivity of the diode array of the GM 32 in-situ gas analyser for NO and SO<sub>2</sub>, cross-duct version, manufactured by Sick AG, was decreased from 49 mA/W to 36 mA/W at a wavelength of 210 nm. The part itself remains unchanged. The change has no significant influence on the performance of the system.

Statement of TÜV Rheinland Energie und Umwelt GmbH of 22 May 2015

Publication in the German Federal Gazette: BAnz AT 15.03.2017 B6, chapter V notification 27,  
Announcement by UBA from 22 February 2017:

**27 Notification as regards Federal Environment Agency (UBA) notices of 3 August 2009 (BAnz. p. 2929, chapter I number 3.2) and of 22 July 2015 (BAnz AT 26.08.2015 B4, chapter V, 35<sup>th</sup> notification)**

The current software version of the GM-32 in-situ gas analyser in the cross-duct version for NO and SO<sub>2</sub> manufactured by SICK AG is YE19 9171698.

Deuterium lamp D2Plus may now also be used for the measuring system.

Statement of TÜV Rheinland Energy GmbH dated 12 October 2016

### Certified product

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

The GM32 in-situ gas analyser continuously measures NO and SO<sub>2</sub> concentrations in the gas duct.

The GM32 in-situ gas analyser in its cross duct version is based on an in-situ technology with electro-optical direct measurement. Measured values are recorded directly in the gas flow without contact across the complete duct cross-section.

The GM32 SR-unit determines the concentration of the respective gases based on light absorption by the gas mixture in the active measuring path which is specific to the wavelength.

Light from the sender/receiver unit (SR-unit) passing through the measuring path in the gas duct is reflected back by a triple reflector situated at the end of the active measuring path (opposite duct side). The beam splitter diverts the returning light to the polychromatic sub-assembly comprising a condenser lens with slit diaphragm, optical grid and receiver element. The optical grid dissects the returning light spectrally and maps it to the receiver element consisting of a highly sensitive diode array.

The algorithms of the GM32 evaluation software process the measured signals of the receiver element together with the related parameters according to the DOAS (Differential Optical Absorption Spectroscopy) method.

In order to ensure stable measurements, the measuring system carries out a reference cycle at certain intervals (standard setting: every 60 min). This reference cycle compensates for changes in lamp intensity (e.g. through aging) and possible contamination in the SR-unit. Precisely adjusting the intensity of the spectra and recording the dark and zero point spectra (with the blanking diaphragm retracted) allows to generate an intensity spectrum which corresponds to that of a spectrum determined in a smoke-free path and hence facilitates the creation of a reference spectrum as a basis for compensation.

Furthermore, the measuring system monitors the stability of the zero and span points by means of a check cycle. Two grid filters, an NO cell and a zero point reflector which can be swivelled in are used as a measuring means for the checks.

This check cycle allows to determine possible wavelength scale drifts, resolution drifts and extinction drifts, and therefore to monitor measurement stability.

#### Zero point:

The zero point is determined by creating a zero spectrum by swivelling in a zero point reflector. This spectrum corresponds to measurement with a measuring path free from gas. The relevant measured concentration values are determined by means of the device's calibration function. A maintenance request is signalled when one of the zero values exceeds a certain limit value (in this case: 2 % of the FS).

Span point:

In addition to the zero point reflector, an internal swivel element with 2 grid filters and an NO-filled cell is swivelled in during the check cycle, and the reference value is measured. The control values are scaled to 70 % of the measuring range selected.

The median deviation of the extinction measurement of the 2 grid filters is used to calculate the reference value, and the value of (70 % + deviation) x FS is output in % for all components. A maintenance request is signalled when the limit value is exceeded (in this case: > 2 % of the FS).

The expression “concentration measuring path product” is used to describe the connection between full scale value and active measuring path length.

The concentration measuring path product is used to calculate the relevant full scale value for any active measuring path length. The measuring range indications refer to an active measuring path of 1m. In accordance with the measuring path length x, all measuring ranges are reduced or increased by the factor 1/x [m].

The table below gives some examples of such factors.

Active measuring path length or measuring gap in mm	Factor for full scale value FS
1000	FS * 1
1860	FS * 0,538
3000	FS * 0,333

### Version “Pro”

As “Basis” version, plus

- Automatic mirror tracking
- Check cycle (QAL3) + CUSUM-card
- Control unit

### Version “Comfort”

As “Pro” version, plus

- 2 separately calibrated measured ranges per component

Two instruments of the “Comfort” version were used for the testing at hand. In terms of hardware and software components, the version “Pro” is identical to the “comfort” version – however, there is only 1 instead of 2 calibrated measured ranges for each component. According to the type coding, the “Comfort” version is called “C” and the “Pro” version is called “P”.

The following variants of instruments are possible with regard to specific measured components

Device designation according to type code	NO	SO <sub>2</sub>
C1 or P1		x
C2 or P2	x	x
C4 or P4	x	

“C”= variant “Comfort“

“P”= variant “Pro“

The current software version is:  
YE19 9171698

The current version of the manual is: 8012703/YHS4/V2-0/2016-10.

#### **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 can be applied to the product or used in publicity material 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:  
**qal1.de**.

Certification of GM32 In-Situ-Gasanalysator model Cross Duct for NO and SO<sub>2</sub> is based on the documents listed below and the regular, continuous monitoring of the Quality Management System of the manufacturer:

#### **Basic test**

Test report: 936/21209185/A of 07 October 2008  
TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, Cologne  
Publication: BAnz. 11 March 2009, No. 38, p. 899, chapter I no. 2.1  
Federal Environmental Agency notice of 19 February 2009

#### **Supplementary test**

Test report 936/21209185/C of 06 March 2009  
TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, Cologne  
Publication: BAnz. 25 August 2009, No. 125, p. 2929, chapter I no. 3.2  
Federal Environmental Agency notice of 03 August 2009  
(extension of the maintenance interval)

#### **Notifications**

Statement of TÜV Rheinland Immissionsschutz und Energiesysteme GmbH of 9 October 2009

Publication: BAnz. 12 February 2010, No. 24, p. 552, chapter IV notification 8  
Federal Environmental Agency notice of 25 January 2010  
(Update of software versions)

Statement of TÜV Rheinland Energie und Umwelt GmbH of 4 October 2010  
Publication: BAnz. 26 January 2011, No. 14, p. 294, chapter IV notification 1  
Federal Environmental Agency notice of 10 January 2011  
(SOPAS ET software change)

Statement of TÜV Rheinland Energie und Umwelt GmbH of 8 November 2010  
Publication: BAnz. 26 January 2011, No. 14, p. 294, chapter IV notification 30  
Federal Environmental Agency notice of 10 January 2011  
(Update of software versions)

Statement of TÜV Rheinland Energie und Umwelt GmbH of 24 March 2011  
Publication: BAnz. 29. July 2011, No. 113, p. 2725, chapter III notification 16  
Federal Environmental Agency notice of 15 July 2011  
(Update of software versions, hardware change)

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

Certificate No. 0000037051: 20 August 2012  
Expiry date of the certificate: 19 July 2017

Statement of TÜV Rheinland Energie und Umwelt GmbH of 20 March 2012  
Publication: BAnz AT 20.07.2012 B11, chapter IV notification 22  
Announcement by UBA dated 06 July 2012

**Notifications according to EN 15267**

Statement of TÜV Rheinland Energie und Umwelt GmbH of 02 October 2012  
Publication: BAnz AT 05.03.2013 B10, chapter V notification 17  
Announcement by UBA dated 12 February 2013  
(Ex-Version, new processor, new software version)

Statement of TÜV Rheinland Energie und Umwelt GmbH of 25 March 2013  
Publication: BAnz AT 23.07.2013 B4, chapter V notification 12  
Announcement by UBA dated 03 July 2013  
(manufacturer name)

Statement of TÜV Rheinland Energie und Umwelt GmbH of 25 March 2013  
Publication: BAnz AT 23.07.2013 B4, chapter V notification 13  
Announcement by UBA dated 03 July 2013  
(SOPAS ET software version)

Statement of TÜV Rheinland Energie und Umwelt GmbH of 10 October 2013  
Publication: BAnz AT 01.04.2014 B4, chapter V notification 15  
Announcement by UBA dated 27 February 2014  
(new software version)

Statement of TÜV Rheinland Energie und Umwelt GmbH of 22 May 2015  
Publication: BAnz AT 26.05.2015 B4, chapter V notification 35  
Announcement by UBA dated 22 July 2015  
(specification change of diode array)

Statement of TÜV Rheinland Energie und Umwelt GmbH of 12 October 2016  
Publication: BAnz AT 15.03.2017 B6, chapter V notification 27  
Announcement by UBA dated 22 February 2017  
(new software, new lamp)

**Renewal of the certificate**

Certificate No. 0000037051\_01: 18 July 2017  
Expiry date of the certificate: 19 July 2022

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

1

**Manufacturer data**

Manufacturer	SICK MAIHAK
Name of measuring system	GM32, Cross-Duct
Serial Number	8043 / 8044
Measuring Principle	UV-DOAS

**TÜV Data**

Approval Report	936/21209185/C
	2009-03-06
Editor	Pletscher
Date	2009-03-03

**Measurement Component**

Certificated range	NO	
	70	mg/m <sup>3</sup>

**Evaluation of the cross sensitivity (CS)**

	QE $\Delta X_{\max, j}$	
to 3 Vol.-% Oxygen	0.00	mg/m <sup>3</sup>
to 21 Vol.-% Oxygen	0.00	mg/m <sup>3</sup>
to 30 Vol.-% Humidity	0.00	mg/m <sup>3</sup>
to 300 mg/m <sup>3</sup> Carbon monoxide	- 0.34	mg/m <sup>3</sup>
to 15 Vol.-% Carbon dioxide	0.00	mg/m <sup>3</sup>
to 50 mg/m <sup>3</sup> Methane	0.29	mg/m <sup>3</sup>
to 100 mg/m <sup>3</sup> Dinitrogen monoxide	0.49	mg/m <sup>3</sup>
to 30 mg/m <sup>3</sup> Nitrogen dioxide	0.49	mg/m <sup>3</sup>
to 20 mg/m <sup>3</sup> Ammonia	0.57	mg/m <sup>3</sup>
to 1000 mg/m <sup>3</sup> Sulphur dioxide	- 0.66	mg/m <sup>3</sup>
to 200 mg/m <sup>3</sup> Hydrogen chloride	1.40	mg/m <sup>3</sup>
Sum of positive cross sensitivities	3.23	mg/m <sup>3</sup>
Sum of negative cross sensitivities	- 1.00	mg/m <sup>3</sup>

**Calculation of the combined standard uncertainty**

Test Value	$\Delta X_{\max, j}$		u	u <sup>2</sup>	
Standard deviation from paired measurements under field conditions *	0.47	mg/m <sup>3</sup>	u <sub>r</sub>	0.47	0.221
Lack of fit	0.63	mg/m <sup>3</sup>	u <sub>inf</sub>	0.36	0.132
Zero drift from field test	0.42	mg/m <sup>3</sup>	u <sub>d,z</sub>	0.24	0.059
Span drift from field test	- 1.61	mg/m <sup>3</sup>	u <sub>d,s</sub>	-0.93	0.864
Influence of ambient temperature at span	0.42	mg/m <sup>3</sup>	u <sub>t</sub>	0.24	0.059
Influence of supply voltage	0.21	mg/m <sup>3</sup>	u <sub>v</sub>	0.12	0.015
Cross sensitivity (interference) **	3.23	mg/m <sup>3</sup>	u <sub>i</sub>	1.87	3.486
Influence of sample pressure	0.00	mg/m <sup>3</sup>	u <sub>n</sub>	0.00	0.000
Uncertainty of reference material at 70% of certification range	0.98	mg/m <sup>3</sup>	u <sub>rm</sub>	0.57	0.320
Excursion of measurement beam	- 0.70	mg/m <sup>3</sup>	u <sub>mb</sub>	-0.40	0.163

\* The bigger value of: "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"

\*\* The absolut value of the Sum of positiv cross sensitivity is greater than the Sum of negativ cross sensitivity

Combined standard uncertainty (u <sub>c</sub> )	$u_c = \sqrt{\sum (u_{\max, j})^2}$	2.31	mg/m <sup>3</sup>
Total expanded uncertainty	U = u <sub>c</sub> * k = u <sub>c</sub> * 1,96	4.52	mg/m <sup>3</sup>

**Relative total expanded uncertainty**

Requirement of 2000/76/EC and 2001/80/EC	U in % of the ELV 40 mg/m <sup>3</sup>	11.3
Requirement of EN 15267-3	U in % of the ELV 40 mg/m <sup>3</sup>	20.0
	U in % of the ELV 40 mg/m <sup>3</sup>	15.0

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

**Manufacturer data**

Manufacturer	SICK MAIHAK
Name of measuring system	GM32, Cross-Duct
Serial Number	8043 / 8044
Measuring Principle	UV-DOAS

**TÜV Data**

Approval Report	936/21209185/C
	2009-03-06
Editor	Pletscher
Date	2009-03-03

**Measurement Component**

	SO <sub>2</sub>	
Certificated range	75	mg/m <sup>3</sup>

**Evaluation of the cross sensitivity (CS)**

	QE Δ X <sub>max, i</sub>	
to 3 Vol.-% Oxygen	0.00	mg/m <sup>3</sup>
to 21 Vol.-% Oxygen	0.00	mg/m <sup>3</sup>
to 30 Vol.-% Humidity	0.00	mg/m <sup>3</sup>
to 300 mg/m <sup>3</sup> Carbon monoxide	0.00	mg/m <sup>3</sup>
to 15 Vol.-% Carbon dioxide	0.00	mg/m <sup>3</sup>
to 50 mg/m <sup>3</sup> Methane	0.46	mg/m <sup>3</sup>
to 100 mg/m <sup>3</sup> Dinitrogen monoxide	0.00	mg/m <sup>3</sup>
to 300 mg/m <sup>3</sup> Nitrogen monoxide	- 2.01	mg/m <sup>3</sup>
to 30 mg/m <sup>3</sup> Nitrogen dioxide	1.07	mg/m <sup>3</sup>
to 20 mg/m <sup>3</sup> Ammonia	0.61	mg/m <sup>3</sup>
to 200 mg/m <sup>3</sup> Hydrogen chloride	- 0.54	mg/m <sup>3</sup>
Sum of positive cross sensitivities	2.14	mg/m <sup>3</sup>
Sum of negative cross sensitivities	- 2.55	mg/m <sup>3</sup>

**Calculation of the combined standard uncertainty**

Test Value	Δ X <sub>max, j</sub>		u	u <sup>2</sup>	
Standard deviation from paired measurements under field conditions *	0.68	mg/m <sup>3</sup>	u <sub>r</sub>	0.68	0.462
Lack of fit	0.45	mg/m <sup>3</sup>	u <sub>inf</sub>	0.26	0.068
Zero drift from field test	1.43	mg/m <sup>3</sup>	u <sub>dz</sub>	0.82	0.677
Span drift from field test	- 1.58	mg/m <sup>3</sup>	u <sub>ds</sub>	-0.91	0.827
Influence of ambient temperature at span	0.38	mg/m <sup>3</sup>	u <sub>t</sub>	0.22	0.047
Influence of supply voltage	0.53	mg/m <sup>3</sup>	u <sub>v</sub>	0.30	0.092
Cross sensitivity (interference) **	- 2.55	mg/m <sup>3</sup>	u <sub>i</sub>	-1.47	2.168
Influence of sample pressure	0.00	mg/m <sup>3</sup>	u <sub>n</sub>	0.00	0.000
Uncertainty of reference material at 70% of certification range	1.05	mg/m <sup>3</sup>	u <sub>rm</sub>	0.61	0.368
Excursion of measurement beam	1.28	mg/m <sup>3</sup>	u <sub>mb</sub>	0.74	0.542

\* The bigger value of: "Repeatability standard deviation at span" or "Standard deviation from paired measurements under field conditions"

\*\* The absolut value of the Sum of negativ cross sensitivity is greater than Sum of positiv cross sensitivity

Combined standard uncertainty (u <sub>c</sub> )	$u_c = \sqrt{\sum (u_{max, j})^2}$	2.29	mg/m <sup>3</sup>
Total expanded uncertainty	$U = u_c * k = u_c * 1,96$	4.49	mg/m <sup>3</sup>

<b>Relative total expanded uncertainty</b>	<b>U in % of the ELV 35 mg/m<sup>3</sup></b>	<b>12.8</b>
<b>Requirement of 2000/76/EC and 2001/80/EC</b>	<b>U in % of the ELV 35 mg/m<sup>3</sup></b>	<b>20.0</b>
Requirement of EN 15267-3	U in % of the ELV 35 mg/m <sup>3</sup>	15.0