Umwelt Bundes Amt
For our Environment

TÜVRheinland®
Precisely Right.

CERTIFICATE

on Product Conformity (QAL1)

Number of Certificate: 0000037053

Certified AMS:	TEOM 1405-DF Ambient Particulate Monitor with PM_{10}-pre-separator and virtual impactor for particulate matter PM_{10} and $PM_{2,5}$
Manufacturer:	Thermo Fisher Scientific 27 Forge Parkway Franklin, MA 02038 USA
Test Institute:	TÜV Rheinland Energie und Umwelt GmbH

This is to certify that the AMS has been tested and found to comply with:

VDI 4202-1: 2010; VDI 4203-3: 2010, EN 12341: 1998; EN 14907: 2005; Guide on Demonstration of Equivalence of Ambient Air Monitoring Methods: 2010, EN 15267-1: 2009, EN 15267-2: 2009

Certification is awarded in respect of the conditions stated in this certificate (also see the following pages).

www.tuv.com TÜVRheinland® ID: 0000037053

- Certified equivalent EN method
- Complying with 2008/50/EC
- TUV approved
- Annual inspection

Publication in the German Federal Gazette (BAnz.) of 20 July 2012

The certificate is valid until: 19 July 2017

Umweltbundesamt
Dessau, 20 August 2012

i. A. Marion Wichmann-Fiebig

TÜV Rheinland Energie und Umwelt GmbH
Köln, 17 August 2012

ppa. Dr. Peter Wilbring

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Accreditation according to EN ISO/IEC 17025 and certified according to ISO 9001:2008.

10/221 2.08

Test report:	936/21209885/A of 11 March 2012
First certification:	20 July 2012
Validity ends:	19 July 2017
Publication:	BAnz AT 20 July 2012 B11, chapter III, No. 2.1

Approved application
The certified AMS is suitable for continuous ambient air monitoring (stationary operation).

The suitability of the product for this application was assessed on the basis of a laboratory test and a field test for four different test sites or time periods respectively.

The AMS is approved for a temperature range of +8 °C to +25 °C.

Any potential user should ensure, in consultation with the manufacturer, that this AMS is suitable for ambient air applications at which it will be installed.

Basis of the certification
This certification is based on:

- test report 936/21209885/A of 11 March 2012 of TÜV Rheinland Energie und Umwelt GmbH
- suitability announced by the German Environmental Agency (UBA) as the relevant body
- the ongoing surveillance of the product and the manufacturing process
- publication in the German Federal Gazette: BAnz AT 20 July 2012 B11, chapter III, No. 2.1

AMS name:

TEOM 1405-DF Ambient Particulate Monitor with PM_{10}-pre-separator and virtual impactor for particulate matter PM_{10} and $PM_{2,5}$

Manufacturer:

Thermo Fisher Scientific, Franklin, USA

Approval:

For the continuous and parallel measurement of suspended particulate matter of the PM_{10}- and $PM_{2.5}$-fraction in ambient air (stationary operation)

Measuring ranges during the suitability test:

Component	Certification range	Unit
PM_{10}	0 – 1000	µg/m³
$PM_{2,5}$	0 – 1000	µg/m³

Software version:

1.56

Restriction:

The permissible range of ambient temperature at the site of installation for the measuring system is 8 °C to 25 °C.

Remarks:

1. Requirements for the variation coefficient R^2 according to the EN 12341 standard were not met at the Teddington site.
2. The reference equivalence function for the Teddington site is outside the bounds of the acceptance envelope as laid down in standard EN 12341.
3. Requirements according to the guide “Demonstration of Equivalence of Ambient Air Monitoring Methods” are met for the components PM_{10} and $PM_{2.5}$.
4. The measuring system shall be calibrated on site regularly using a gravimetric PM_{10}-reference method in accordance with DIN EN 12341.
5. The measuring system shall be calibrated on site regularly using a $PM_{2.5}$-reference method in accordance with DIN EN 14907.
6. The test report on the suitability test is available on the Internet: www.qal1.de.

Test report:

TÜV Rheinland Energie und Umwelt GmbH, Köln
Report No.: 936/21209885/A of 11 March 2012

Certified product
This certificate applies to automated measurement systems confirming to the following description:

The ambient air measuring system TEOM 1405-DF Ambient Particulate Monitor is based on the measuring principle of oscillating micro weighing.

For the weighing principle, which is used in the TEOM mass transducer in the measuring system TEOM 1405-DF Ambient Particulate Monitor, the change in mass determined with the sensor, results from the measurement of the change in frequency of the tapered element.

The particle sample passes the PM_{10} pre-separator with a flow rate of 16.67 l/min (=1 m³/h). Subsequently, the PM_{10}-fraction is divided in a PM_{Coarse}-fraction (flow rate 1.67 l/min) and in a $PM_{2.5}$-fraction (flow rate 15 l/min) by a virtual impactor. Whilst the PM_{Coarse}-flow is directly heading to the measuring system, the flow of the $PM_{2.5}$-fraction is divided into two further sub-flows via a flow splitter – the $PM_{2.5}$-flow of 3 l/min and the bypass-flow of 12 l/min. The PM_{Coarse}-flow and the $PM_{2.5}$-flow are directed to the actual measuring system TEOM 1405-DF via the FDMS-unit and are secreted to the respective TEOM-filter (constantly heated at 30 °C) and the secreted mass of particles is quantified.

To take into account non-volatile as well as volatile particulate during the measuring, the FDMS technology is used. The FDMS-unit is placed between the flow-splitter and the measuring device TEOM 1405-DF in the so called FDMS-tower. The FDMS-unit compensated automatically the part of the semi-volatile particulate using a switching valve and two operation modi – the base mode and the reference mode.

Every six minutes the switching valve changes the sampling flow rate from base to reference mode. In the base mode the sampling is done on a straight way via a dryer directly to the mass measuring. In the reference mode the air flow is directed through a cooled filter after the dryer, to remove and restrain the non-volatile and volatile part of the particulate from the sample. During normal operation the temperature of the cooler is maintained at constantly 4 °C.

Based on the mass concentration measuring during the base- and reference-modi the FDMS-system updates every six minutes the 1h-average of the following results:

Base-MC	=	Particle concentration of the particle-loaded sampling flow.
Ref-MC	=	Particle concentration of the particle-free sampling flow after passing through the cooled filter.
MC	=	Base-MC adjusted for Ref-MC
		Base-mass-concentration (normally positive)
		reference-mass-concentration (negative, in case mass of the filter evaporates).

After the mass determination the sampling flows are directed over a mass flow rate regulator. To guarantee a constant sampling volume flow at the inlet, bearing in mind the ambient temperature and pressure, the volume flow control shall be operated in the mode „active/ actual“.

The tested measuring system consists of PM_{10}-sampling inlet, the virtual impactor, flow splitter, the respective sampling tubes, a tripod to support the sample, the measuring device TEOM 1405-DF incl. FDMS-tower, the vacuum pump with its respective power supply cord and cables as well as adapters, the hole in the roof incl. a flange and a manual in German/English.

The measuring device is operated via touch screen at the front of the device. The user can retrieve data and instrument information, change parameters as well as perform tests and controls of the functionality of the measuring device.

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 Energie und Umwelt GmbH must be notified at the given address 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 is presented on page 1 of this certificate.

This document as well as the certification mark remains property of TÜV Rheinland Energie und Umwelt GmbH. With revocation of the publication the certificate looses its validity. After the expiration of the validity of the certificate and on requests of the TÜV Rheinland Energie und Umwelt GmbH this document shall be returned and the certificate mark must not be employed anymore.

The relevant version of this certificate and the validity is also accessible on theIiternet Address: **qal1.de**.

Certification of TEOM 1405-DF Ambient Particulate Monitor with PM_{10}-pre-separator and virtual impactor for particulate matter PM_{10} and $PM_{2,5}$ is based on the documents listed below and the regular, continuous monitoring of the Quality Management System of the manufacturer:

Initial certification according to EN 15267

Certificate No. 0000037053: 20 August 2012

Validity of the certificate: 19 July 2017

Test report: 936/21209885/A of 11 March 2012
TÜV Rheinland Energie und Umwelt GmbH, Köln

Publication: BAnz AT 20 July 2012 B11, chapter III, No. 2.1
Announcement by UBA from 06 July 2012

PM10 1405DF FDMS	25,3% > 28 µg m-3	Orthogonal Regression				Between Instrument Uncertainties	
	W_{CM} / %	n_{c-s}	r^2	Slope (b) +/- u_b	Intercept (a) +/- u_a	Reference	Candidate
All Data	11.2	336	0.976	1.016 +/- 0.009	1.078 +/- 0.224	0.56	0.75
< 30 µg m-3	13.4	260	0.916	1.042 +/- 0.019	0.706 +/- 0.327	0.55	0.68
> 30 µg m-3	13.3	76	0.945	1.026 +/- 0.028	0.453 +/- 1.239	0.60	1.06

SN 20014	Dataset	Orthogonal Regression				Limit Value of 50 µg m-3	
		n_{c-s}	r^2	Slope (b) +/- u_b	Intercept (a) +/- u_a	W_{CM} / %	% > 28 µg m-3
Individual Datasets	Bornheim Winter	63	0.993	1.057 +/- 0.011	1.154 +/- 0.313	16.83	38.1
	Cologne Winter	74	0.985	1.027 +/- 0.015	0.575 +/- 0.523	10.60	55.4
	Bornheim Summer	75	0.977	1.109 +/- 0.020	-0.348 +/- 0.406	21.44	10.7
	Teddington	124	0.930	0.875 +/- 0.021	3.180 +/- 0.442	15.35	9.7
Combined Datasets	< 30 µg m-3	260	0.908	1.043 +/- 0.020	0.709 +/- 0.342	13.85	3.5
	> 30 µg m-3	76	0.935	1.042 +/- 0.031	-0.144 +/- 1.376	14.94	100.0
	All Data	336	0.973	1.021 +/- 0.009	1.010 +/- 0.241	12.15	25.3

SN 20116	Dataset	Orthogonal Regression				Limit Value of 50 µg m-3	
		n_{c-s}	r^2	Slope (b) +/- u_b	Intercept (a) +/- u_a	W_{CM} / %	% > 28 µg m-3
Individual Datasets	Bornheim Winter	65	0.993	1.032 +/- 0.011	0.921 +/- 0.301	11.13	36.9
	Cologne Winter	74	0.988	1.023 +/- 0.013	0.671 +/- 0.465	9.60	55.4
	Bornheim Summer	75	0.974	1.113 +/- 0.021	0.011 +/- 0.438	23.77	10.7
	Teddington	124	0.942	0.896 +/- 0.020	2.751 +/- 0.410	13.01	9.7
Combined Datasets	< 30 µg m-3	262	0.914	1.047 +/- 0.019	0.603 +/- 0.330	13.91	3.4
	> 30 µg m-3	76	0.950	1.014 +/- 0.026	0.880 +/- 1.176	12.43	100.0
	All Data	338	0.976	1.013 +/- 0.008	1.105 +/- 0.221	10.75	25.1

PM2.5 1405DF FDMS	30,2% > 17 µg m-3	Orthogonal Regression				Between Instrument Uncertainties	
	W_{CM} / %	n_{c-s}	r^2	Slope (b) +/- u_b	Intercept (a) +/- u_a	Reference	Candidate
All Data	14.0	338	0.976	0.997 +/- 0.008	1.212 +/- 0.163	0.55	0.76
< 18 µg m-3	23.8	247	0.892	1.094 +/- 0.023	0.426 +/- 0.235	0.54	0.64
> 18 µg m-3	17.0	91	0.955	1.015 +/- 0.023	0.330 +/- 0.748	0.56	1.05

SN 20014	Dataset	Orthogonal Regression				Limit Value of 30 µg m-3	
		n_{c-s}	r^2	Slope (b) +/- u_b	Intercept (a) +/- u_a	W_{CM} / %	% > 17 µg m-3
Individual Datasets	Bornheim Winter	61	0.990	1.055 +/- 0.014	1.110 +/- 0.307	20.49	42.6
	Cologne Winter	71	0.983	1.029 +/- 0.016	0.883 +/- 0.406	16.06	59.2
	Bornheim Summer	81	0.972	1.080 +/- 0.020	0.848 +/- 0.295	23.71	18.5
	Teddington	125	0.957	0.851 +/- 0.016	2.791 +/- 0.254	15.74	15.2
Combined Datasets	< 18 µg m-3	247	0.872	1.086 +/- 0.025	0.722 +/- 0.254	24.38	4.5
	> 18 µg m-3	91	0.948	1.029 +/- 0.025	0.336 +/- 0.819	19.57	100.0
	All Data	338	0.972	1.006 +/- 0.009	1.352 +/- 0.176	16.38	30.2

SN 20116	Dataset	Orthogonal Regression				Limit Value of 30 µg m-3	
		n_{c-s}	r^2	Slope (b) +/- u_b	Intercept (a) +/- u_a	W_{CM} / %	% > 17 µg m-3
Individual Datasets	Bornheim Winter	64	0.992	1.028 +/- 0.012	0.351 +/- 0.259	10.99	40.6
	Cologne Winter	71	0.982	1.003 +/- 0.016	0.971 +/- 0.408	13.17	59.2
	Bornheim Summer	81	0.972	1.084 +/- 0.020	0.410 +/- 0.294	21.90	18.5
	Teddington	125	0.968	0.861 +/- 0.014	2.317 +/- 0.219	15.55	15.2
Combined Datasets	< 18 µg m-3	250	0.899	1.112 +/- 0.022	0.037 +/- 0.229	24.63	4.4
	> 18 µg m-3	91	0.958	1.005 +/- 0.022	0.237 +/- 0.717	15.71	100.0
	All Data	341	0.977	0.991 +/- 0.008	1.040 +/- 0.158	12.49	29.9