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Air quality - Certification of automated measuring systems - Part 3: Performance specifications and test procedures forautomated measuring systems for monitoring emissionsfrom stationary sources

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Air quality - Certification of automated measuring systems - Part 3: Performance specifications and test procedures for automated measuring systems for monitoring emissions from stationary sources

Qualité de l'air - Certification des systèmes de mesurage automatisés - Partie 3 : Spécifications de performance et modes opératoires d'essai pour systèmes de mesurage automatisés

Luftbeschaffenheit - Zertifizierung von automatischen Messeinrichtungen - Teil 3: Mindestanforderungen und Prüfprozeduren für automatische Messeinrichtungen zur Überwachung von Emissionen aus stationären Quellen

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 264.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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COMITÉ EUROPÉEN DE NORMALISATION
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Contents

Page

Foreword

This document (prEN 15267:2005) has been prepared by Technical Committee CEN/TC 264 “Air quality”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

Introduction

0.1 General

CEN has established standards for the certification of automated measuring systems (AMS). This certification is based on:

— type testing of AMS for compliance with relevant performance specifications;

— initial assessment of the AMS related to factory production control, (part of the manufacturer's quality management system);

— periodic surveillance of the on-going manufacturing and performance of a certified AMS.

This European Standard defines the performance specifications and test procedures for AMS used to monitor emissions from stationary sources.

0.2 Legal drivers

This European Standard supports the requirements of particular EU Directives and the QAL1 requirements of EN 14181. The EU Directives supported by this European Standard include:

— Directive on the limitation of emissions of certain pollutants into the air from large combustion plants (2001/80/EC);

— Directive on the incineration of waste (2000/76/EC);

— Directive on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations (1999/13/EC);

— Integrated Pollution Prevention and Control Directive (1996/61/EC);

— Directive establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC (2003/87/EC);

— Processes emitting greenhouse gases covered by Directive 2003/87/EC.

0.3 Processes

Field testing of an AMS is ordinarily carried out on the most highly demanding industrial process in the range of applications for which a manufacturer seeks certification. The premise is that if the AMS performs acceptably on this process, then experience has shown that the AMS generally performs well on the majority of other processes. However, there are always exceptions and it is the responsibility of the manufacturer in conjunction with the user to ensure that the AMS performs adequately on a specific process.

NOTE 1 While covered by 2001/80/EC, there is evidence that gas turbines are highly specialised and demanding applications for monitoring, particularly regarding the measurement of low concentrations of nitrogen dioxide and nitrogen oxide.

NOTE 2 AMS for large combustion plants can be considered applicable for gas turbine monitoring if (i) the AMS can measure total NO_x and (ii) the range for NO_x is sufficiently low.

0.4 Performance characteristics

The main AMS performance characteristics are:

— lack of fit (linearity) under laboratory and field conditions;

— cross-sensitivity to likely components of the stack gas other than the determinand;

— influence of variations in flow rate on extractive AMS;

— influence of variations of the stack gas pressure;

— response time;

— detection limit;

— influence of ambient conditions on zero and span readings;

— performance and accuracy of the AMS against a standard reference method (SRM) under field conditions;

— reproducibility from two AMS under identical field conditions;

— availability and maintenance interval under field conditions;

— time-dependent zero and span drift under field conditions;

— repeatability at zero and reference points;

— susceptibility to physical disturbances.

A combination of laboratory and field testing is detailed within this European Standard. Laboratory testing is designed to assess whether an AMS can meet, under controlled conditions, the technical requirements of the relevant performance specification. Field testing, over a minimum 3 month period, is designed to assess whether an AMS can continue to work and meet the relevant performance specification in a real application. Field testing is carried out on an industrial process representative of the intended application for the AMS for which the manufacturer seeks certification.

This European Standard is an application and elaboration of EN ISO 9169 with additional and alternative provisions for paired testing. Where this European Standard appears to differ from EN ISO 9169, it either elaborates upon the requirements of EN ISO 9169 or differs in minor ways to the necessity to conduct paired testing.

1 Scope

This European Standard lays down the performance specifications and test procedures for automated measuring systems which measure gases and particulates in, and flow of, the waste gas of stationary sources.

This European Standard supports the requirements of particular EU Directives and the QAL1 requirements of EN 14181. The performance specifications cover a range of emission levels for large combustion plant, waste incineration and solvent using processes.

2 Normative references

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

EN 12619, *Stationary source emissions – Determination of the mass concentration of total gaseous organic carbon at low concentrations in flue gases – Continuous flame ionisation detector method.*

EN 13284-1, *Stationary source emissions – Determination of low range mass concentration of dust – Part 1: Manual gravimetric method.*

EN 13284-2, *Stationary source emissions – Determination of low range mass concentration of dust – Part 2: Automated measuring systems.*

EN 13526, *Stationary source emissions – Determination of the mass concentration of total gaseous organic carbon in flue gases from solvent using processes – Continuous flame ionisation detector method.*

EN 14181, *Stationary source emissions – Quality assurance of automated measuring systems.*

EN 50160, *Voltage characteristics of electricity supplied by public distribution systems.*

EN 60529, *Specification for degrees of protection provided by enclosures (IP code).*

EN ISO 14956, *Air quality – Evaluation of the suitability of a measurement method by comparison with a stated measurement uncertainty.*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories.*

IEC 60068-1, *Environmental testing – Part 1: General and guidance.*

IEC 60068-2, *Environmental testing – Part 2: Tests.*

3 Terms and definitions

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

3.1
accuracy
closeness of agreement between a single measured value of the measurand, and the true value (or an accepted reference value)

3.2
availability
fraction of the total monitoring time for which data of acceptable quality have been collected

3.3
averaging time
period of time over which an arithmetic or time-weighted average of concentrations is calculated

NOTE t_a is the averaging time used by the AMS. t_{ra} is the required data averaging period, e.g. prescribed by legislation.

3.4
automated measuring system
AMS
entirety of all measuring instruments and additional devices for obtaining a result of measurement

NOTE 1 Apart from the actual measuring device (the analyser), an AMS includes facilities for taking samples (e.g. probe, sample gas lines, flow meters and regulator, delivery pump) and for sample conditioning (e.g. dust filter, pre-separator for disturbing components, cooler, converter). This definition also includes testing and adjusting devices that are required for functional checks and, if applicable, for commissioning.

NOTE 2 The term automated measuring system (AMS) is typically used in Europe. The term CEM for continuous emission monitoring system is also typically used in the UK and USA.

3.5
calibration
determination of a calibration function with (time) limited validity applicable to an AMS at a specific measurement site

3.6
calibration function
statistical relationship between the starting variable (measured signal) of the measuring system and the associated result of measurement (measured value) simultaneously determined at the same point of measurement using a standard reference method of measurement

NOTE The calibration function is normally calculated using linear regression.

3.7
certification range
range over which the AMS is to be tested

3.8
converter efficiency
efficiency with which the internal converter unit of a NO_x analyser reduces NO_2 to NO

3.9
critical path
components of the AMS which have an influence on the measured value

NOTE 1 The manufacturer defines the critical path when submitting an AMS for type-testing.

NOTE 2 The critical path usually includes software of the AMS.

3.10
cross-sensitivity
response of the AMS to determinands other than those that it is designed to measure

NOTE See interference.

3.11
delay time, t_{10}
time taken for the output signal of the AMS to reach 10 % of the total change in instrument response

3.12
drift
monotonic change of the calibration function over a stated period of unattended operation, which results in a change of the measured value

3.13
emissions limit value
ELV
limit values given in EU Directives, ordinances, regulations, permits, licences, authorisations or consents

NOTE ELV can be stated as concentration limits expressed as half-hourly, hourly and daily averaged values, or mass flow limits expressed as hourly, daily, weekly, monthly or annually aggregated values.

3.14
expanded uncertainty
quantity defining a level of confidence about the result of measurement that can be expected to encompass a specific fraction of the distribution of values that could be reasonably be attributed to a measurand

NOTE The level of confidence is typically 95 %.

3.15
field test
test for at least three months on an industrial facility appropriate to the AMS's field of application

3.16
functional check
establishment, at regularly recurring intervals using measuring points prescribed for this purpose, of the correct working order of measuring and evaluation systems used for monitoring emissions

3.17
gas analyser
analytical instrument that provides an output signal which is a function of the concentration, partial pressure, flow or temperature of one or more components of a gas mixture

3.18
indicating range
output range of an AMS

3.19
interference
negative or positive effect that a substance has upon the output of the instrument, when that substance is not the target determinand

3.20
interferent
component of the sample, excluding the measured constituent, that affects the output signal

3.21
legislation
directives, acts, ordinances, regulations, permits, licences, authorisations and consents

3.22
limiting conditions
extreme conditions which an AMS can withstand without damage or decrease in its abilities to perform reliable measurements within specifications, when it is working under its rated operating conditions

3.23
lack of fit
systematic deviation, within the range of application, between the accepted value of a reference material applied to the measuring system and the corresponding result of measurement produced by the calibrated measuring system

NOTE 1 Lack of fit can be a function of the result of measurement.

NOTE 2 Since bias is considered as too specific and too difficult to be determined experimentally, the concept of lack of fit is used in this document.

3.24
maintenance interval
maximum admissible interval of time for which the performance characteristics remain within a pre-defined range without servicing, e.g. refill, calibration

NOTE This is also known as the period of unattended operation.

3.25
measured signal
output from an AMS in analogue or digital form which is converted into the measured value with the aid of the analytical function

3.26
output
reading, or digital or analogue electrical signal generated by an AMS in response to a determinand

3.27
paired measurement
simultaneous recording of results of measurement at the same measurement point using two AMS of identical design

3.28
performance characteristic
one of the quantities (described by values, tolerances, range) assigned to an AMS in order to define its performance

3.29
range
range of all values that can be output by the AMS

3.30
reference conditions
specified set of values (including tolerances) of influence variables, delivering representative values of performance characteristics

3.31
reference material
substance or mixture of substances, with a known composition within specified limits

NOTE One or more of the properties of the reference material are sufficiently well established over a stated period of time to be used for the calibration of an apparatus, the assessment of a measuring method, or for assigning values to materials.

3.32
reference point
value of the output quantity (measured signal) of the measuring AMS for the purpose of calibrating, functional check, adjusting, etc. that represents a correct measured value generated by the measured object

3.33
repeatability
ability of an AMS to provide closely similar indications for repeated applications of the same determinand under the same conditions of measurement

3.34
repeatability at zero
concentration value of the determinand below which there is at least a 95% level of confidence that the measured value corresponds to a sample free of that determinand

3.35
reproducibility
R_{field}
measure of the agreement between two identical measuring systems applied in parallel in field tests at a level of confidence of 95 % using the standard deviation of the difference of the paired measurements:

$$R_{\text{field}} = t_{n-1;\,0,95} \times s_{\text{D}} \tag{1}$$

$$s_{\text{D}} = \sqrt{\frac{\sum_{i=1}^{n} \left(x_{1,i} - x_{2,i} \right)^2}{2n}} \tag{2}$$

where

R_{field} is the reproducibility under field conditions;

$t_{n-1;\,0,95}$ is the two-sided Students t-factor at a confidence level of 95 % with a number of degrees of freedom n–1;

s_{D} is the standard deviation of the difference of paired measurements;

$x_{1,\,i}$ is the ith measured signal of the first measuring system;

$x_{2,\,i}$ is the ith measured signal of the second measuring system;

n is the number of parallel measurements.

NOTE 1 Reproducibility is determined by means of two identical AMS operated side by side. It is a AMS performance characteristic for describing the production tolerance specific to that AMS. The reproducibility is calculated from the half-hour averaged output signals (raw values as analogue or digital outputs) during the three-month field test.

NOTE 2 The term *field repeatability* is sometimes used instead of reproducibility

3.36
response time
t_{90}
time interval between the instant 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 The response time is also referred to as the 90 % time.

3.37
sampling of the sample gas flow
continuous removal, by extraction (active) or by flow division (passive) of a part of the gas flow representative of the substance flow under evaluation in terms of chemical composition and physical boundary conditions

3. 38
standard reference method
SRM
method described and standardised to define an air quality characteristic, temporarily installed on site for verification purposes

NOTE Also known as a reference method.

3.39
span
difference of the AMS readings between zero and a stated value of the measurand

3.40
span drift
change in AMS reading in response to a specified value of a measurand over a stated period of unattended operation

3.41
stable test gas mixture
mixture of gases where the component to be measured is known and does not interact with the containment system, and does not change significantly with time

3.42
standard uncertainty
uncertainty of the result of measurement expressed as a standard deviation

3.43
test institute
laboratory accredited to EN ISO/IEC 17025 for carrying out the tests defined in this standard

NOTE A document providing an elaboration of EN ISO/IEC 17025 for application to stack-emission measurement which should be followed when using standard reference methods listed in Annex A is under preparation.

3.44
uncertainty
parameter associated with the result of a measurement, that characterises the dispersion of the values that could reasonably be attributed to the measurand

3.45
zero gas
gas mixture used to establish the zero point of a calibration curve when used with a given analytical procedure within a given calibration range

3.46
zero drift
change in instrument reading in response to a zero value of the measurand over a stated period of unattended operation

3.47
zero point
specified value of the output quantity (measured signal) of the measuring AMS and which, in the absence of the measured object, represents the zero crossing of the AMS characteristic

4 Symbols and abbreviations

4.1 Symbols

b_{sp}	sensitivity coefficient of sampling gas pressure
c	concentration
$c_{NO,\,0}$	concentration of NO with ozone generator switched-off
$c_{NO,\,i}$	concentration of NO with ozone generator at setting i (i = 1 to n)
$c_{NOx,\,0}$	concentration of total NO_x with ozone generator switched-off
$c_{NOx,\,i}$	concentration of total NO_x with ozone generator at setting i (i = 1 to n)
c_{P_1}	average concentration of the measurements at sampling gas pressure P_1
c_{P_2}	average concentration of the measurements at sampling gas pressure P_2
C_i	converter efficiency at setting i of the ozone generator (i = 1 to n)
n	number of measurements, number of parallel measurements
P_1	is the sampling gas pressure P_1
P_2	is the sampling gas pressure P_2
ΔP	difference in sample gas pressure
r	repeatability
R_{field}	reproducibility under field conditions
R^2	correlation coefficient of calibration function
s_D	standard deviation of the difference of paired measurements
s_r	repeatability standard deviation of the measurement
$t_{n-1;\,0,95}$	two-sided Students t-factor at a confidence level of 95 % with a number of degrees of freedom n–1
t_{90}	response time
t_d	is the relative difference between the response times determined in rise and fall mode
t_{rise}	response time determined in rise mode (average of 4 measurements)
t_{fall}	response time determined in fall mode (average of 4 measurements)
t_{out}	outage time
t_{tot}	total operating time