CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000028733_04

AMS designation:	SWAM 5a Dual Channel Monitor, SWAM 5a Dual Channel Hourly Mode Monitor for PM_{10} and $PM_{2,5}$ and SWAM 5a Monitor for PM_{10} or $PM_{2,5}$
Manufacturer:	FAI Instruments s.r.l. Via Aurora, 25 00013 Fonte Nuova (Rome) Italy
Test Laboratory:	TÜV Rheinland Energy GmbH

This is to certify that the AMS has been tested and found to comply with:
VDI 4202-1 (2002), VDI 4203-3 (2004),
EN 12341 (1999), EN 14907 (2005), EN 16450 (2017)
Guide to the demonstration of equivalence of ambient air monitoring methods (2010)
EN 15267-1 (2009) and DIN EN 15267-2 (2009).

Certification is awarded in respect of the conditions stated in this certificate (this certificate contains 18 pages).
The present certificate replaces certificate 0000028733_03 of 12 June 2019

TÜVRheinland® CERTIFIED
Suitability Tested
Complying with
2008/50/EC
EN 15267
Regular Surveillance
www.tuv.com
ID 0000028733

Publication in the German Federal Gazette (BAnz) of 26 March 2019

This certificate will expire on:
25 March 2024

German Federal Environment Agency
Dessau, 29 November 2019

Dr Marcel Langner
Head of Section II 4.1

TÜV Rheinland Energy GmbH
Cologne, 28 November 2019

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 17025:2005 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:	936/21207522/A dated 23 March 2009 and Addendum 936/21239762/B dated 7 September 2018
Initial certification:	29 July 2011
Expiry date:	25 March 2024
Publication:	BAnz AT 26.03.2019 B7, chapter IV notification 34

Approved application
The tested AMS is suitable for continuous ambient air monitoring of suspended particulate matter, $PM_{2.5}$ and PM_{10} fractions (stationary operation).

The suitability of the AMS for this application was assessed on the basis of a laboratory test and a field test performed at up to six different sites and different periods.

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, in consultation with the manufacturer, 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 intended purpose.

Basis of the certification
This certification is based on:

- Test report No. 936/21207522/A dated 23 March 2009
  issued by TÜV Rheinland Immissionsschutz und Energiesysteme GmbH and
  Addendum No. 936/21239762/B dated 7 September 2018
  issued by TÜV Rheinland Energy GmbH
- Suitability announced by the German Federal Environment Agency (UBA)
  as the relevant body
- The ongoing surveillance of the product and the manufacturing process

Certificate:
0000028733_04 / 29 November 2019

Publication in the German Federal Gazette: BAnz. 25 August 2009, No. 125, p. 2929, chapter II No. 2.1, UBA announcement dated 3 August 2009:

AMS designation:

SWAM 5a Dual Channel Monitor for $PM_{2,5}$ and PM_{10}

Manufacturer:

FAI Instruments s.r.l., Fonte Nuova (Rome), Italy

Field of application:

For continuous and parallel ambient air monitoring of suspended particulate matter, M_{10} and $PM_{2,5}$ fractions, (stationary operation)

Measuring ranges during performance testing:

PM_{10}: 0–200 µg/m^3
$PM_{2,5}$ 0–200 µg/m^3

software version:

Version Rel 04-08.01.65-30.02.00

Notes:

1. The measuring system complies with the requirements of the guide to "Demonstration of Equivalence of Ambient Air Monitoring Methods".
2. Filter cartridges with a spot area of 5.20 cm² have been used for the test work.
3. The instrument must be calibrated on-site regularly using a gravimetric PM_{10} reference method in accordance with EN 12341.
4. The instrument must be calibrated on-site regularly using a gravimetric $PM_{2.5}$ reference method in accordance with EN 14907.

Test Report:

TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, Cologne
Report no.: 936/21207522/A dated 23 March 2009

Publication in the German Federal Gazette: BAnz. 29 July 2011, no. 113, page 2725, chapter III, notification 7, UBA announcement dated 15 July 2011:

7 Notification as regards Federal Environment Agency notice of 3 August 2009 (BAnz. p. 2929, chapter II, number 2.1)

The measuring system SWAM 5a Dual Channel Monitor for PM_{10} and $PM_{2.5}$ manufactured by FAI Instruments s.r.l. meets the requirements of EN 12341, EN 14907 as well as those of the Guide on the “Demonstration of Equivalence of Ambient Air Monitoring Methods” in its version of November 2005. Furthermore, the manufacturing process and quality management of the SWAM 5a Dual Channel Monitor for PM_{10} and $PM_{2,5}$ meet the requirements of EN 15267.

This report on the performance test is available online at www.qal1.de.

Statement issued by TÜV Rheinland Energie und Umwelt GmbH
dated 26 March 2011

Publication in the German Federal Gazette: BAnz. 2 March 2012, No. 36, p. 920, chapter V notification 2, UBA announcement dated 23 February 2012:

2 Notification as regards Federal Environment Agency (UBA) notices of 3 July 2009 (BAnz. p. 2929, chapter II, number 2.1) and of 15 July 2011 (BAnz. p. 2725, chapter III 7th notification)

The SWAM 5a Dual Channel Monitor ambient air measuring system for PM_{10} and $PM_{2.5}$ manufactured by FAI Instruments s.r.l. can also be used in a model version which applies a 1-h measuring mode. This version is distributed under the name of SWAM 5a Dual Channel Hourly Mode Monitor.

Teledyne Advanced Pollution Instrumentation, San Diego/USA distributes an identical instrument to the SWAM 5a Dual Channel Hourly Mode Monitor ambient air measuring system for PM_{10} and $PM_{2.5}$ manufactured by FAI Instruments s.r.l. under the name of Model 602 BetaPlus

Statement issued by TÜV Rheinland Energie und Umwelt GmbH
dated 11 October 2011

Publication in the German Federal Gazette: BAnz. 2 March 2012, No. 36, p. 920, chapter V notification 3, UBA announcement dated 23 February 2012:

3 Notification as regards Federal Environment Agency (UBA) notices of 3 August 2009 (BAnz. p. 2929, chapter II, number 2.1) and of 15 July 2011 (BAnz. p. 2725, chapter III 7th notification)

The suitability announcement of the SWAM 5a Dual Channel Monitor ambient air quality measuring system for PM_{10} and $PM_{2,5}$ manufactured by FAI Instruments s.r.l. also covers instrument version SWAM 5a Monitor, which is a single-channel version of the former.

Statement issued by TÜV Rheinland Energie und Umwelt GmbH
dated 3 November 2011

Publication in the German Federal Gazette: BAnz AT 05.03.2013 B10, chapter V notification 12, UBA announcement dated 12 February 2013:

12 Notification as regards Federal Environment Agency (UBA) notices of 3 August 2009 (BAnz. p. 2929, chapter II, number 2.1) and o 23 February 2012 (BAnz. p. 920, chapter V 2nd und 3rd notification)

The current software version of the SWAM 5a Dual Channel Monitor ambient air monitor for PM_{10} and $PM_{2,5}$ manufactured by FAI Instruments s.r.l. is:

04-09.01.85-30.02.00

Statement issued by TÜV Rheinland Energie und Umwelt GmbH
dated 15 October 2012

Publication in the German Federal Gazette: BAnz AT 02.04.2015 B5,
chapter IV notification 8, UBA announcement dated 25 February 2015:

8 Notification as regards Federal Environment Agency (UBA) notices of 3 August 2009 (BAnz. p. 2929, chapter II, number 2.1) and of 12 February 2013 (BAnz AT 05.03.2013 B10, chapter V 12th notification)

The current software versions for the SWAM 5a Dual Channel Monitor for PM_{10} and $PM_{2,5}$ are:

04-09.01.85-30.02.00 (old micro controller, until 2008) and

04-09.01.85-30.03.00 (new micro controller, starting from 2008)

An optional Ethernet Board, which enables the communication with the measuring system via LAN network, is available for SWAM 5a Dual Channel Hourly Mode Monitor for PM_{10} and $PM_{2.5}$. The current software version of the measuring system is:

05-02.08.56-30.03.00

The current software version for SWAM 5a Monitor for PM_{10} and $PM_{2.5}$ is:

01-05.05.13-30.03.00

Statement issued by TÜV Rheinland Energie und Umwelt GmbH
dated 19 September 2014

Publication in the German Federal Gazette: BAnz AT 26.08.2015 B4,
chapter V notification 44, UBA announcement dated 22 July 2015:

44 Notification as regards Federal Environment Agency (UBA) notices of 3 July 2009 (BAnz. p. 2934, chapter II, number 2.1) and of 25 February 2015 (BAnz AT 02.04.2015 B5, chapter IV, 8th notification)

PM10-EN12341-2014 and PM2.5-EN12341-2014 standard sample ports in accordance with Annex A of standard EN 12341 (issued August 2014 [German version]) are available for the SWAM 5a Dual Channel Monitor for PM_{10} and $PM_{2.5}$, SWAM 5a Dual Channel Hourly Mode Monitor for PM_{10} and $PM_{2.5}$ and SWAM 5a Monitor for PM_{10} or $PM_{2.5}$ measuring systems manufactured by FAI Instruments s.r.l.

Statement issued by TÜV Rheinland Energie und Umwelt GmbH
dated 17 March 2015

Publication in the German Federal Gazette: BAnz AT 26.03.2018 B8, chapter V notification 6, UBA announcement dated 21 February 2018:

6 Notification as regards Federal Environment Agency (UBA) notices of 3 August 2009 (BAnz. p. 2934, chapter II, number 2.1) and of 22 July 2015 (BAnz AT 26.08.2015 B4, chapter V 44th notification)

The SWAM 5a Dual Channel Monitor, SWAM 5a Dual Channel Hourly Mode Monitor for PM_{10} and $PM_{2,5}$ and SWAM 5a Monitor for PM_{10} or $PM_{2,5}$ manufactured by FAI Instruments s.r.l. meet the requirements defined in standard EN 16450 (July 2017 version). An addendum to test report No. 936/21239762/A is available online at www.qal1.de.

The current software version for the SWAM 5a Dual Channel Monitor for PM_{10} and $PM_{2,5}$ is:

04-09.01.92-30.03.00

The current software version for the SWAM 5a Dual Channel Hourly Mode Monitor for PM_{10} and $PM_{2,5}$ is:

05-03.00.01-30.03.00

The current software version for SWAM 5a Monitor for PM_{10} and $PM_{2.5}$ is:

01-05.05.17-30.03.00

Statement issued by TÜV Rheinland Energy GmbH dated 22 September 2017

Publication in the German Federal Gazette: BAnz AT 26.03.2019 B7, chapter IV notification 34, UBA announcement dated 27 February 2019:

34 Notification as regards Federal Environment Agency (UBA) notices of 3 August 2009 (BAnz. p. 2934, chapter II number 2.1) and of 21 February 2018 (BAnz AT 26.03.2018 B8, chapter V 6th notification)

The addendum to the report no. 936/21239762/A dated 22 September 2017 on testing the SWAM 5a Dual Channel Monitor, SWAM 5a Dual Channel Hourly Mode Monitor for PM_{10} and $PM_{2,5}$ and SWAM 5a Monitor for PM_{10} or $PM_{2,5}$ manufactured by FAI Instruments s.r.l. contains an error with regard to calculating random uncertainty of the reference method. This error was corrected by way of an additional addendum to test report no. 936/21239762/B dated 7 September 2018. The addendum no. 936/21239762/A dated 22 September 2017 was withdrawn.

The current software version for the SWAM 5a Dual Channel Monitor for PM_{10} and $PM_{2,5}$ is:

04-09.01.97-30.03.00

The current software version for the SWAM 5a Dual Channel Monitor for PM_{10} and $PM_{2,5}$ is:

05-03.00.01-30.03.00

The current software version for SWAM 5a Monitor for PM_{10} and $PM_{2.5}$ is:

01-05.05.21-30.03.00

Statement issued by TÜV Rheinland Energy GmbH dated 7 September 2018

Certified product

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

For mass measurement of separated particles, the SWAM 5a Dual Channel Monitor, SWAM 5a Dual Channel Hourly Mode Monitor and SWAM 5a Monitor measuring systems rely on the principle of beta attenuation observed on passing through a thin film of material.

The measuring system is available in three instrument versions: SWAM 5a Dual Channel Monitor (PM_{10} and $PM_{2,5}$ via tow independent sampling lines, 24h measuring cycle tested), SWAM 5a Dual Channel Hourly Monitor (PM_{10} and $PM_{2,5}$ via two independent sampling lines, 1h measuring cycle teste) and SWAM 5a Monitor (PM_{10} or $PM_{2,5}$ via a single sampling line, 24 measuring cycle tested).

The SWAM 5a Dual Channel Monitor, SWAM 5a Dual Channel Hourly Mode Monitor and SWAM 5a Monitor are automated and sequential measuring systems for the determination of particles on filter membranes. For the dual-channel versions, two separate pumps serve to such in ambient air via the PM_{10} sampling head on the one hand and the $PM_{2,5}$ sampling head on the other. Dust-loaded sample air is then precipitated on a filter (1 x PM_{10}, 1 x $PM_{2,5}$). A single pump is used for sampling on the filter via the sampling head of the SWAM 5a Monitor instrument version.

The determination of the mass concentration precipitated on a filter is then performed relying on the principle of beta absorption. A single radiometric mass measurement module is used to determine the dust mass deposited on the filters – also for the dual-channel instrument versions.

The SWAM 5a Dual Channel Monitor and SWAM 5a Dual Channel Hourly Mode Monitor consist of two sampling heads (PM_{10} & $PM_{2,5}$), two intake pipes, two vacuum pumps, the measuring instrument, a compressor for generating compressed air and the two filter cartridges for virgin and sampled filters.

The SWAM 5a Monitor consists of one sampling head (PM_{10} or $PM_{2.5}$), one intake pipe, one vacuum pump, the instrument, the compressor for generating compressed air and the two filter cartridges for virgin and sampled filters.

The sampling inlets are manufactured by the instrument manufacturer and are available for various flow rates (2.3 m³/h or 1 m³/h). Sampling heads for a flow of 2.3 m³/h were used for performance testing, whose design conformed to the reference standards EN 12341:1998 (PM_{10}) and EN 14907:2005 ($PM_{2,5}$). The certification also covers sampling heads whose design complies with the reference standard EN 12341:2014 (PM_{10}, $PM_{2,5}$).

Ambient air containing particles is taken in through the sampling inlet, it passes through the intake pipe and finally reaches the filter.

In situations with expected high amounts of volatile dust components it is possible to have the intake pipe purged co-axially with ambient air (it may alternatively be heated or cooled).

As part of instrument approval, neither purging with ambient air, nor active heating or cooling of the intake pipe took place. Inside the measuring rack, the intake pipes were simply isolated by wrapping foamed material around it.

The vacuum pumps suck ambient air through the sampling heads, the intake pipes and the filters. They consist of a piston pump with an upstream silencer filter to balance out pressure fluctuations.

In principle, it is possible to use a different pump type (e.g. graphite rotary vane pump) as long as the required pump performance is ensured at any given time.

The sampling unit contains all the servo mechanics, the pneumatic and beta measurement component as well as all electronic parts and microprocessors for operation, control and monitoring of the measuring system. The control panel with display is located at the front of the system; pneumatic and electronic connections as well as communication interfaces are located at the back of the system. Filter loader/unloader housings and intake pipes are located on the upper instrument surface.

The instrument is equipped with a service air compressor able to supply compressed air (200–300 kPa) used for the servomechanisms movements (e.g. for loading/unloading filters into the relevant housing). A compressor generates the necessary compressed air.

The measuring system is operated via a membrane keypad combined with a display at the front of the instrument. This is where all necessary parameters can be adjusted (e.g. sampling time). Moreover, information regarding the current instrument status (on-going sampling), data saved on completed measurements and numerous parameters for quality assurance can be accessed here.

In addition to direct communication via keyboard and display, the AMS offers a means of connection suited for a standard terminal (e.g. HyperTerminal) or a PC/modem via serial port RS-232. The AMS can be controlled, operated and parameterised through the terminal or with the help of the operating software Dr. FAI Manager, either directly via PC or indirectly via GSM modem.

The current software version for the SWAM 5a Dual Channel Monitor for PM_{10} and $PM_{2,5}$ is:
4-09.01.97-30.03.00

The current software version for the SWAM 5a Dual Channel Hourly Mode Monitor for PM_{10} and $PM_{2,5}$ is: 05-03.00.01-30.03.00

The current software version for SWAM 5a Monitor for PM_{10} and $PM_{2.5}$ is:
01-05.05.21-30.03.00

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 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. 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**.

Document history

Certification of the SWAM 5a Dual Channel Monitor, SWAM 5a Dual Channel Hourly Mode Monitor for PM_{10} and $PM_{2,5}$ and SWAM 5a Monitor for PM_{10} or $PM_{2,5}$ measuring systems is based on the documents listed below and the regular, continuous surveillance of the manufacturer's quality management system:

Basic testing

Test report: 936/21207522/A dated 23 March 2009
TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, Cologne
Publication: 25 August 2009, no. 125, p. 2929, chapter II No. 2.1
UBA announcement dated 3 August 2009

Initial certification according to EN 15267

Certificate no. 0000028733: 19 August 2011
Expiry date of the certificate: 28 July 2016
Test report: 936/21207522/A dated 23 March 2009
TÜV Rheinland Immissionsschutz und Energiesysteme GmbH, Cologne
Publication: BAnz. 29 July 2011, no. 113, p. 2725, chapter III notification 7
UBA announcement dated 15 July 2011

Notifications in accordance with EN 15267

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 11 October 2011
Publication: BAnz. 2 March 2012, no. 36, p. 920, chapter V notification 2
UBA announcement dated 23 February 2012
(new instrument version)

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 3 November 2011
Publication: BAnz. 2 March 2012, no. 36, p. 920, chapter V notification 3
UBA announcement dated 23 February 2012
(new instrument version)

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 15 October 2012
Publication: BAnz AT 05.03.2013 B10, chapter V notification 12
UBA announcement dated 12 February 2013
(new software version)

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 19 September 2014
Publication: BAnz AT 02.04.2015 B5, chapter IV notification 8
UBA announcement dated 25 February 2015
(new software version)

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 17 March 2015
Publication: BAnz AT 26.08.2015 B4, chapter V notification 44
UBA announcement dated 22 July 2015
(hardware changes)

Renewal of the certificate

Certificate no. 0000028733_01: 22 July 2016
Expiry date of the certificate: 28 July 2021

Notifications in accordance with EN 15267

Certificate no.0000028733_02: 13 April 2018
Expiry date of the certificate: 28 July 2021
Statement issued by TÜV Rheinland Energy GmbH dated 22 September 2017
Publication: BAnz AT 26.03.2018 B8, chapter V notification 6
UBA announcement dated 21 February 2018
(Compliance with the requirements of EN 16450 (2017), new software version)

Certificate no. 0000028733_03: 29 November 2019
Expiry date of the certificate: 25 March 2024
Statement issued by TÜV Rheinland Energy GmbH dated 7 September 2018
Publication: BAnz AT 26.03.2019 B7, chapter IV notification 34
UBA announcement dated 27 February 2019
(correction of uncertainty calculation, new software version)

Certificate no.0000028733_04: 29 November 2019
Expiry date of the certificate: 25 March 2024
(Correction of standard version on the front page of the english certificate)

Certificate:
0000028733_04 / 29 November 2019

Uncertainty FAI SWAM5a

Consolidated results of equivalence testing, SWAM 5a Dual Channel Monitor, Measured component $PM_{2,5}$ after slope and offset correction

Comparison candidate with reference according to Standard EN 16450: 2017					
Candidate	SWAM 5a DC		SN	I 145 / SN 248 & SN 131 / SN 149 / SN 249	
			Limit value	30	µg/m^3
Status of measured values	Slope & offset corrected		Allowed uncertainty	25	%
All comparisons					
Uncertainty between Reference	**0.51**	**µg/m^3**			
Uncertainty between Candidates	**0.73**	**µg/m^3**			
SN 127 / SN 145 / SN 248 & SN 131 / SN 149 / SN 249					
Number of data pairs	**312**				
Slope b	**1.001**	**not significant**			
Uncertainty of b	**0.011**				
Ordinate intercept a	**-0.007**	**not significant**			
Uncertainty of a	**0.189**				
Expanded meas. uncertainty W_{CM}	**12.40**	**%**			
All comparisons, ≥18 µg/m^3					
Uncertainty between Reference	**0.64**	**µg/m^3**			
Uncertainty between Candidates	**0.79**	**µg/m^3**			
SN 127 / SN 145 / SN 248 & SN 131 / SN 149 / SN 249					
Number of data pairs	**91**				
Slope b	**1.051**				
Uncertainty of b	**0.029**				
Ordinate intercept a	**-2.028**				
Uncertainty of a	**0.804**				
Expanded meas. uncertainty W_{CM}	**15.74**	**%**			
All comparisons, <18 µg/m^3					
Uncertainty between Reference	**0.50**	**µg/m^3**			
Uncertainty between Candidates	**0.45**	**µg/m^3**			
SN 127 / SN 145 / SN 248 & SN 131 / SN 149 / SN 249					
Number of data pairs	**221**				
Slope b	**0.959**				
Uncertainty of b	**0.022**				
Ordinate intercept a	**0.606**				
Uncertainty of a	**0.237**				
Expanded meas. uncertainty W_{CM}	**11.04**	**%**			

Comparison candidate with reference according to Standard EN 16450: 2017				
Candidate	SWAM 5a DC		SN	145 / SN 248 & SN 131 / SN 149 / SN 249
			Limit value	30 µg/m³
Status of measured values	Slope & offset corrected		Allowed uncertainty	25 %
Cologne, parking lot (2007)				
Uncertainty between Reference	**0.67**	**µg/m³**		
Uncertainty between Candidates	**0.71**	**µg/m³**		
	SN 127		**SN 131**	
Number of data pairs	**45**		**46**	
Slope b	**1.029**		**0.995**	
Uncertainty of b	**0.023**		**0.023**	
Ordinate intercept a	**-0.653**		**-0.372**	
Uncertainty of a	**0.393**		**0.391**	
Expanded meas. uncertainty W_{CM}	**7.89**	**%**	**8.51**	**%**
Bonn, Belderberg				
Uncertainty between Reference	**0.46**	**µg/m³**		
Uncertainty between Candidates	**0.44**	**µg/m³**		
	SN 127		**SN 131**	
Number of data pairs	**41**		**41**	
Slope b	**1.025**		**1.052**	
Uncertainty of b	**0.020**		**0.022**	
Ordinate intercept a	**-1.611**		**-2.437**	
Uncertainty of a	**0.456**		**0.504**	
Expanded meas. uncertainty W_{CM}	**10.17**	**%**	**10.90**	**%**
Bruehl				
Uncertainty between Reference	**0.65**	**µg/m³**		
Uncertainty between Candidates	**0.65**	**µg/m³**		
	SN 127		**SN 131**	
Number of data pairs	**43**		**45**	
Slope b	**1.013**		**1.032**	
Uncertainty of b	**0.033**		**0.033**	
Ordinate intercept a	**-1.357**		**-1.595**	
Uncertainty of a	**0.509**		**0.534**	
Expanded meas. uncertainty W_{CM}	**11.26**	**%**	**10.95**	**%**
Teddington				
Uncertainty between Reference	**0.33**	**µg/m³**		
Uncertainty between Candidates	**0.45**	**µg/m³**		
	SN 145		**SN 149**	
Number of data pairs	**74**		**80**	
Slope b	**1.005**		**1.002**	
Uncertainty of b	**0.023**		**0.020**	
Ordinate intercept a	**0.801**		**1.020**	
Uncertainty of a	**0.290**		**0.252**	
Expanded meas. uncertainty W_{CM}	**12.04**	**%**	**11.73**	**%**
Cologne, parking lot (2011)				
Uncertainty between Reference	**0.52**	**µg/m³**		
Uncertainty between Candidates	**1.37**	**µg/m³**		
	SN 127		**SN 131**	
Number of data pairs	**67**		**53**	
Slope b	**1.053**		**1.000**	
Uncertainty of b	**0.027**		**0.032**	
Ordinate intercept a	**-0.904**		**0.277**	
Uncertainty of a	**0.634**		**0.824**	
Expanded meas. uncertainty W_{CM}	**17.35**	**%**	**19.33**	**%**
Bornheim				
Uncertainty between Reference	**0.65**	**µg/m³**		
Uncertainty between Candidates	**0.33**	**µg/m³**		
	SN 248		**SN 249**	
Number of data pairs	**57**		**60**	
Slope b	**1.084**		**1.094**	
Uncertainty of b	**0.041**		**0.043**	
Ordinate intercept a	**-0.213**		**-0.338**	
Uncertainty of a	**0.441**		**0.456**	
Expanded meas. uncertainty W_{CM}	**18.79**	**%**	**20.08**	**%**
All comparisons, ≥18 µg/m³				
Uncertainty between Reference	**0.64**	**µg/m³**		
Uncertainty between Candidates	**0.79**	**µg/m³**		
	SN 127 / SN 145 / SN 248		**SN 131 / SN 149 / SN 249**	
Number of data pairs	**95**		**95**	
Slope b	**1.067**		**1.023**	
Uncertainty of b	**0.029**		**0.029**	
Ordinate intercept a	**-2.358**		**-1.408**	
Uncertainty of a	**0.810**		**0.81**	
Expanded meas. uncertainty W_{CM}	**16.02**	**%**	**16.40**	**%**
All comparisons, <18 µg/m³				
Uncertainty between Reference	**0.50**	**µg/m³**		
Uncertainty between Candidates	**0.45**	**µg/m³**		
	SN 127 / SN 145 / SN 248		**SN 131 / SN 149 / SN 249**	
Number of data pairs	**232**		**230**	
Slope b	**0.958**		**0.985**	
Uncertainty of b	**0.021**		**0.024**	
Ordinate intercept a	**0.593**		**0.413**	
Uncertainty of a	**0.226**		**0.252**	
Expanded meas. uncertainty W_{CM}	**10.75**	**%**	**11.18**	**%**
All comparisons				
Uncertainty between Reference	**0.51**	**µg/m³**		
Uncertainty between Candidates	**0.73**	**µg/m³**		
	SN 127 / SN 145 / SN 248		**SN 131 / SN 149 / SN 249**	
Number of data pairs	**327**		**325**	
Slope b	**1.009**	**not significant**	**0.991**	**not significant**
Uncertainty of b	**0.011**		**0.011**	
Ordinate intercept a	**-0.118**	**not significant**	**0.137**	**not significant**
Uncertainty of a	**0.187**		**0.193**	
Expanded meas. uncertainty W_{CM}	**12.42**	**%**	**13.00**	**%**

Consolidated results of equivalence testing, SWAM 5a Dual Channel Monitor, Measured component PM_{10} after slope correction

Comparison candidate with reference according to Standard EN 16450: 2017					
Candidate	SWAM 5a DC		SN	I 145 / SN 248 & SN 131 / SN 149 / SN 249	
			Limit value	50	µg/m³
Status of measured values	Slope corrected		Allowed uncertainty	25	%
All comparisons					
Uncertainty between Reference	**0.75**	**µg/m³**			
Uncertainty between Candidates	**0.63**	**µg/m³**			
SN 127 / SN 145 / SN 248 & SN 131 / SN 149 / SN 249					
Number of data pairs	**404**				
Slope b	**0.999**	**not significant**			
Uncertainty of b	**0.009**				
Ordinate intercept a	**-0.240**	**not significant**			
Uncertainty of a	**0.228**				
Expanded measured uncertainty WCM	**9.10**	**%**			
All comparisons, ≥30 µg/m³					
Uncertainty between Reference	**0.78**	**µg/m³**			
Uncertainty between Candidates	**1.14**	**µg/m³**			
SN 127 / SN 145 / SN 248 & SN 131 / SN 149 / SN 249					
Number of data pairs	**83**				
Slope b	**1.111**				
Uncertainty of b	**0.030**				
Ordinate intercept a	**-5.296**				
Uncertainty of a	**1.307**				
Expanded measured uncertainty WCM	**13.55**	**%**			
All comparisons, <30 µg/m³					
Uncertainty between Reference	**0.74**	**µg/m³**			
Uncertainty between Candidates	**0.43**	**µg/m³**			
SN 127 / SN 145 / SN 248 & SN 131 / SN 149 / SN 249					
Number of data pairs	**321**				
Slope b	**0.962**				
Uncertainty of b	**0.015**				
Ordinate intercept a	**0.527**				
Uncertainty of a	**0.276**				
Expanded measured uncertainty WCM	**8.99**	**%**			

Comparison candidate with reference according to Standard EN 16450: 2017				
Candidate	SWAM 5a DC	SN	145 / SN 248 & SN 131 / SN 149 / SN 249	
		Limit value	50	µg/m³
Status of measured values	Slope corrected	Allowed uncertainty	25	%
Cologne, parking lot (2007)				
Uncertainty between Reference	**1.12**	**µg/m³**		
Uncertainty between Candidates	**0.83**	**µg/m³**		
	SN 127		**SN 131**	
Number of data pairs	**98**		**100**	
Slope b	**1.070**		**1.021**	
Uncertainty of b	**0.012**		**0.011**	
Ordinate intercept a	**-0.306**		**0.394**	
Uncertainty of a	**0.321**		**0.295**	
Expanded measured uncertainty W_{CM}	**14.51**	**%**	**8.39**	**%**
Bonn, Belderberg				
Uncertainty between Reference	**0.53**	**µg/m³**		
Uncertainty between Candidates	**0.43**	**µg/m³**		
	SN 127		**SN 131**	
Number of data pairs	**62**		**62**	
Slope b	**1.076**		**1.060**	
Uncertainty of b	**0.020**		**0.019**	
Ordinate intercept a	**-1.113**		**-0.986**	
Uncertainty of a	**0.542**		**0.513**	
Expanded measured uncertainty W_{CM}	**12.73**	**%**	**10.36**	**%**
Bruehl				
Uncertainty between Reference	**0.77**	**µg/m³**		
Uncertainty between Candidates	**0.54**	**µg/m³**		
	SN 127		**SN 131**	
Number of data pairs	**51**		**53**	
Slope b	**0.996**		**0.985**	
Uncertainty of b	**0.026**		**0.024**	
Ordinate intercept a	**-1.815**		**-1.594**	
Uncertainty of a	**0.614**		**0.570**	
Expanded measured uncertainty W_{CM}	**10.65**	**%**	**11.41**	**%**
Teddington				
Uncertainty between Reference	**0.45**	**µg/m³**		
Uncertainty between Candidates	**0.50**	**µg/m³**		
	SN 145		**SN 149**	
Number of data pairs	**73**		**79**	
Slope b	**0.901**		**0.921**	
Uncertainty of b	**0.020**		**0.020**	
Ordinate intercept a	**2.370**		**1.927**	
Uncertainty of a	**0.379**		**0.371**	
Expanded measured uncertainty W_{CM}	**11.81**	**%**	**9.99**	**%**
Cologne, parking lot (2011)				
Uncertainty between Reference	**0.59**	**µg/m³**		
Uncertainty between Candidates	**0.83**	**µg/m³**		
	SN 127		**SN 131**	
Number of data pairs	**69**		**66**	
Slope b	**0.982**		**0.983**	
Uncertainty of b	**0.021**		**0.024**	
Ordinate intercept a	**-1.574**		**-1.966**	
Uncertainty of a	**0.728**		**0.836**	
Expanded measured uncertainty W_{CM}	**13.63**	**%**	**15.53**	**%**
Bornheim				
Uncertainty between Reference	**0.63**	**µg/m³**		
Uncertainty between Candidates	**0.33**	**µg/m³**		
	SN 248		**SN 249**	
Number of data pairs	**56**		**59**	
Slope b	**0.991**		**0.990**	
Uncertainty of b	**0.031**		**0.032**	
Ordinate intercept a	**-0.575**		**-0.723**	
Uncertainty of a	**0.553**		**0.568**	
Expanded measured uncertainty W_{CM}	**8.08**	**%**	**8.76**	**%**
All comparisons, ≥30 µg/m³				
Uncertainty between Reference	**0.78**	**µg/m³**		
Uncertainty between Candidates	**1.14**	**µg/m³**		
	SN 127 / SN 145 / SN 248		**SN 131 / SN 149 / SN 249**	
Number of data pairs	**86**		**85**	
Slope b	**1.137**		**1.085**	
Uncertainty of b	**0.031**		**0.031**	
Ordinate intercept a	**-6.111**		**-4.605**	
Uncertainty of a	**1.330**		**1.32**	
Expanded measured uncertainty W_{CM}	**14.24**	**%**	**13.74**	**%**
All comparisons, <30 µg/m³				
Uncertainty between Reference	**0.74**	**µg/m³**		
Uncertainty between Candidates	**0.43**	**µg/m³**		
	SN 127 / SN 145 / SN 248		**SN 131 / SN 149 / SN 249**	
Number of data pairs	**323**		**334**	
Slope b	**0.964**		**0.964**	
Uncertainty of b	**0.015**		**0.015**	
Ordinate intercept a	**0.547**		**0.428**	
Uncertainty of a	**0.281**		**0.272**	
Expanded measured uncertainty W_{CM}	**8.78**	**%**	**8.96**	**%**
All comparisons				
Uncertainty between Reference	**0.75**	**µg/m³**		
Uncertainty between Candidates	**0.63**	**µg/m³**		
	SN 127 / SN 145 / SN 248		**SN 131 / SN 149 / SN 249**	
Number of data pairs	**409**		**419**	
Slope b	**1.010**	**not significant**	**0.986**	**not significant**
Uncertainty of b	**0.009**		**0.009**	
Ordinate intercept a	**-0.376**	**not significant**	**-0.069**	**not significant**
Uncertainty of a	**0.237**		**0.223**	
Expanded measured uncertainty W_{CM}	**9.41**	**%**	**9.47**	**%**

Consolidated results of the equivalence testing, SWAM 5a Dual Channel Hourly Mode Monitor, Measured component $PM_{2,5}$, raw data

Comparison candidate with reference according to Standard EN 16450: 2017					
Candidate	SWAM 5a DC HM		SN	SN 111 & SN 112	
			Limit value	30	µg/m³
Status of measured values	Raw data		Allowed uncertainty	25	%
All comparisons					
Uncertainty between Reference	**0.52**	**µg/m³**			
Uncertainty between Candidates	**0.74**	**µg/m³**			
	SN 111 & SN 112				
Number of data pairs	**61**				
Slope b	**0.998**	**not significant**			
Uncertainty of b	**0.016**				
Ordinate intercept a	**0.685**	**not significant**			
Uncertainty of a	**0.393**				
Expanded meas. uncertainty W_{CM}	**10.68**	**%**			
Cologne, parking lot (2011)					
Uncertainty between Reference	**0.52**	**µg/m³**			
Uncertainty between Candidates	**0.74**	**µg/m³**			
	SN 111			**SN 112**	
Number of data pairs	**68**			**61**	
Slope b	**1.005**			**0.992**	
Uncertainty of b	**0.018**			**0.018**	
Ordinate intercept a	**0.657**			**0.901**	
Uncertainty of a	**0.429**			**0.428**	
Expanded meas. uncertainty W_{CM}	**12.28**	**%**		**11.58**	**%**

Consolidated results of the equivalence testing, SWAM 5a Dual Channel Hourly Mode Monitor, Measured component PM_{10}, raw data

Comparison candidate with reference according to Standard EN 16450: 2017					
Candidate	SWAM 5a DC HM		SN	SN 111 & SN 112	
			Limit value	50	µg/m³
Status of measured values	Raw data		Allowed uncertainty	25	%
All comparisons					
Uncertainty between Reference	**0.59**	**µg/m³**			
Uncertainty between Candidates	**0.73**	**µg/m³**			
	SN 111 & SN 112				
Number of data pairs	**63**				
Slope b	**0.972**	**not significant**			
Uncertainty of b	**0.016**				
Ordinate intercept a	**-0.305**	**not significant**			
Uncertainty of a	**0.548**				
Expanded measured uncertainty WCM	**9.47**	**%**			
Cologne, parking lot (2011)					
Uncertainty between Reference	**0.59**	**µg/m³**			
Uncertainty between Candidates	**0.73**	**µg/m³**			
	SN 111			**SN 112**	
Number of data pairs	**71**			**63**	
Slope b	**0.982**			**0.965**	
Uncertainty of b	**0.018**			**0.015**	
Ordinate intercept a	**-0.079**			**-0.314**	
Uncertainty of a	**0.634**			**0.535**	
Expanded measured uncertainty W_{CM}	**8.92**	**%**		**10.50**	**%**

Consolidated results of equivalence testing, SWAM 5a Monitor, Measured component $PM_{2.5}$, raw data

Comparison candidate with reference according to Standard EN 16450: 2017					
Candidate	SWAM 5a		SN	SN 331 & SN 333	
			Limit value	30	µg/m³
Status of measured values	Raw data		Allowed uncertainty	25	%
All comparisons					
Uncertainty between Reference	**0.65**	**µg/m³**			
Uncertainty between Candidates	**0.56**	**µg/m³**			
	SN 331 & SN 333				
Number of data pairs	**40**				
Slope b	**0.971**	**not significant**			
Uncertainty of b	**0.041**				
Ordinate intercept a	**0.235**	**not significant**			
Uncertainty of a	**0.455**				
Expanded meas. uncertainty W_{CM}	**10.01**	**%**			
Bornheim					
Uncertainty between Reference	**0.65**	**µg/m³**			
Uncertainty between Candidates	**0.56**	**µg/m³**			
	SN 331			**SN 333**	
Number of data pairs	**40**			**60**	
Slope b	**0.976**			**1.031**	
Uncertainty of b	**0.038**			**0.047**	
Ordinate intercept a	**0.157**			**-0.022**	
Uncertainty of a	**0.419**			**0.491**	
Expanded meas. uncertainty W_{CM}	**9.03**	**%**		**13.60**	**%**

Consolidated results of equivalence testing, SWAM 5a Monitor, Measured component PM_{10}, raw data

Comparison candidate with reference according to Standard EN 16450: 2017					
Candidate	SWAM 5a		SN	SN 329 & SN 330	
			Limit value	50	µg/m³
Status of measured values	Raw data		Allowed uncertainty	25	%
All comparisons					
Uncertainty between Reference	**0.63**	**µg/m³**			
Uncertainty between Candidates	**0.63**	**µg/m³**			
	SN 329 & SN 330				
Number of data pairs	**59**				
Slope b	**1.007**	**not significant**			
Uncertainty of b	**0.035**				
Ordinate intercept a	**-0.900**	**not significant**			
Uncertainty of a	**0.627**				
Expanded measured uncertainty WCM	**8.04**	**%**			
Bornheim					
Uncertainty between Reference	**0.63**	**µg/m³**			
Uncertainty between Candidates	**0.63**	**µg/m³**			
	SN 329			**SN 330**	
Number of data pairs	**59**			**59**	
Slope b	**1.012**			**1.006**	
Uncertainty of b	**0.037**			**0.036**	
Ordinate intercept a	**-1.111**			**-0.746**	
Uncertainty of a	**0.648**			**0.636**	
Expanded measured uncertainty W_{CM}	**8.29**	**%**		**8.06**	**%**