Umwelt Bundesamt

TÜVRheinland®
Precisely Right.

CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000028733_05

Certified AMS:	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 $PM_{2,5}$
Manufacturer:	FAI Instruments s.r.l. Via Aurora 15 00013 Fonte Nuova (Roma) Italy
Test Institute:	TÜV Rheinland Energy & Environment GmbH

This is to certify that the AMS has been tested and found to comply with the standards VDI 4202-3 (2019), EN 12341 (1999), EN 14907 (2005), EN 16450 (2017), Guide for Demonstration of Equivalence of Ambient Air Monitoring Methods (2010), EN 15267-1 (2009) and 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_04 dated 29 November 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 25 August 2009

This certificate will expire on: 25 March 2029

German Environment Agency

Dessau, 20 March 2024

Dr. Marcel Langner
Head of Section II 4

TÜV Rheinland Energy & Environment GmbH
Cologne, 13 March 2024

ppa. Dr. Peter Wilbring

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TÜV Rheinland Energy & Environment GmbH
Am Grauen Stein
51105 Köln

Test institute accredited to EN ISO/IEC 17025 by DAkkS (German Accreditation Body).
This accreditation is limited to the accreditation scope defined in the enclosure to 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 2029
Certificate:	Renewal (of previous certificate 0000028733_04 of 29 November 2019 valid until 25 March 2024)
Publication:	BAnz. 25 August 2009, No. 125, p. 2929, chapter II No. 2.1

Approved application
The tested AMS is suitable for continuous ambient air monitoring of suspended particulate matter, PM_{10} and $PM_{2,5}$ (stationary operation).

The suitability of the AMS for these applications was assessed based on a laboratory test and a field test performed at six different sites with 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 that this AMS is suitable for monitoring the measured values relevant to the application.

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

Basis of the certification
This certification is based on:

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

Publication in the German Federal Gazette: BAnz. 25 August 2009, No. 125, p. 2929, chapter II No. 2.1, Announcement by UBA 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, PM_{10} and $PM_{2,5}$ fractions, (stationary operation)

Measuring ranges during the performance test:

PM_{10}:	0 - 200	µg/m³
$PM_{2,5}$	0 - 200	µg/m³

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

Publication in the German Federal Gazette: BAnz. 29.07.2011, No. 113, p. 2725, Chap. III notification 7, Announcement by UBA dated 15 July 2011:

7 Notification as regards Federal Environment Agency notice of 3 July 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. 02.03.2012, No. 36, p. 920, Chap. V notification 2, Announcement by UBA 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 notification 7)

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 with 1h measurement mode 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. 02.03.2012, No. 36, p. 920, Chap. V notification 3, Announcement by UBA dated 23 February 2012:

3 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 notification 7)

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, Chap. V notification 12, Announcement by UBA dated 12 February 2013:

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

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, Chap. IV notification 8, Announcement by UBA dated 25 February 2015:

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

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, notification 8)

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, Chap. V notification 6, Announcement by UBA dated 21 February 2018:

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

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, Chap. IV notification 34, Announcement by UBA 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 notification 6)

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 with-drawn.

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

Publication in the German Federal Gazette: BAnz AT 07.05.2020 B8, Chap. III notification 2, Announcement by UBA dated 31 March 2020:

2 Notification as regards Federal Environment Agency (UBA) notices of 3 August 2009 (BAnz. 25 August 2009 no. 125 p. 2929, chapter II number 2.1) and of 27 February 2019 (BAnz AT 26.03.2019 B7, chapter IV notification 34)

The current software version for the SWAM 5a Dual Channel Monitor for PM_{10} and $PM_{2,5}$ manufactured by FAI Instruments s.r.l. is:
04-09.02.01-30.03.00

Statement issued by TÜV Rheinland Energy GmbH dated 12 December 2019

Certified product
This certificate 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 moni-toring of the measuring system. The control panel with display is located at the front of the sys-tem; 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.

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 & Environment 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 & Environment 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 & Environment 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**.

History of documents
Certification of SWAM 5a Dual Channel Monitor for PM_{10} und $PM_{2,5}$, SWAM 5a Dual Channel Hourly Mode Monitor for PM_{10} and $PM_{2,5}$ and SWAM 5a Monitor für PM_{10} or $PM_{2,5}$ is based on the documents listed below and the regular, continuous monitoring of the Quality Management System of the manufacturer:

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

Initial certification according to EN 15267
Certificate No. 0000028733_00: 19 August 2011
Expiry date of the certificate: 28 July 2016
Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 26 March 2011
Test report: 936/21207522/A dated 23 March 2009
Publication: BAnz. 29 July 2011, No. 113, p. 2725, chapter III number 7
UBA announcement dated 15 July 2011

Notifications
Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 11 October 2011
Publication: BAnz. 02 March 2012, No. 36, p. 920, chapter V notification 2
UBA announcement dated 23 February 2012
(Hardware changes)

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 3 November 2011
Publication: BAnz. 02 March 2012, No. 36, p. 920, chapter V notification 3
UBA announcement dated 23 February 2012
(Hardware changes)

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
(Software changes)

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
(Software changes)

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

Certificate based on a notification
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
Addendum: 936/21239762/A 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 based on a notification
Certificate No. 0000028733_03: 12 June 2019
Expiry date of the certificate: 25 March 2024
Statement issued by TÜV Rheinland Energy GmbH dated 7 September 2018
Addendum: 936/21239762/B dated 7 September 2018
Publication: BAnz AT 26.03.2019 B7, chapter IV notification 34
UBA announcement dated 27 February 2019
(Correction of the uncertainty calculation, new software version)

Correction of certificate
Certificate No. 0000028733_04: 29 November 2019
Expiry date of the certificate: 25 March 2024
(Correction on the cover sheet in the English version, guidelines added)

Notifications
Statement issued by TÜV Rheinland Energy GmbH dated 12 December 2019
Publication: BAnz AT 07.05.2020 B8, chapter III notification 2
UBA announcement dated 31 March 2020
(Software changes)

Renewal of certificate
Certificate No. 0000028733_05: 20 March 2024
Expiry date of the certificate: 25 March 2029

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	145 / SN 248 & SN 131 / SN 149 / SN 249	
		Limit value	30	µg/m³
Status of measured values	Slope & offset corrected	Allowed uncertainty	25	%
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	**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/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	**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/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	**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	l 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**	**%**	