Umwelt Bundesamt

TÜVRheinland®
Precisely Right.

CERTIFICATE

of Product Conformity (QAL1)

Certificate No.: 0000050628_01

AMS designation:	Mercury Freedom System for Hg
Manufacturer:	Thermo Fisher Scientific 27, Forge Parkway Franklin, MA 02038 USA
Test Laboratory:	TÜV Rheinland Energy GmbH

This is to certify that the AMS has been tested and found to comply with the standards EN 15267-1 (2009), EN 15267-2 (2009), EN 15267-3 (2007) and EN 14181 (2014).

Certification is awarded in respect of the conditions stated in this certificate (this certificate contains 7 pages).
The present certificate replaces certificate 0000050628 of 25 April 2016.

TÜVRheinland® CERTIFIED

Suitability Tested
EN 15267
QAL1 Certified
Regular
Surveillance

www.tuv.com
ID 0000050628

Publication in the German Federal Gazette (BAnz) of 14 March 2016

This certificate will expire on:
13 March 2026

German Federal Environment Agency
Dessau, 13 March 2021

Dr. Marcel Langner
Head of Section II 4.1

TÜV Rheinland Energy GmbH
Cologne, 12 March 2021

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 by DAkkS (German Accreditation Body).
This accreditation is limited to the accreditation scope defined in the enclosure to certificate D-PL-11120-02-00.

Test Report:	936/21219281/B dated 19 October 2015
Initial certification:	14 March 2016
Expiry date:	13 March 2026
Certificate:	Renewal (of previous certificate 0000050628 dated 25 April 2016 valid until 13 March 2021)
Publication:	BAnz AT 14.03.2016 B7, chapter I number 1.1

Approved application
The tested AMS is suitable for use at combustion plants according to Directive 2010/75/EU, chapters III (13th BImSchV) and IV (17th BImSchV). The measured ranges have been selected so as to ensure as broad a field of application as possible.

The suitability of the AMS for this application was assessed on the basis of a laboratory test, a three-months field test at a waste incineration plant and a one-month field test at a lignite-fired power plant (13th BImSchV).

The sampling probe is approved for an ambient air temperature range of -20 °C to +50 °C. The analyser cabinet may only be operated in an ambient temperature range of +15 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 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 936/21219281/B dated 19 October 2015 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

Publication in the German Federal Gazette: BAnz AT 14.03.2016 B7, chapter I number 1.1, UBA announcement dated 18 February 2016:

AMS designation:
Mercury Freedom System for Hg

Manufacturer:
Thermo Fisher Scientific, Franklin, USA

Field of application:
For plants requiring official approval in accordance with 13th and 17th BImSchV

Measuring ranges during performance testing:

Component	Certification range	supplementary measuring ranges		Unit
Hg	0 - 0.030	0 / 0.045	0 / 0.100	mg/m³

Software versions:
Prod: Model 80i
Version: 02.02.04.377
Firmware: 11.54.154

Restrictions:
1. The analyser cabinet may only be operated in an ambient temperature range of +15 to +40 °C.
2. Operation of the AMS and the compensation of cross-sensitivity effects requires an oxygen measuring instrument that is fitted in the same measurement path. The oxygen measurement instrument must be certified according to EN 15267 and operated according to the requirements of EN 14181.

Notes:
1. The maintenance interval is four weeks.
2. Testing Hg requires the application of wet test gases.
3. For regular monitoring of the AMS in operation (QAL3) as well as for annual functional testing (AST), a suitable external test gas generator (e.g. Hovacal) for Mercury test gas must be applied.
4. During performance testing, the measurement path length was 10 m in the laboratory test and in the field test.

Test Report:
TÜV Rheinland Energie und Umwelt GmbH, Cologne
Report no.: 936/21219281/B dated 19 October 2015

Publication in the German Federal Gazette: BAnz AT 01.08.2016 B11, chapter V notification 19, UBA announcement dated 14 July 2016:

19 Notification as regards Federal Environment Agency (UBA) notice of 18 February 2016 (BAnz AT 14.03.2016 B7, chapter I number 1.1).

The current software versions of the Mercury Freedom System for Hg manufactured by Thermo Fisher Scientific are:

Prod:	Model 80i
Vers.:	02.03.04.385
Firmware:	11.54.154

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 29 February 2016

Publication in the German Federal Gazette: BAnz AT 15.03.2017 B6, chapter V notification 29, UBA announcement dated 22 February 2017:

29 Notification as regards Federal Environment Agency (UBA) notices of 18 February 2016 (BAnz AT 14.03.2016 B7, chapter I number 1.1) and of 14 July 2016 (BAnz AT 01.08.2016 B11, chapter V 19th notification)

The Mercury Freedom System for Hg manufactured by Thermo Fisher Scientific may also be operated with a Model 85 sampling probe. The results of the tests are presented in Report No. 936/21232840/B dated 12 October 2016 issued by TÜV Rheinland Energy GmbH.

Statement issued by TÜV Rheinland Energy GmbH dated 12 October 2016

Publication in the German Federal Gazette: BAnz AT 26.03.2019 B7, chapter IV notification 70, UBA announcement dated 27 February 2019:

70 Notification as regards Federal Environment Agency (UBA) notices of 18 February 2016 (BAnz AT 14.03.2016 B7, chapter I number 1.1) and of 22 February 2017 (BAnz AT 15.03.2017 B6, chapter V 29th notification)

The Mercury Freedom System measuring system for Hg manufactured by Thermo Fisher Scientific may also use connectors manufactured by HAM-LET for its gas lines separately or in combination with those provided by Swagelok.

Statement issued by TÜV Rheinland Energy GmbH dated 10 January 2019

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

The Mercury Freedom System is a complex AMS, which uses atom fluorescence to analyse mercury. The sample gas is diluted for measurement. Mercury species present in the sample gas are converted to molecular mercury by way of thermo catalysis.

A large partial volume flow from the flue is taken as sample gas. From this “Fast Loop“ a small sample volume flow is taken and diluted. The sample volume flow is then divided. A portion of the sample volume flow is led through a scrubber. The scrubber separates chemically bound mercury present in the sample. The sample gas flow will then only contain elemental mercury Hg(0). The other part of the sample gas flow is led through a thermal converter. Chemically bonded mercury is converted to elementary mercury in this converter, so that all mercury in this sample gas flow is available as Hg(0). All functionalities that have been described so far are effected in the sampling probe. Both partial flows are led separately to the analyser cabinet.

Analysis of mercury is carried out according to the principle of atomic fluorescence.

By alternating analysis of one or the other partial flow, the measuring system is able to determine total mercury content in the waste gas, part of Hg(0) in the waste gas as well as the chemically bonded Mercury in the waste gas detected by calculating the difference. Since only the total mercury content is relevant for emission monitoring in Europe, the measuring system was operated in the mode of total mercury determination during the entire test.

The Mercury Freedom System mainly consists of the following components:

- Sampling probe model 83i with heated probe tube, a “Fast Loop” suction unit, a dilution unit and a reduction unit,
- the analyser cabinet with the following modules:
  - Mercury analyser model 80i,
  - Mercury reference gas generator model 81i,
  - a sampling control unit model 82i,
  - a hydrator for the test gas,
  - a nitrogen generator (MaxSense),
  - a compressed air processing system for zero air supply,
  - zero air processing consisting of a 3-step absorber unit with filled cartridges of silica gel, a molecular sieve and charcoal.
  - Software version:
    Prod: Model 80i
    Vers.: 02.02.04.377
    Firmware: 11.54.154
  -

Additionally, the operation requires an oxygen analyser certified according to EN 15267. The oxygen analyser’s signal is required for the compensation of cross-sensitivity.

QAL3/AST works require the application of a suitable external test gas generator.

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 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 Mercury Freedom System measuring system is based on the documents listed below and the regular, continuous surveillance of the manufacturer's quality management system:

Initial certification according to EN 15267

Certificate no. 0000050628: 25 April 2016
Expiry date of the certificate: 13 March 2021
Test report no. 936/21219281/B dated 19 October 2015
TÜV Rheinland Energie und Umwelt GmbH, Cologne
Publication: BAnz AT 14.03.2016 B7, chapter I number 1.1
UBA announcement dated 18 February 2016

Notifications in accordance with EN 15267

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 29 February 2016
Publication: BAnz AT 01.08.2016 B11, chapter V notification 19
UBA announcement dated 14 July 2016
(New software version)

Statement issued by TÜV Rheinland Energy GmbH dated 12 October 2016
Publication: BAnz AT 15.03.2017 B6, chapter V notification 29
UBA announcement dated 22 February 2017
(new sampling probe)

Statement issued by TÜV Rheinland Energie und Umwelt GmbH dated 10 January 2019
Publication: BAnz AT 26.03.2019 B7, chapter IV notification 70
UBA announcement dated 27 February 2019
(new connection element for gas lines)

Renewal of the certificate

Certificate no. 0000050628_01: 13 March 2021
Expiry date of the certificate: 13 March 2026

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system			
Manufacturer		Thermo Fisher Scientific	
AMS designation		Mercury Freedom System	
Serial number of units under test		1102146924/0613917119	
Measuring principle		Atomic Fluorescence	
Test report		936/21219281/B	
Test laboratory		TÜV Rheinland	
Date of report		2015-10-19	
Measured component		Hg	
Certification range		0 - 30 µg/m³	
Evaluation of the cross-sensitivity (CS)			
(system with largest CS)			
Sum of positive CS at zero point		0.80 µg/m³	
Sum of negative CS at zero point		0.04 µg/m³	
Sum of postive CS at span point		1.15 µg/m³	
Sum of negative CS at span point		-0.43 µg/m³	
Maximum sum of cross-sensitivities		1.15 µg/m³	
Uncertainty of cross-sensitivity	u_i	0.665 µg/m³	
Calculation of the combined standard uncertainty			
Tested parameter			u^2
Standard deviation from paired measurements under field conditions *	u_D	0.367 µg/m³	0.135 (µg/m³)²
Lack of fit	u_{lof}	0.173 µg/m³	0.030 (µg/m³)²
Zero drift from field test	$u_{d,z}$	0.450 µg/m³	0.203 (µg/m³)²
Span drift from field test	$u_{d,s}$	0.520 µg/m³	0.270 (µg/m³)²
Influence of ambient temperature at span	u_t	0.300 µg/m³	0.090 (µg/m³)²
Influence of supply voltage	u_v	0.306 µg/m³	0.094 (µg/m³)²
Cross-sensitivity (interference)	u_i	0.665 µg/m³	0.442 (µg/m³)²
Influence of sample gas pressure	u_p	0.046 µg/m³	0.002 (µg/m³)²
Influence of sample gas flow	u_D	0.108 µg/m³	0.012 (µg/m³)²
Uncertainty of reference material at 70% of certification range	u_{rm}	0.242 µg/m³	0.059 (µg/m³)²

* The larger value is used :
"Repeatability standard deviation at set point" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max,j})^2}$	1.16	µg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	2.27	µg/m³

Relative total expanded uncertainty	**U in % of the ELV 30 µg/m³**	**7.6**
Requirement of 2010/75/EU	**U in % of the ELV 30 µg/m³**	**40.0**
Requirement of EN 15267-3	U in % of the ELV 30 µg/m³	30.0