Umwelt Bundesamt

TÜVRheinland®
Precisely Right.

CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000062067_01

Certified AMS:	42iQ for NO, NO_2 and NO_x
Manufacturer:	Thermo Fisher Scientific 27, Forge Parkway Franklin, MA 02038 USA
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 4202-1 (2018), EN 14211 (2012), EN 15267-1 (2009) and EN 15267-2 (2009).

Certification is awarded in respect of the conditions stated in this certificate (this certificate contains 11 pages).
The present certificate replaces certificate 0000062067_00 dated 12 June 2019.

TÜVRheinland® CERTIFIED
Suitability Tested
Complying with 2008/50/EC
EN 15267
Regular Surveillance
www.tuv.com
ID 0000062067

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

German Environment Agency

Dessau, 20 March 2024

This certificate will expire on:
25 March 2029

TÜV Rheinland
Energy & Environment GmbH
Cologne, 13 March 2024

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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:	936/21242986/C dated 2 October 2018
Initial certification:	26 March 2019
Expiry date:	25 March 2029
Certificate:	Renewal (of previous certificate 0000062067_00 of 12 June 2019 valid until 25 March 2024)
Publication:	BAnz AT 26.03.2019 B7, chapter III No. 1.1

Approved application
The tested AMS is suitable for continuous ambient air monitoring of NO, NO_2 and NO_x (stationary operation).

The suitability of the AMS for these applications was assessed based on a laboratory test and a three-months field test.

The AMS is approved for an ambient temperature range of +0 °C to +30 °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 936/21242986/C dated 2 October 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 AT 26.03.2019 B7, chapter III No. 1.1, Announcement by UBA dated 27 February 2019:

AMS designation:
42iQ for NO, NO_2 and NO_x

Manufacturer:
Thermo Fisher Scientific, Franklin, USA

Field of application:
For the continuous measurement of nitrogen oxide concentrations in ambient air in stationary use

Measuring ranges during the performance test:

Component	Certification range	Unit
Nitrogen monoxide	0 – 1,200	µg/m³
Nitrogen dioxide	0 – 500	µg/m³

Software version:
Version: 1.6.1.32120

Restrictions:
None

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

Test Institute:
TÜV Rheinland Energy GmbH, Cologne
Report No.: 936/21242986/C dated 2 October 2018

Publication in the German Federal Gazette: BAnz AT 05.08.2021 B5, Chap. IV notification 9, Announcement by UBA dated 29 June 2021:

9 Notification as regards Federal Environment Agency (UBA) notice of 27 February 2019 (BAnz AT 26.03.2019, chapter III number 1.1)

The latest software version of the Thermo Fisher Scientific ambient air monitoring system 42iQ for NO, NO_2 and NO_X is:

01.06.10

In addition, the version 01.06.07 is available.

Statement issued by TÜV Rheinland Energy GmbH dated 25 February 2021

Publication in the German Federal Gazette: BAnz AT 20.03.2023 B6, Chap. IV notification 81, Announcement by UBA dated 21 February 2023:

81 Notification as regards Federal Environment Agency (UBA) notices of 27 February 2019 (BAnz AT 26.03.2019, chapter III number 1.1) and of 29 June 2021 (BAnz AT 05.08.2021 B5, chapter IV notification 9)

The current software version of the 42iQ ambient air measuring system for NO, NO_2 and NO_X from Thermo Fisher Scientific is:

01.06.14.34444

In addition, the versions 01.06.11.33737, 01.06.12.34057, 01.06.12.34061, 01.06.13.34157 and 01.06.14.34442 are available.

Alternatively, the K.N.F PU4877-N811 pump can be used for the measuring system. To increase operational reliability, a "footprint" has been corrected on the optional analog IO board of the measuring system.

Statement issued by TÜV Rheinland Energy GmbH dated 15 September 2022

Certified product

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

The 42iQ ambient air quality measuring system is a continuous nitrogen oxide analyser. The instrument uses the chemiluminescence method as a measuring principle.

The ambient air sample is drawn into the 42iQ through the “sample” bulkhead. The sample flows through a capillary, and then to the mode solenoid valve. The solenoid valve routes the sample either straight to the reaction chamber (NO mode) or through the NO_2-to-NO converter and then to the reaction chamber (NO_x mode). The reaction chamber pressure is measured to infer the sample flow. Pressure deviations outside of the acceptable range are reported as a fault.

Dry air enters the 42iQ through the permeation dryer, passes through a flow switch, and then through a silent discharge ozonator. The ozonator generates the ozone needed for the chemiluminescent reaction. At the reaction chamber, the ozone reacts with the NO in the sample to produce excited NO_2 molecules. A photomultiplier tube (PMT) housed in a thermoelectric cooler detects the luminescence generated during this reaction. From the reaction chamber, the exhaust travels through the ozone (O_3) converter to the pump, and is released through the vent.

NO and NO_x concentrations calculated in the NO and NO_X mode are recorded. The difference between the concentrations is used to calculate the NO_2 concentration.
The 42iQ outputs NO, NO_2, and NO_X concentrations to the front panel display and the analogue outputs. and also makes the data available over the serial or Ethernet connection.

The system components include:

- Reaction chamber DMC: The reaction chamber is where the sample reacts with ozone and produces excited NO_2 that gives off a photon of energy when it decays. The reac-tion chamber is heated and controlled to approximately 50 °C in order to ensure the greatest instrument stability. The sample and ozone flow capillaries and a thermistor sensor are also housed in/on the reaction chamber assembly. The optical filter housed in the reaction chamber limits the spectral region viewed by the detector and eliminates possible interferences due to other chemiluminescent reactions. The photomultiplier tube (PMT) provides the infrared sensitivity required to detect the NO_2 luminescence resulting from the reaction of the ozone with the ambient air sample. Optical energy from the reaction is converted to an electrical signal by the PMT and sent to the input board that transmits it to the processor. The thermoelectric PMT cooler reduces the PMT temperature to approximately -3 °C to minimize dark current and increase instru-ment sensitivity.
- Ozone generator: The Ozonator generates the necessary ozone concentration required for the chemiluminescent reaction. The ozone reacts with the NO in the ambient air sample to produce the electronically excited NO_2 molecules.
- Permeation dryer: The permeation dryer provides a continuous stream of dry air to the ozonator.
- NO_2-NO converter: The converter heats molybdenum to approximately 325 °C in order to convert and detect NO_2. The converter consists of an insulated housing, heater, replaceable cartridge, and a type K thermocouple sensor.
- Common electronics: The common electronics contain the core computational and power routing hardware for the iQ, and is replicated throughout other iQ series products. It also contains front panel display, the USB ports, the Ethernet port, and the I/O interfaces. All electronics operate from a universal VDC supply. The System Con-troller Board (SCB)

contains the main processor, power supplies, and a sub-processor, and serves as the communication hub for the instrument.

- Peripheral Support System: The peripheral support system operates these additional devices that are needed, but do not require special feedback control or processing. The chassis fan provides air cooling of the active electronic components. Internal vac-uum pump for generating air/sample through the instrument.
- Flow/Pressure DMC: The flow/pressure DMC is used to measure instrument pressures that assure proper flow regulation and for sample pressure within the measurement bench for pressure corrections and compensation. The DMC includes two pressure sensors.

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 42iQ 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. 0000062067_00: 12 June 2019
Expiry date of the certificate: 25 March 2024
Test report: 936/21242986/C dated 2 October 2018
TÜV Rheinland Energy GmbH
Publication: BAnz AT 26.03.2019 B7, chapter III number 1.1
UBA announcement dated 27 February 2019

Notifications
Statement issued by TÜV Rheinland Energy GmbH dated 25 February 2021
Publication: BAnz AT 05.08.2021 B5, chapter IV notification 9
UBA announcement dated 29 June 2021
(Software change)

Statement issued by TÜV Rheinland Energy GmbH dated 15 September 2022
Publication: BAnz AT 20.03.2023 B6, chapter IV notification 81
UBA announcement dated 21 February 2023
(Soft- and hardware changes)

Renewal of certificate
Certificate No. 0000062067_01: 20 March 2024
Expiry date of the certificate: 25 March 2029

Expanded uncertainty laboratory, system 1

Measuring device:	42iQ			Serial-No.:		1180540003	
Measured component:	NO_2			1h-limit value:		104.6	nmol/mol

No.	Performance characteristic		Performance criterion	Result	Partial uncertainty		Square of partial uncertainty
1	Repeatability standard deviation at zero	≤	1.0 nmol/mol	0.130	$u_{r,z}$	0.03	0.0011
2	Repeatability standard deviation at 1h-limit value	≤	3.0 nmol/mol	0.350	$u_{r,lh}$	0.02	0.0003
3	"lack of fit" at 1h-limit value	≤	4.0% of measured value	1.130	$u_{l,lh}$	0.68	0.4657
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤	8.0 nmol/mol/kPa	0.300	u_{gp}	0.74	0.5468
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤	3.0 nmol/mol/K	0.000	u_{gt}	0.00	0.0000
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤	3.0 nmol/mol/K	0.601	u_{st}	1.51	2.2870
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤	0.30 nmol/mol/V	0.040	u_V	0.12	0.0138
8a	Interferent H_2O with 19 mmol/mol	≤	10 nmol/mol (Zero)	0.200	u_{H2O}	0.09	0.0075
		≤	10 nmol/mol (Span)	-0.200			
8b	Interferent CO_2 with 500 µmol/mol	≤	5.0 nmol/mol (Zero)	0.600	$u_{int,pos}$ or $u_{int,neg}$	1.22	1.4929
		≤	5.0 nmol/mol (Span)	-0.200			
8c	Interferent NH_3 mit 200 nmol/mol	≤	5.0 nmol/mol (Zero)	1.600			
		≤	5.0 nmol/mol (Span)	2.000			
9	Averaging effect	≤	7.0% of measured value	-3.400	u_{av}	-2.05	4.2160
18	Difference sample/calibration port	≤	1.0%	-0.330	$u_{\Delta sc}$	-0.35	0.1191
21	Converter efficiency	≥	98	99.50	u_{EC}	0.52	0.2735
23	Uncertainty of test gas	≤	3.0%	2.000	u_{cg}	1.05	1.0941

Combined standard uncertainty	u_c	3.2434	nmol/mol
Expanded uncertainty	U	6.4867	nmol/mol
Relative expanded uncertainty	W	6.20	%
Maximum allowed expanded uncertainty	W_{req}	15	%

Expanded uncertainty laboratory, system 2

Measuring device:	42iQ				Serial-No.:		1180540004	
Measured component:	NO_2				1h-limit value:		104.6	nmol/mol
No.	**Performance characteristic**	**Performance criterion**		**Result**	**Partial uncertainty**		**Square of partial uncertainty**	
1	Repeatability standard deviation at zero	≤	1.0 nmol/mol	0.250	$u_{r,z}$	0.06	0.0040	
2	Repeatability standard deviation at 1h-limit value	≤	3.0 nmol/mol	0.390	$u_{r,lh}$	0.02	0.0004	
3	"lack of fit" at 1h-limit value	≤	4.0% of measured value	0.820	$u_{l,lh}$	0.50	0.2452	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤	8.0 nmol/mol/kPa	0.290	u_{gp}	0.72	0.5152	
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤	3.0 nmol/mol/K	0.000	u_{gt}	0.00	0.0000	
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤	3.0 nmol/mol/K	0.271	u_{st}	0.68	0.4650	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤	0.30 nmol/mol/V	0.000	u_V	0.00	0.0000	
8a	Interferent H_2O with 19 mmol/mol	≤	10 nmol/mol (Zero)	0.000	u_{H2O}	-0.02	0.0006	
		≤	10 nmol/mol (Span)	0.000				
8b	Interferent CO_2 with 500 µmol/mol	≤	5.0 nmol/mol (Zero)	0.000	$u_{int,pos}$ or $u_{int,neg}$	1.14	1.2902	
		≤	5.0 nmol/mol (Span)	0.200				
8c	Interferent NH_3 mit 200 nmol/mol	≤	5.0 nmol/mol (Zero)	1.800				
		≤	5.0 nmol/mol (Span)	2.400				
9	Averaging effect	≤	7.0% of measured value	-0.400	u_{av}	-0.24	0.0584	
18	Difference sample/calibration port	≤	1.0%	-0.190	$u_{\Delta sc}$	-0.20	0.0395	
21	Converter efficiency	≥	98	98.50	u_{EC}	1.57	2.4618	
23	Uncertainty of test gas	≤	3.0%	2.000	u_{cg}	1.05	1.0941	
			Combined standard uncertainty		u_c		2.4857	nmol/mol
			Expanded uncertainty		U		4.9714	nmol/mol
			Relative expanded uncertainty		W		4.75	%
			Maximum allowed expanded uncertainty		W_{req}		15	%

Certificate:
0000062067_01 / 20 March 2024

Combined uncertainty, laboratory and field, system 1

Measuring device:	42iQ	Serial-No.:	1180540003	
Measured component:	NO_2	1h-limit value:	104.6	nmol/mol

No.	Performance characteristic		Performance criterion	Result	Partial uncertainty		Square of partial uncertainty
1	Repeatability standard deviation at zero	≤	1.0 nmol/mol	0.130	$u_{r,z}$	0.03	0.0011
2	Repeatability standard deviation at 1h-limit value	≤	3.0 nmol/mol	0.350	$u_{r,lh}$	not considered, as √2*ur,lh = 0,02 < ur,f	-
3	"lack of fit" at 1h-limit value	≤	4.0% of measured value	1.130	$u_{l,lh}$	0.68	0.4657
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤	8.0 nmol/mol/kPa	0.300	u_{gp}	0.74	0.5468
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤	3.0 nmol/mol/K	0.000	u_{gt}	0.00	0.0000
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤	3.0 nmol/mol/K	0.601	u_{st}	1.51	2.2870
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤	0.30 nmol/mol/V	0.040	u_V	0.12	0.0138
8a	Interferent H_2O with 19 mmol/mol	≤	10 nmol/mol (Zero)	0.200	u_{H2O}	0.09	0.0075
		≤	10 nmol/mol (Span)	-0.200			
8b	Interferent CO_2 with 500 µmol/mol	≤	5.0 nmol/mol (Zero)	0.600	$u_{int,pos}$ or $u_{int,neg}$	1.22	1.4929
		≤	5.0 nmol/mol (Span)	-0.200			
8c	Interferent NH_3 mit 200 nmol/mol	≤	5.0 nmol/mol (Zero)	1.600			
		≤	5.0 nmol/mol (Span)	2.000			
9	Averaging effect	≤	7.0% of measured value	-3.400	u_{av}	-2.05	4.2160
10	Reproducibility standard deviation under field conditions	≤	5.0% of average over 3 months	2.440	$u_{r,f}$	2.55	6.5139
11	Long term drift at zero level	≤	5.0 nmol/mol	1.200	$u_{d,l,z}$	0.69	0.4800
12	Long term drift at span level	≤	5.0% of max. of certification range	0.240	$u_{d,l,lh}$	0.14	0.0210
18	Difference sample/calibration port	≤	1.0%	-0.330	$u_{\Delta sc}$	-0.35	0.1191
21	Converter efficiency	≥	98	99.500	u_{EC}	0.52	0.2735
23	Uncertainty of test gas	≤	3.0%	2.000	u_{cg}	1.05	1.0941

Combined standard uncertainty	u_c	4.1873	nmol/mol
Expanded uncertainty	U	8.3746	nmol/mol
Relative expanded uncertainty	W	8.01	%
Maximum allowed expanded uncertainty	W_{req}	15	%

Combined uncertainty, laboratory and field, system 2

Measuring device:	42iQ				Serial-No.:		1180540004	
Measured component:	NO_2				1h-limit value:		104.6	nmol/mol
No.	**Performance characteristic**		**Performance criterion**	**Result**	**Partial uncertainty**		**Square of partial uncertainty**	
1	Repeatability standard deviation at zero	≤	1.0 nmol/mol	0.250	$u_{r,z}$	0.06	0.0040	
2	Repeatability standard deviation at 1h-limit value	≤	3.0 nmol/mol	0.390	$u_{r,lh}$	not considered, as √2*ur,lh = 0,02 < ur,f	-	
3	"lack of fit" at 1h-limit value	≤	4.0% of measured value	0.820	$u_{l,lh}$	0.50	0.2452	
4	Sensitivity coefficient of sample gas pressure at 1h-limit value	≤	8.0 nmol/mol/kPa	0.290	u_{gp}	0.72	0.5152	
5	Sensitivity coefficient of sample gas temperature at 1h-limit value	≤	3.0 nmol/mol/K	0.000	u_{gt}	0.00	0.0000	
6	Sensitivity coefficient of surrounding temperature at 1h-limit value	≤	3.0 nmol/mol/K	0.271	u_{st}	0.68	0.4650	
7	Sensitivity coefficient of electrical voltage at 1h-limit value	≤	0.30 nmol/mol/V	0.000	u_V	0.00	0.0000	
8a	Interferent H_2O with 19 mmol/mol	≤	10 nmol/mol (Zero)	-0.200	u_{H2O}	-0.02	0.0006	
		≤	10 nmol/mol (Span)	0.600				
8b	Interferent CO_2 with 500 µmol/mol	≤	5.0 nmol/mol (Zero)	0.000	$u_{int,pos}$ or $u_{int,neg}$	1.14	1.2902	
		≤	5.0 nmol/mol (Span)	0.200				
8c	Interferent NH_3 mit 200 nmol/mol	≤	5.0 nmol/mol (Zero)	1.800				
		≤	5.0 nmol/mol (Span)	2.400				
9	Averaging effect	≤	7.0% of measured value	-0.400	u_{av}	-0.24	0.0584	
10	Reproducibility standard deviation under field conditions	≤	5.0% of average over 3 months	2.440	$u_{r,f}$	2.55	6.5139	
11	Long term drift at zero level	≤	5.0 nmol/mol	1.200	$u_{d,l,z}$	0.69	0.4800	
12	Long term drift at span level	≤	5.0% of max. of certification range	0.640	$u_{d,l,lh}$	0.39	0.1494	
18	Difference sample/calibration port	≤	1.0%	-0.190	$u_{\Delta sc}$	-0.20	0.0395	
21	Converter efficiency	≥	98	98.500	u_{EC}	1.57	2.4618	
23	Uncertainty of test gas	≤	3.0%	2.000	u_{cg}	1.05	1.0941	
				Combined standard uncertainty		u_c	3.6498	nmol/mol
				Expanded uncertainty		U	7.2996	nmol/mol
				Relative expanded uncertainty		W	6.98	%
				Maximum allowed expanded uncertainty		W_{req}	15	%