

CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000037053_01

Certified AMS: TEOM 1405-DF Ambient Particulate Monitor with PM₁₀-pre-separator and virtual impactor for particulate matter PM₁₀ and PM_{2,5}

Manufacturer: Thermo Fisher Scientific
27 Forge Parkway
Franklin, MA 02038
USA

Test Institute: TÜV Rheinland Energy GmbH

This is to certify that the AMS has been tested and certified according to the standards

**VDI 4202-1 (2010), VDI 4203-3 (2010), EN 12341 (1998), EN 14907 (2005),
Guide to 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
(this certificate contains 10 pages).

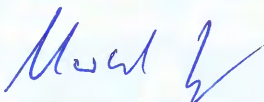


Suitability Tested
Complying with
2008/50/EC
EN 15267
Regular
Surveillance

www.tuv.com
ID 0000037053

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

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

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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:
0000037053_01 / 18 July 2017

Test report: 936/21209885/A of 11 March 2012
Initial certification: 20 July 2012
Expiry date: 19 July 2022
Certificate: renewal (previous certificate 0000037053 dated from 20 August 2012 with validity up to the 19 July 2017)
Publication: BAnz AT 20.07.2012 B11, chapter III, No. 2.1

Approved application

The certified AMS is suitable for continuous ambient air monitoring of particulate matters PM₁₀ and PM_{2.5} (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.

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 in consultation with the manufacturer that this AMS is suitable for monitoring the limit value relevant to the application.

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 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 AT 20.07.2012 B11, chapter III number 2.1,
Announcement by UBA from 06 July 2012:

AMS name:

TEOM 1405-DF Ambient Particulate Monitor with PM₁₀-pre-separator and virtual impactor for particulate matter PM₁₀ and PM_{2.5}

Manufacturer:

Thermo Fisher Scientific, Franklin, USA

Approval:

For the continuous and parallel measurement of suspended particulate matter of the PM₁₀- 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/m ³
PM _{2.5}	0 – 1000	µg/m ³

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 R² 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 PM₁₀ and PM_{2.5}.
4. The measuring system shall be calibrated on site regularly using a gravimetric PM₁₀-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, Cologne
Report No.: 936/21209885/A of 11 March 2012

Publication in the German Federal Gazette: BAnz AT 23.07.2013 B4, chapter V notification 21,
Announcement by UBA from 03 July 2013:

21 Notification as regards Federal Environmental Agency notices of 6 July 2012 Federal Gazette (BAnz AT 20.07.2012 B11, chapter III, no. 2.1)

The ambient air measuring system TEOM 1405-DF Ambient Particulate Monitor with PM₁₀-pre-separator and virtual impactor for particulate matters PM₁₀ and PM_{2.5} manufactured by Thermo Fisher Scientific can also be operated with the vacuum pump GAST 75R647 V45-H306X.

Statement of TÜV Rheinland Energie und Umwelt GmbH of 18 March 2013

Publication in the German Federal Gazette: BAnz AT 01.04.2014 B12, chapter VI notification 34,
Announcement by UBA from 27 February 2014:

34 Notification of the announcements of the Federal Environment Agency of 6 July 2012 (BAnz AT 20.07.2012 B11, chapter III number 2.1) and of 3 July 2013 (BAnz AT 23.07.2013 B4, chapter V notification 21)

The current software version of the TEOM 1405-DF Ambient Particulate Monitor measuring system with PM₁₀-pre-separator and virtual impactor by Thermo Fisher Scientific for particulate matters PM₁₀ and PM_{2.5} is: 1.57

Statement of TÜV Rheinland Energie und Umwelt GmbH of 1 October 2013

Publication in the German Federal Gazette: BAnz AT 02.04.2015 B5, chapter IV notification 22,
Announcement by UBA from 25 February 2015:

22 Notification as regards Federal Environment Agency (UBA) notices of 6 July 2012 (Federal Gazette BAnz AT 20.07.2012 B11, chapter III number 2.1) and of 27 February 2014 (Federal Gazette BAnz AT 01.04.2014 B12, chapter VI notification 34)

The current software version for the TEOM 1405-DF Ambient Particulate Monitor measuring system with PM₁₀-pre-separator and virtual impactor, manufactured by Thermo Fisher Scientific, for the suspended particulate matters PM₁₀ and PM_{2.5} is:

1.70

Statement of TÜV Rheinland Energie und Umwelt GmbH of 22 September 2014

Publication in the German Federal Gazette: BAnz AT 26.08.2015 B4, chapter V
notification 41,
Announcement by UBA from 22 July 2015:

41 Notification as regards Federal Environment Agency (UBA) notices of 6 July 2012 (Federal Gazette BAnz AT 20.07.2012 B11, chapter III number 2.1) and of 25 February 2015 (Federal Gazette BAnz AT 02.04.2015 B5, chapter IV notification 22)

The current software version for the TEOM 1405-DF Ambient Particulate Monitor measuring system with PM₁₀-pre-separator and virtual impactor, manufactured by Thermo Fisher Scientific, for suspended particulate matters PM₁₀ and PM_{2.5} is:
1.71

The switching valve of the FDMS unit was redesigned in order to improve its mechanical stability.

The measuring system can also be used with the GAST 87R647-PDS-HV-913 vacuum pump.

Statement of TÜV Rheinland Energie und Umwelt GmbH of 17 March 2015

Publication in the German Federal Gazette: BAnz AT 14.03.2016 B7, chapter V
notification 40,
Announcement by UBA from 18 February 2016:

40 Notification as regards Federal Environment Agency (UBA) notices of 6 July 2012 (BAnz AT 20.07.2012 B11, chapter III number 2.1) and of 22 July 2015 (BAnz AT 26.08.2015 B4, chapter V notification 41)

The current software version of the TEOM 1405-DF Ambient Particulate Monitor with PM₁₀-pre-separator and virtual impactor manufactured by Thermo Fisher Scientific for the suspended particles PM₁₀ and PM_{2.5} meets the requirements stipulated in CEN/TS 16450 (August 2013 version). An addendum to test report number 936/21221597/A is available online at www.qal1.de.

Statement of TÜV Rheinland Energie und Umwelt GmbH of 20 November 2015

Publication in the German Federal Gazette: BAnz AT 01.08.2016 B11, chapter V notification 40,
Announcement by UBA from 14 July 2016:

40 Notification as regards Federal Environmental Agency (UBA) notices of 6 July 2012 (BAnz AT 20.07.2012 B11, chapter III number 2.1) and of 18 February 2016 (BAnz AT 14.03.2016 B7 chapter V notification 40)

The current software version of the TEOM 1405-DF Ambient Particulate Monitor with PM₁₀-pre-separator and virtual impactor for suspended particulate matters PM₁₀ and PM_{2.5} manufactured by Thermo Fisher Scientific is:

1.72

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 1 March 2016

Publication in the German Federal Gazette: BAnz AT 15.03.2017 B6, chapter IV correction 3,
Announcement by UBA from 22 February 2017:

3 Correction for the announcement as regards Federal Environmental Agency (UBA) of 18 February 2016 (BAnz AT 14.03.2016 B7 chapter V notification 40)

In the above mentioned announcement to the measuring system TEOM 1405-DF Ambient Particulate Monitor with PM₁₀-pre-separator and virtual impactor for suspended particulate matters PM₁₀ and PM_{2.5} manufactured by Thermo Fisher Scientific is the correct wording of the first sentence of the announcement as follows:

The measuring system TEOM 1405-DF Ambient Particulate Monitor with PM₁₀-pre-separator and virtual impactor manufactured by Thermo Fisher Scientific for the suspended particles PM₁₀ and PM_{2.5} meets the requirements stipulated in CEN/TS 16450 (August 2013 version)

Statement of TÜV Rheinland Energy GmbH dated 14 October 2016

Certified product

This certificate applies to automated measurement systems conforming 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 PM₁₀-pre-separator with a flow rate of 16.67 l/min (=1 m³/h). Subsequently, the PM₁₀-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 PM₁₀-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.

The current software version is 1.72.

The current version of the Manual is:

42-010815 Revision A.003 16Sep2009.

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 TEOM 1405-DF Ambient Particulate Monitor with PM₁₀-pre-separator and virtual impactor for particulate matter PM₁₀ 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
Expiry date of the certificate: 19 July 2017

Test report: 936/21209885/A of 11 March 2012
TÜV Rheinland Energie und Umwelt GmbH, Cologne
Publication: BAnz AT 20.07.2012 B11, chapter III, no. 2.1
Announcement by UBA dated 06 July 2012

Notifications according to EN 15267

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 18 March 2013
Publication: BAnz AT 23.07.2013 B4, chapter V notification 21
Announcement by UBA dated 03 July 2013
(new vacuum pump)

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 1 October 2013
Publication: BAnz AT 01.04.2014 B12, chapter VI notification 34
Announcement by UBA dated 27 February 2014
(new software version)

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 22 September 2014
Publication: BAnz AT 02.04.2015 B5, chapter IV notification 22
Announcement by UBA dated 25 February 2015
(new software version)

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 17 March 2015
Publication: BAnz AT 26.08.2014 B4, chapter V notification 41
Announcement by UBA dated 22 July 2015
(new vacuum pump, revision switch valve, new software version)

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 20 November 2015
Publication: BAnz AT 14.03.2016 B7, chapter V notification 40
Announcement by UBA dated 18 February 2016
(Addendum)

Statement of TÜV Rheinland Energie und Umwelt GmbH dated 1 March 2016
Publication: BAnz AT 07.08.2016 B11, chapter V notification 40
Announcement by UBA dated 14 July 2016
(new software version)

Statement of TÜV Rheinland Energy GmbH dated 14 October 2016
Publication: BAnz AT 15.03.2017 B6, chapter IV correction 3
Announcement by UBA dated 22 February 2017
(correction of notification text)

Renewal of the certificate

Certificate No. 0000037053_01: 18 July 2017
Expiry date of the certificate: 19 July 2022

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