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Stationary source emissions — Greenhouse gases —

Part 1: Calibration of automated measuring systems

Émissions de sources fixes — Gaz à effet de serre —

Partie 1: Étalonnage des systèmes de mesurage automatiques

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Foreword

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 146, *Air quality*, Subcommittee SC 1, *Stationary source emissions*.

ISO 14385 consists of the following parts, under the general title *Stationary source emissions — Greenhouse gases*:

— *Part 1: Calibration of automated measuring systems*

— *Part 2: Ongoing quality control of automated measuring systems*

Introduction

The measurement of greenhouse gas emissions (carbon dioxide, nitrous oxide, methane) in a framework of emission trading requires an equal and known quality of data.

This part of ISO 14385 describes the quality assurance procedures for calibration and ongoing quality control needed to ensure that automated measuring systems (AMS) installed to measure emissions of greenhouse gases to air are capable of meeting the uncertainty requirements on measured values specified, e.g. by legislation, competent authorities, or in an emission trade scheme.

Stationary source emissions — Greenhouse gases —

Part 1: Calibration of automated measuring systems

1 Scope

This part of ISO 14385 specifies the procedures for establishing quality assurance for automated measuring systems (AMS) installed on industrial plants for the determination of the concentration of greenhouse gases in flue and waste gas and other flue gas parameters.

This part of ISO 14385 specifies a procedure to calibrate the AMS and determine the variability of the measured values obtained by an AMS, which is suitable for the validation of an AMS following its installation.

This part of ISO 14385 is designed to be used after the AMS has been accepted according to the procedures specified in ISO 14956.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14385-2, *Stationary source emissions — Greenhouse gases — Part 2: Ongoing quality control of automated measuring systems*

ISO 14956, *Air quality — Evaluation of the suitability of a measurement procedure by comparison with a required measurement uncertainty*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
automated measuring system
AMS
measuring system permanently installed on site for continuous monitoring of emissions

Note 1 to entry: An AMS is a method which is traceable to a reference method.

Note 2 to entry: Apart from the analyser, an AMS includes facilities for taking samples (e.g. sample probe, sample gas lines, filters, flow meters, regulators, delivery pumps, blowers) and for sample conditioning (e.g. dust filter, water vapour removal devices, converters, diluters). This definition also includes testing and adjusting devices that are required for regular functional checks.

3.2
calibration function
linear relationship between the values of the SRM and the AMS with the assumption of a constant residual standard deviation

3.3
calibration gas
gas of known composition that can be used to check the response of the AMS

3.4
competent authority
organization or organizations which implement the requirements of legislation and regulate installations which must comply with the requirements of legislation

3.5
confidence interval
interval estimator (T_1, T_2) for the parameter θ with the statistics T_1 and T_2 as interval limits and for which it holds that $P[T_1 < \theta < T_2] \geq 1 - \alpha$

Note 1 to entry: The two-sided 95 % confidence interval of a normal distribution is illustrated in Figure 1, where

$T_1 = \theta - 1{,}96\sigma_0$	is the lower 95 % confidence limit;
$T_2 = \theta + 1{,}96\sigma_0$	is the upper 95 % confidence limit;
$I = T_2 - T_1 = 2 \times 1{,}96 \times \sigma_0$	is the length of the 95 % confidence interval;
$\sigma_0 = I / (2 \times 1{,}96)$	is the standard deviation associated with a 95 % confidence interval;
n	is the number of observed values;
f	is the frequency;
m	is the measured value.

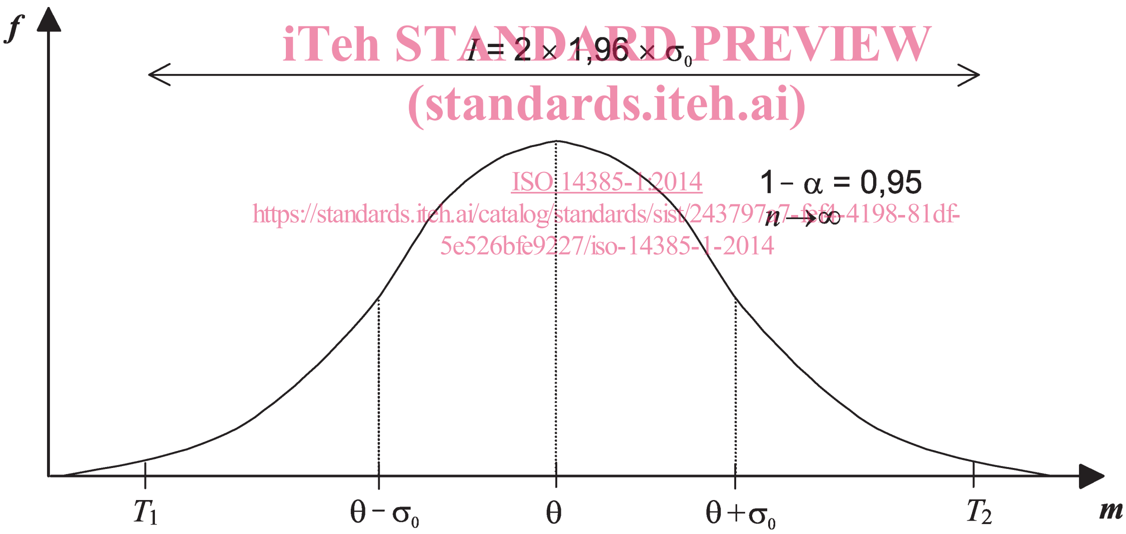

Figure 1 — Illustration of the 95 % confidence interval of a normal distribution

Note 2 to entry: In this part of ISO 14385, the standard deviation, σ_0, is estimated by parallel measurements with an SRM. It is assumed that the requirement for σ_0, presented in terms of an allowable uncertainty budget, i.e. variability is provided by the regulators. In the procedures of this part of ISO 14385, the premise is that the required variability is given as σ_0 itself, or as a quarter of the length of the full 95 % confidence interval.

[SOURCE: ISO 3534-1:2006, 1.28, modified: Figure 1 has been added. Notes 1 and 2 are different.]

3.6
drift
monotonic change of the calibration function over stated maintenance interval, which results in a change of the measured value

3.7
extractive AMS
AMS having the detection unit physically separated from the gas stream by means of a sampling system

3.8
in-situ AMS
AMS having the detection unit in the gas stream, or in a part of it

3.9
instrument reading
indication of the measured value directly provided by the AMS without using the calibration function

3.10
legislation
directives, acts, ordinances, and regulations

3.11
low-level cluster
cluster of measurement values less than the maximum permissible uncertainty and between 0 % and 15 % of the lowest measuring range

3.12
measurand
particular quantity subject to measurement[5]

3.13
measured component
constituent of the waste gas for which a defined measurand is to be determined by measurement

3.14
measured value
estimated value of the measurand derived from an output signal

Note 1 to entry: This usually involves calculations related to the calibration process and conversion to required quantities

Note 2 to entry: A measured value is a short-term average. The averaging time can be, e.g. 10 min, 30 min, or 1 h.

3.15
period of unattended operation
maximum admissible interval of time for which the performance characteristics will remain within a predefined range without external servicing, e.g. refill, calibration, adjustment

Note 1 to entry: This is also known as the maintenance interval.

3.16
peripheral parameter
specified physical or chemical quantity which is needed for conversion of the AMS measured value to standard conditions

3.17
peripheral AMS
AMS used to gather the data required to convert the AMS measured value to standard conditions

Note 1 to entry: A peripheral AMS is used to measure water vapour, temperature, pressure, and oxygen.

3.18
peripheral SRM
SRM used to gather the data required to convert the SRM measured values to AMS or standard conditions

Note 1 to entry: A peripheral SRM is used to measure water vapour, temperature, pressure, and oxygen.

3.19
precision
closeness of agreement of results obtained from the AMS for successive zero readings and successive span readings at defined time intervals

3.20
reference material
substance or mixture of substances with a known concentration within specified limits, or a device of known characteristics

Note 1 to entry: Normally used are calibration gases, gas cells, gratings, or filters.

3.21
response time
t90
time interval between the instance of a sudden change in the value of the input quantity to an AMS and the time as from which the value of the output quantity is reliably maintained above 90 % of the correct value of the input quantity

Note 1 to entry: The response time is also referred to as the 90 % time.

3.22
span reading
instrument reading of the AMS for a simulation of the input parameter at a fixed elevated concentration. This simulation should test as much as possible all the measuring elements of the system, which contribute significantly to its performance.

Note 1 to entry: The span reading is approximately 80 % of the measured range.

3.23
standard conditions
conditions as given in legislation to which measured values have to be standardized

3.24
standard deviation
positive square root of the mean squared deviation from the arithmetic mean, divided by the degrees of freedom

Note 1 to entry: The number of degrees of freedom is the number of measurements minus 1.

3.25
Standard Reference Method
SRM
method described and standardised to define a measurand, temporarily conducted on site for verification purposes

Note 1 to entry: Also known as a reference method.

3.26
uncertainty
parameter associated with the result of a measurement that characterises the dispersion of the values that could reasonably be attributed to the measurand[5]

3.27
variability
standard deviation of the differences of parallel measurements between the SRM and AMS

3.28
zero reading
instrument reading of the AMS on simulation of the input parameter at zero concentration, which shall test as much as possible all the measuring elements of the AMS, that contribute significantly to its performance

4 Symbols and abbreviations

4.1 Symbols

a intercept of the calibration function

$\hat{a}$ best estimate of a

b slope of the calibration function

$\hat{b}$ best estimate of b

D_i difference between SRM value y_i and calibrated AMS measured value $\hat{y}_i$

$\bar{D}$ average of D_i

E maximum value of measuring range

k_v test value for variability (based on a χ^2-test, with a β-value of 50 %, for N numbers of paired measurements)

N number of paired samples in parallel measurements

σ standard deviation of the differences D_i in parallel measurements

$t_{0,95;\,N-1}$ value of the t distribution for a significance level of 95 % and a number of degrees of freedom of $N - 1$

u_{inst} uncertainty due to instability (expressed as a standard deviation)

u_{temp} uncertainty due to influence of temperature (expressed as a standard deviation)

u_{pres} uncertainty due to influence of pressure (expressed as a standard deviation)

u_{volt} uncertainty due to influence of voltage (expressed as a standard deviation)

u_{others} any other uncertainty that can influence the zero and span reading (expressed as a standard deviation)

x_i i^{th} measured signal obtained with the AMS at AMS measuring conditions

$\bar{x}$ average of AMS measured signals x_i

y_i i^{th} measured value obtained with the SRM

$\bar{y}$ average of the SRM measured values y_i

$y_{i,s}$ SRM measured value y_i at standard conditions

$y_{s,min}$ lowest SRM measured value at standard conditions

$y_{s,max}$ highest SRM measured value at standard conditions

$\hat{y}_i$ best estimate for the “true value”, calculated from the AMS measured signal x_i by means of the calibration function

$\hat{y}_{i,s}$ best estimate for the “true value”, calculated from the AMS measured signal x_i at standard conditions

$\hat{y}_{s,max}$ best estimate for the “true value”, calculated from the maximum value of the AMS measured signals x_i at standard conditions

Z offset (the difference between the AMS zero reading and the zero)

s_{AMS} standard deviation of the AMS used in ongoing quality control

α significance level

ε_i deviation between y_i and the expected value σ_0 standard deviation associated with the uncertainty derived from requirements of legislation

4.2 Abbreviations

AMS automated measuring system

AST annual surveillance test

QA quality assurance

SRM Standard Reference Method

5 Principle

5.1 General

An AMS to be used shall be proven suitable for its measuring task (parameter and composition of the flue gas) by use of the procedures specified in ISO 14956. Using this part of ISO 14385, it shall be proven that the total uncertainty of the results obtained from the AMS meets the specification for uncertainty stated in legislation or in requirements and specifications established in an international trading program. In ISO 14956, the total uncertainty required by the relevant regulations is calculated by summing all the relevant uncertainty components arising from the individual performance.

This part of ISO 14385 provides a procedure for the validation and calibration of an AMS. It consists of the determination of the calibration function and its variability, and a test of the variability of the measured values of the AMS compared with the uncertainty given by legislation or in requirements and specifications established in international trading programs. The tests are based on a number of parallel measurements performed with a Standard Reference Method (SRM). The variability of the measured values obtained with the AMS can then be evaluated against the maximum permissible uncertainty.

The tests are performed on AMS that have been correctly installed and commissioned.

The tests can be used to

a) establish a calibration function over a range of plant operating conditions and

b) calibrate the AMS and demonstrate that an AMS meets the required accuracy at a constant operating load.

The procedure is repeated periodically after a major change of plant operation, after a failure of the AMS, or as required by legislation.

5.2 Limitations

Figure 2 illustrates the components of the AMS covered by this part of ISO 14385.

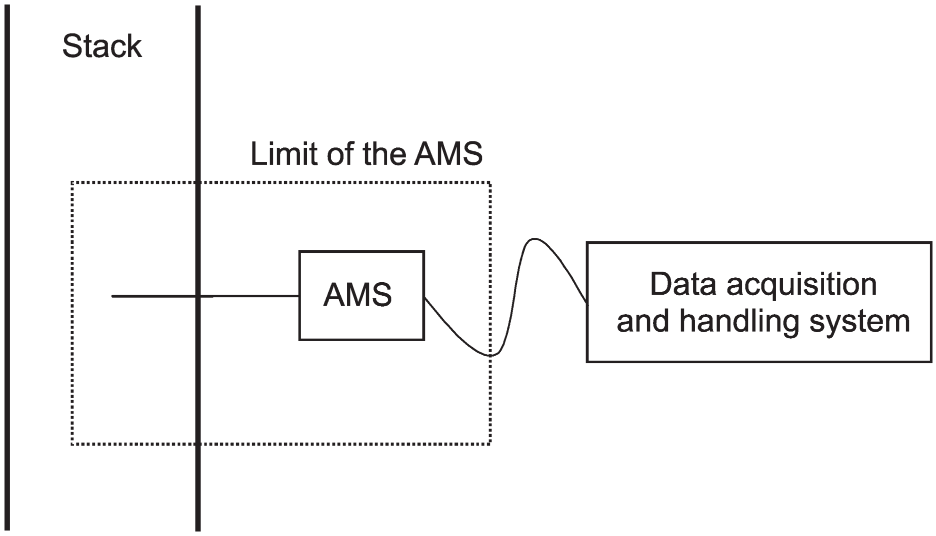

Figure 2 — Limits for the QA of the AMS excluding the data acquisition and handling system

NOTE 1 The influence of the uncertainty of the measurement results, which arise from the data acquisition recording and handling system of the AMS or of the plant system and its determination, are excluded from this part of ISO 14385.

NOTE 2 The performance of the data collection and recording system can be as influential as the AMS performance in determining the quality of the results obtained from the whole measuring system/process. There are different requirements for data collection recording and presentation in different countries.

When conducting parallel measurements, the measured signals from the AMS are taken directly from the AMS (e.g. expressed as analogue or digital signal) during the calibration and annual surveillance test (AST) procedures specified in this part of ISO 14385 by using an independent data collection system provided by the organization(s) carrying out the calibration and AST tests, as specified in ISO 14385-2. All data shall be recorded in their uncorrected form (without corrections for, e.g. temperature and oxygen). A plant data collection system with quality control can additionally be used to collect the measured signal from the AMS.

5.3 Measurement site and installation

The AMS shall be installed in accordance with the requirements of the relevant national or international standards, as specified by legislation, competent authorities, or in emission trade scheme. Special attention shall be given to ensure that the AMS is readily accessible for regular maintenance and other necessary activities.

NOTE The AMS is intended to be positioned as far as practical so that it measures a sample representative of the stack gas composition.

All measurements shall be carried out on a suitable AMS and peripheral AMS installed within an appropriate working environment.

The working platform used to access the AMS shall readily allow parallel measurements to be performed using an SRM. The sampling ports for measurements with the SRM shall be placed as close as possible, but not more than three times the equivalent diameter up- or down-stream of the location of the AMS, in order to achieve comparable measurements between AMS and SRM.

It is necessary to have good access to the AMS to enable inspections to take place and also to minimize time taken to implement the quality assurance procedures of this part of ISO 14385. A clean, well-ventilated, and well-lit working space around the AMS is required to enable the staff to perform this work effectively. Suitable protection is required for the personnel and the equipment, if the working platform is exposed to the weather.

