SLOVENSKI STANDARD
SIST EN 15267-3:2008

01-marec-2008

Kakovost zraka - Certificiranje avtomatskih merilnih sistemov - 3. del: Zahteve za delovanje in postopki preskušanja avtomatskih merilnih sistemov za spremljanje in nadzor emisij nepremičnih virov

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

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

Qualité de l'air - Certification des systèmes de mesurage automatisés - Partie 3: Spécifications de performance et procédures d'essai pour systèmes de mesurage automatisés des émissions de sources fixes

Ta slovenski standard je istoveten z: **EN 15267-3:2007**

ICS:

03.120.20	Certificiranje proizvodov in podjetij. Ugotavljanje skladnosti	Product and company certification. Conformity assessment
13.040.01	Kakovost zraka na splošno	Air quality in general

SIST EN 15267-3:2008 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 15267-3

December 2007

ICS 13.040.40

English Version

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

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This European Standard was approved by CEN on 17 November 2007.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

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Foreword

This document (EN 15267-3:2007) has been prepared by Technical Committee CEN/TC 264 “Air quality”, the secretariat of which is held by DIN.

This document shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2008 and conflicting national standards shall be withdrawn at the latest by June 2008.

This document is Part 3 of a series of European Standards:

— EN 15267-1, *Air quality — Certification of automated measuring systems — Part 1: General principles*

— EN 15267-2, *Air quality — Certification of automated measuring systems — Part 2: Initial assessment of the AMS manufacturer’s quality management system and post certification surveillance for the manufacturing process*

— EN 15267-3, *Air quality — Certification of automated measuring systems — Part 3: Performance criteria and test procedures for automated measuring systems for monitoring emissions from stationary sources*

— EN 15267-4, *Air quality — Certification of automated measuring systems — Part 4: Performance criteria and test procedures for automated measuring systems for monitoring ambient air quality*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

0 Introduction

0.1 General

CEN has established standards for the certification of automated measuring systems (AMS) used for monitoring emissions from stationary sources and ambient air quality. This product certification is based on the following four sequential stages:

a) performance testing of an AMS;

b) initial assessment of the AMS manufacturer's quality management system;

c) certification;

d) post certification surveillance.

This European Standard defines the performance criteria and test procedures for performance testing of AMS used to monitor emissions from stationary sources. Testing applies to complete measuring systems.

The overall assessment for the purposes of certification is *conformity testing*, whilst the evaluation of performance against specified performance criteria is *performance testing*.

0.2 Legal drivers

This European Standard supports the requirements of the following EU Directives:

— 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 on processes emitting greenhouse gases (2003/87/EC).

However, this European Standard can also be applied to the monitoring requirements specified in other EU Directives.

0.3 Relationship to EN 14181

The Quality Assurance Levels (QAL) defined in EN 14181 cover the suitability of an AMS for its measuring task (QAL1), the regular calibration and validation of the AMS (QAL2), and the control of the AMS during its ongoing operation on an industrial plant (QAL3). An Annual Surveillance Test (AST) is also defined in EN 14181.

This European Standard provides the detailed procedures covering the QAL1 requirements of EN 14181. Furthermore, it provides input data for QAL3.

0.4 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.

0.5 Performance characteristics

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 relevant performance criteria. Field testing, over a minimum three month period, is designed to assess whether an AMS can continue to work and meet the relevant performance criteria 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.

The main AMS performance characteristics are

— response time,

— repeatability standard deviation at zero and span points,

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

— zero and span drift under laboratory and field conditions,

— influence of ambient temperature,

— influence of sample gas pressure,

— influence of sample gas flow for extractive AMS,

— influence of voltage variations,

— influence of vibration,

— cross-sensitivity to likely interferents contained in the waste gas other than the measured component,

— excursion of measurement beam of in-situ AMS,

— converter efficiency for NO_x AMS,

— response factors,

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

— maintenance interval under field conditions,

— availability under field conditions and

— reproducibility under field conditions.

The quality of reference or surrogate materials used under QAL3 for particulate matter measuring AMS is also assessed.

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 owing to the necessity to conduct paired testing.

1 Scope

This European Standard specifies the performance criteria and test procedures for automated measuring systems that measure gases and particulate matter in, and flow of, the waste gas from stationary sources.

This European Standard supports the requirements of particular EU Directives. It provides the detailed procedures covering the QAL1 requirements of EN 14181 and, where required, input data used in QAL3.

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 14181:2004, *Stationary source emissions — Quality assurance of automated measuring systems*

EN 15259:2007, *Air quality — Measurement of stationary source emissions — Requirements for measurement sections and sites and for the measurement objective, plan and report*

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

EN 60529, *Degrees of protection provided by enclosures (IP code) (IEC 60529:1989)*

EN 60068-1, *Environmental testing — Part 1: General and guidance (IEC 60068-1:1988 + Corrigendum 1988 + A1:1992)*

EN 60068-2 (all tests), *Environmental testing — Part 2: Tests*

EN ISO 14956, *Air quality — Evaluation of the suitability of a measurement procedure by comparison with a required measurement uncertainty (ISO 14956:2002)*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:2005)*

3 Terms and definitions

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

3.1
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 interferents, 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 “continuous emission monitoring system” (CEM) is also typically used in the UK and USA.

3.2
reference method
RM
measurement method taken as a reference by convention, which gives, the accepted reference value of the measurand

NOTE 1 A reference method is fully described.

NOTE 2 A reference method can be a manual or an automated method.

NOTE 3 Alternative methods can be used if equivalence to the reference method has been demonstrated.

[EN 15259:2007, 3.8]

3.3
standard reference method
SRM
reference method prescribed by European or national legislation

NOTE Standard reference methods are used e.g. to calibrate and validate AMS and for periodic measurements to check compliance with limit values.

[EN 15259:2007, 3.9]

3.4
measurement
set of operations having the object of determining a value of a quantity

[VIM:1993, 2.1]

3.5
paired measurement
simultaneous recording of results of measurement at the same measurement point using two AMS of identical design

3.6
measurand
particular quantity subject to measurement

[VIM:1993, 2.6]

NOTE The measurand is a quantifiable property of the waste gas under test, for example mass concentration of a measured component, temperature, velocity, mass flow, oxygen content and water vapour content.

3.7
measured component
constituent of the waste gas for which a defined measurand is to be determined by measurement

[EN 15259:2007, 3.6]

NOTE Measured component is also called determinand.

3.8
interferent
substance present in the waste gas under investigation, other than the measured component, that affects the output

3.9
calibration
determination of a calibration function with (time) limited validity applicable to an AMS at a specific measurement site

3.10
calibration function
linear relationship between the values of the SRM and the AMS with the assumption of a constant residual standard deviation

[EN 14181:2004, 3.3]

NOTE The calibration function describes the 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 SRM.

3.11
reference material
substance or mixture of substances, with a known concentration within specified limits, or a device of known characteristics

3.12
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

3.13
zero point
specified value of the output quantity (measured signal) of the AMS and which, in the absence of the measured component, represents the zero crossing of the AMS characteristic

NOTE In case of oxygen and some flow monitoring AMS, the zero point is interpreted as the lowest measurable value.

3.14
span point
value of the output quantity (measured signal) of the AMS for the purpose of calibrating, adjusting, etc. that represents a correct measured value generated by reference material between 70 % and 90 % of the range tested

3.15
measured signal
output from an AMS in analogue or digital form which is converted into the measured value with the aid of the calibration function

3.16
output
reading, or digital or analogue electrical signal generated by an AMS in response to a measured object

3.17
independent reading
reading that is not influenced by a previous individual reading by separating two individual readings by at least four response times

3.18
individual reading
reading averaged over a time period equal to the response time of the AMS

3.19
performance characteristic
quantity assigned to an AMS in order to define its performance

NOTE The values of relevant performance characteristics are determined in the performance testing and compared to the applicable performance criteria.

3.20
accuracy
closeness in agreement between a single measured value of the measurand, and the true value (or an accepted reference value)

3.21
availability
fraction of the total monitoring time for which data of acceptable quality have been collected

3.22
averaging time
period of time over which an arithmetic or time-weighted average of concentrations is calculated

3.23
converter efficiency
efficiency with which the converter unit of a NO_x analyser reduces NO_2 to NO

3.24
interference
negative or positive effect that a substance has upon the output of the AMS, when that substance is not the measured component

3.25
cross-sensitivity
response of the AMS to interferents

NOTE See interference.

3.26
drift
monotonic change of the calibration function over a stated period of unattended operation, which results in a change of the measured value

3.27
zero drift
change in the AMS reading at the zero point over the maintenance interval

3.28
span drift
change in AMS reading at the span point over the maintenance interval

3.29
maintenance interval
maximum admissible interval of time for which the performance characteristics remain within a pre-defined range without external servicing, e.g. refill, calibration, adjustment

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

3.30
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 In common language lack of fit is often called "linearity" or "deviation from linearity". Lack of fit test is often called "linearity test".

3.31
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.

3.32
repeatability
ability of an AMS to provide closely similar indications for repeated applications of the same measurand under the same conditions of measurement

3.33
reproducibility
R_f
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

NOTE 1 Reproducibility is determined by means of two identical AMS operated side by side. It is an 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.

3.34
uncertainty
parameter associated with the result of a measurement, that characterises the dispersion of the values that could reasonably be attributed to the measurand

[ENV 13005:1999, B.2.18]

3.35
standard uncertainty
uncertainty of the result of measurement expressed as a standard deviation

[ENV 13005:1999, 2.3.1]

3.36
expanded uncertainty
quantity defining an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurand

[ENV 13005:1999, 2.3.5]

NOTE The interval about the result of measurement is established for a level of confidence of typically 95 %.

3.37
test laboratory
laboratory accredited to EN ISO/IEC 17025 for carrying out performance tests

NOTE CEN/TS 15675 provides an elaboration of EN ISO/IEC 17025 for application to emission measurements, which should be followed when using standard reference methods listed in Annex A.

3.38
field test
test for at least three months on a plant appropriate to the field of application of the AMS

3.39
certification range
range over which the AMS is tested and certified for compliance with the relevant performance criteria

NOTE Certification range is always related to the daily ELV.

3.40
emissions limit value
ELV
limit value given in regulations such as EU Directives, ordinances, administrative 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.

3.41
plant
installation
industrial facility on which an AMS is installed

4 Symbols and abbreviations

For the purposes of this document, the following symbols and abbreviations apply.

4.1 Symbols

a average value of the AMS readings in the linearity test

A intercept of the regression function in the linearity test

b_f sensitivity coefficient of sample gas flow

b_p sensitivity coefficient of sample gas pressure

b_t sensitivity coefficient of ambient temperature

b_v sensitivity coefficient of supply voltage

B slope of the regression function in the linearity test

c concentration; value of the reference material

c_i carbon mass concentration of substance i at 273 K and 1 013 hPa; individual reference material value

c_{ref} carbon mass concentration of propane at 273 K and 1 013 hPa

$c_{NO,0}$	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)
$\bar{c}$	average of c values
d_c	residual
$d_{c,rel}$	relative residual
E_i	converter efficiency at setting i of the ozone generator (i = 1 to n)
f_i	carbon-related response factor for substance i
m_c	number of repetitions at reference material level c
n	number of measurements; number of parallel measurements
p_1	lower sample gas pressure
p_2	higher sample gas pressure
Δp	difference in sample gas pressure
r_1	nominal flow rate
r_2	lowest flow rate specified by the manufacturer
R_f	reproducibility under field conditions
R	regression coefficient of calibration function
R^2	determination coefficient of calibration function
s_D	standard deviation from 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_d	relative difference between the response times determined in rise and fall mode
t_r	response time determined in rise mode (average of four measurements)
t_f	response time determined in fall mode (average of four measurements)
t_o	outage time
t_{tot}	total operating time
T	temperature (absolute)
T_i	ith temperature