

SLOVENSKI STANDARD SIST EN ISO 20988:2008 01-januar-2008

Kakovost zraka - Smernice za ocenjevanje merilne negotovosti (ISO 20988:2007)

Air quality - Guidelines for estimating measurement uncertainty (ISO 20988:2007)

Luftbeschaffenheit - Leitlinien zur Schätzung der Messunsicherheit (ISO 20988:2007)

Qualité de l'air - Lignes directrices pour estimer l'incertitude de mesure (ISO 20988:2007) iTeh STANDARD PREVIEW

Ta slovenski standard je istoveten z: arEN ISO 20988:2007

ICS:Ittps://standards.iteh.ai/catalog/standards/sist/1a&c1d06-3568-4ab5-bfb1-
4589219fd184/sist-en-iso-20988-200813.040.01Kakovost zraka na splošnoAir quality in general

SIST EN ISO 20988:2008

en

iTeh STANDARD PREVIEW (standards.iteh.ai)

EUROPEAN STANDARD NORME EUROPÉENNE EUROPÄISCHE NORM

EN ISO 20988

June 2007

ICS 13.040.01

English Version

Air quality - Guidelines for estimating measurement uncertainty (ISO 20988:2007)

Qualité de l'air - Lignes directrices pour estimer l'incertitude de mesure (ISO 20988:2007)

Luftbeschaffenheit - Leitlinien zur Schätzung der Messunsicherheit (ISO 20988:2007)

This European Standard was approved by CEN on 9 June 2007.

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. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of 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.

> SIST EN ISO 20988:2008 https://standards.iteh.ai/catalog/standards/sist/1a8c1d06-3568-4ab5-bfb1-4589219fd184/sist-en-iso-20988-2008



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

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

© 2007 CEN All rights of exploitation in any form and by any means reserved worldwide for CEN national Members. Ref. No. EN ISO 20988:2007: E

Foreword

This document (EN ISO 20988:2007) has been prepared by Technical Committee ISO/TC 146 "Air quality" in collaboration with Technical Committee CEN/TC 264 "Air quality", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2007, and conflicting national standards shall be withdrawn at the latest by December 2007.

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.

Endorsement notice

The text of ISO 20988:2007 has been approved by CEN as EN ISO 20988:2007 without any modifications.

(standards.iteh.ai)

INTERNATIONAL STANDARD



First edition 2007-06-15

Air quality — Guidelines for estimating measurement uncertainty

Qualité de l'air — Lignes directrices pour estimer l'incertitude de mesure

iTeh STANDARD PREVIEW (standards.iteh.ai)

SIST EN ISO 20988:2008 https://standards.iteh.ai/catalog/standards/sist/1a8c1d06-3568-4ab5-bfb1-4589219fd184/sist-en-iso-20988-2008



Reference number ISO 20988:2007(E)

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

iTeh STANDARD PREVIEW (standards.iteh.ai)

SIST EN ISO 20988:2008 https://standards.iteh.ai/catalog/standards/sist/1a8c1d06-3568-4ab5-bfb1-4589219fd184/sist-en-iso-20988-2008



COPYRIGHT PROTECTED DOCUMENT

© ISO 2007

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office Case postale 56 • CH-1211 Geneva 20 Tel. + 41 22 749 01 11 Fax + 41 22 749 09 47 E-mail copyright@iso.org Web www.iso.org Published in Switzerland

Contents

| Forewordiv | | | |
|---|---|----------------------------------|--|
| Introductionv | | | |
| 1 | Scope | . 1 | |
| 2 | Normative references | . 1 | |
| 3 | Terms and definitions | . 1 | |
| 4 | Symbols and abbreviated terms | 5 | |
| 5 5.1 5.2 5.3 5.4 | Basic concepts Outline Measurement uncertainty Correction for systematic effects Provision of input data | 6 6 9 10 | |
| 6 6.1 6.2 6.3 6.4 6.4.1 6.4.2 6.5 | Problem specification. Objectives. Measurement. Uncertainty parameters S.T.A.N.D.A.R.D. P.R.E.V.E.W. Input data General. Assessment of representativeness Effects not described by series of observations. | 13 13 15 15 15 16 | |
| 7 7.1 7.2 7.3 7.4 | Statistical analysis indards itch ai catalog standards/sist/1a8c1d06-3568-4ab5-bfb1- Objectives | 18 18 19 21 22 | |
| 8 8.1 8.2 8.3 8.4 | Estimation of variances and covariances | 23 23 23 23 23 24 | |
| 9 9.1 9.2 9.3 9.3.1 9.3.2 | Evaluation of uncertainty parameters | 25 25 25 26 26 27 | |
| 10 | Reporting | 28 | |
| Annex | A (informative) Testing a coverage probability | 30 | |
| Annex B (informative) Type A evaluation methods for experimental designs A1 to A8 | | | |
| Annex C (informative) Examples | | | |
| Bibliog | raphy | 31 | |

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 20988 was prepared by Technical Committee ISO/TC 146, Air quality, Subcommittee SC 4, General aspects.

iTeh STANDARD PREVIEW (standards.iteh.ai)

Introduction

The general concept of uncertainty estimation is described in the *Guide to the Expression of Uncertainty in Measurement* (GUM). Practical considerations of the GUM are focussed on evaluation of series of unbiased observations. In air quality measurements, series of observations may rarely be considered unbiased due to the presence of random effects not varying throughout a series of observations.

This International Standard supports evaluation of random effects causing variation or bias in series of observations for the purpose of uncertainty estimation. Appropriate data may be collected in experimental designs providing comparison with reference material, or with reference instruments, or with independent measurements of the same type. In provision of experimental data for uncertainty estimation, it is important to ensure representativeness for variations and bias occurring in intended use of the method of measurement.

Generic guidance and statistical procedures presented by this International Standard are addressed to technical experts of air quality measurement, acting, e.g. in standardization, validation or documentation of methods of measurement in ambient air, indoor air, stationary source emissions, workplace atmospheres or meteorology.

This International Standard does not provide comprehensive information on planning and execution of experimental designs to be evaluated for the purpose of uncertainty estimation.

Uncertainties of results of measurement caused by incomplete time-coverage of measurement data are not considered in this document, but in ISO(1222^[2]) Uncertainties of results of measurement induced by incomplete spatial coverage by measurement data are not considered in this document.

iTeh STANDARD PREVIEW (standards.iteh.ai)

Air quality — Guidelines for estimating measurement uncertainty

1 Scope

This International Standard provides comprehensive guidance and specific statistical procedures for uncertainty estimation in air quality measurements including measurements of ambient air, stationary source emissions, indoor air, workplace atmospheres and meteorology. It applies the general recommendations of the *Guide to the Expression of Uncertainty in Measurement* (GUM) to boundary conditions met in air quality measurement. The boundary conditions considered include measurands varying rapidly in time, as well as the presence of bias in a series of observations obtained under conditions of intended use of methods of air quality measurement.

The methods of measurement considered comprise

- methods corrected for systematic effects by repeated observation of reference materials,
- methods calibrated by paired measurement with a reference method.
- methods not corrected for systematic effects because they are unbiased by design, and
- methods not corrected for systematic effects in intended use deliberately taking into account a bias.

Experimental data for uncertainty estimation can be provided either by a single experimental design in a direct approach or by a combination of different experimental designs in an indirect approach.

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.

ISO/IEC Guide 98:1995, Guide to the expression of uncertainty in measurement (GUM)

3 Terms and definitions

3.1

- uncertainty (of measurement)
- measurement uncertainty

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

[ISO/IEC Guide 98:1995, B.2.18; VIM:1993, 3.9]

3.2

standard uncertainty

uncertainty of the result of measurement expressed as a standard deviation

[ISO/IEC Guide 98:1995, 2.3.1]

NOTE The standard uncertainty of a result of measurement is an estimate of the standard deviation of the population of all possible results of measurement which can be obtained by means of the same method of measurement for the measurand exhibiting a unique value.

3.3

combined standard uncertainty

standard uncertainty of the result of measurement when that result is obtained from the values of a number of other input quantities, equal to the positive square root of a sum of terms, the terms being the variances or covariance of these other quantities weighted according to how the measurement result varies with changes in these quantities

[ISO/IEC Guide 98:1995, 2.3.4]

NOTE The adjective "combined" can be omitted often without loss of generality.

3.4

expanded uncertainty

quantity defining an interval $[y - U_p(y); y + U_p(y)]$ about the result of a measurement y that may be expected to encompass a large fraction p of the distribution of values that could reasonably be attributed to the measurand

NOTE 1 Adapted from ISO/IEC Guide 98:1995, 2.3.5.

NOTE 2 If the uncertainty has been obtained mainly by Type A evaluation, the interval $[y - U_p(y); y + U_p(y)]$ can be understood as confidence interval for the true value of the measurand on a level of confidence *p*.

NOTE 3 The interval $[y - U_p(y), y + U_p(y)]$ characterizes the range of values within which the true value of the measurand is confidently expected to lie (see ISO/IEC Guide 98.1995, 2.2.4).

3.5

(standards.iteh.ai)

4589219fd184/sist-en-iso-20988-2008

coverage factor

numerical factor used as multiplier of the combined standard suncertainty in order to obtain an expanded uncertainty https://standards.iteh.ai/catalog/standards/sist/1a8c1d06-3568-4ab5-bfb1-

[ISO/IEC Guide 98:1995, 2.3.6]

3.6

coverage probability

fraction of results of measurement expected to be encompassed by a specified interval

3.7

Type A evaluation (of uncertainty)

method of evaluation of uncertainty by the statistical analysis of series of observations

[ISO/IEC Guide 98:1995, 2.3.2]

3.8

Type B evaluation (of uncertainty)

method of evaluation of uncertainty by means other than the statistical analysis of series of observations

[ISO/IEC Guide 98:1995, 2.3.3]

3.9

standard deviation

positive square root of the variance

[ISO/IEC Guide 98:1995, C.2.12]

NOTE In general, the standard deviation of the population of a random variable *X* is estimated by the positive square root of an estimate of the variance of the population of *X*.

3.10

experimental standard deviation

for a series of N measurements of the same measurand, the quantity s(x) characterizing the dispersion of the results is given by the formula

$$s(x) = \sqrt{\sum_{j=1}^{N} \frac{\left(x(j) - \overline{x}\right)^2}{N - 1}}$$

x(j) being the result of the *j*th measurement and \overline{x} being the arithmetic mean of the N results considered

NOTE 1 Adapted from ISO/IEC Guide 98:1995, B.2.17.

 $s^{2}(x)$ is an unbiased estimate of the variance $\sigma^{2}(X)$ of the investigated random variable X, if the series of NOTE 2 observations x(j) with j = 1 to N is unbiased.

3.11

variance

the expectation of the square of the centred random variable:

$$\sigma^{2}(X) = E\left\{ \left[X - E(X) \right]^{2} \right\}$$

[ISO/IEC Guide 98:1995, C.2.11]

The population variance $q^2(X)$ of a random variable X can be estimated by the square of the experimental NOTE standard deviation $s^2(x)$ of a simple random sample of unbiased observations x(j) with j = 1 to N of the random variable X. Otherwise, $s^2(x)$ underestimates the population variance. (standards.iteh.ai)

3.12

covariance

mean of the product of two centred random variables in their joint probability distribution

Adapted from ISO 3534-1: 2006, 2.43. NOTE 1

NOTE 2 The covariance cov(x, y) is a sample statistic used to estimate the covariance of the populations of x and y.

3.13

expectation

- expected value
- 1) For a discrete random variable X taking the values x_i with probabilities p_i , the expectation, if it exists, is $E(X) = \sum p_i x_i$, the sum being extended over all values x_i which may be taken by X.
- 2) For a continuous random variable X having the probability density function f(x), the expectation, if it exists, is $E(X) = |x \cdot f(x) \cdot dx|$, the integral being extended over the interval(s) of variation of X.

[ISO/IEC Guide 98:1995, C.2.9]

3.14

degrees of freedom

in general, the number of terms in a sum minus the number of constraints on the terms of the sum

[ISO/IEC Guide 98:1995, C.2.31]

NOTE For a variance estimate, the (effective) number of degrees of freedom can be understood as the number of independent pieces of information used to obtain that variance estimate.

3.15

measurement

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

[VIM:1993, 2.1]

3.16

result of measurement

value attributed to the measurand, obtained by measurement

[VIM:1993, 3.1]

3.17

sensitivity coefficient

deviation of the result of measurement divided by the deviation of an influence quantity causing the change, if all other influence quantities are kept constant

3.18

measurand

particular quantity subject to measurement

[VIM:1993, 2.6]

NOTE The measurand is considered to exhibit a unique value at least for the time period needed for a single measurement.

3.19

measuring system

complete set of measuring instruments and other equipment with operating procedures to carry out specified air quality measurements

[ISO 11222:2002, 3.9]

iTeh STANDARD PREVIEW

A measuring system is a technical realization of a method of measurement. Method documentation is NOTE considered part of a measuring system.

3.20

SIST EN ISO 20988:2008 https://standards.iteh.ai/catalog/standards/sist/1a8c1d06-3568-4ab5-bfb1reference material 4589219fd184/sist-en-iso-20988-2008 RM

material or substance for which one or more properties are sufficiently homogeneous and well established to be used for the calibration and/or the validation of a measuring system

NOTE 1 Adapted from VIM:1993, 6.13.

NOTE 2 A reference material may be in the form of a pure or mixed gas, liquid or solid.

3.21

systematic effect

Influence causing a bias that is expected to occur consistently in each series of observations obtained in repeated or parallel execution of the measurement

3.22

random effect

influence causing either random variation or a bias of random value (inconsistent bias) in a series of observation obtained in repeated execution of the measurement

NOTE An effect exhibiting a fixed, but random value while executing the measurement repeatedly causes a bias of random value.

3.23

hias

systematic error of the indication of a measuring instrument

[VIM:1993, 5.25]

NOTE A bias of a series of observations about an accepted reference value can be caused either by systematic effects, or by random effects exhibiting (unknown) fixed values in the series of observations.

3.24

representativeness

ability of a series of observations to provide an unbiased estimate of a parameter of a specified statistical population

3.25

population

totality of items under consideration

[ISO 3534-1:2006, 1.1]

NOTE Ensemble of possible results of measurement which can be obtained for a unique measurand by all possible technical realizations of a specified method of measurement.

4 Symbols and abbreviated terms

| a | parameter (constant) |
|-----------------|---|
| b | parameter (constant) |
| С | parameter (constant) |
| c _i | sensitivity coefficient |
| $cov(x_i, x_k)$ | estimate of covariance between input quantities x_i and x_k |
| E(X) | expectation of random variable X |
| i | index SIST EN ISO 20988:2008 https://standards.iteh.ai/catalog/standards/sist/1a8c1d06-3568-4ab5-bfb1- |
| j | index 4589219fd184/sist-en-iso-20988-2008 |
| k | index |
| k _p | coverage factor |
| Κ | number |
| L | number of laboratories |
| М | number |
| Ν | number |
| р | coverage probability; level of confidence |
| $\sigma(x)$ | standard deviation of the population of a random variable X |
| s(x) | experimental standard deviation of data set $x(j)$ with $j = 1$ to N |
| t(p, v) | (1 - p)-quantile of Student's <i>t</i> -distribution of v degrees of freedom |
| u _B | uncertainty caused by bias |
| $u(x_i)$ | standard uncertainty of input value x_i |