INTERNATIONAL STANDARD

ISO 14807

First edition
2001-10-15

Photography — Transmission and reflection densitometers — Method for determining performance

Photographie — Densitomètres à transmission et à réflexion — Méthode pour la détermination de la performance

Reference number
ISO 14807:2001(E)

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Contents

Page

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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 14807 was prepared by Technical Committee ISO/TC 42, *Photography*.

Introduction

Over the past few years, the subject of densitometer performance specifications has been discussed at length, with the observation made that the densitometer customer is met with a plethora of claims and specifications, in a variety of formats, pertaining to densitometer performance. Furthermore, various manufacturers have often used different terminology for describing what is speculated to be the same characteristic. With this in mind, this International Standard was developed and it identifies three characteristics of performance: ISO repeatability, ISO stability and ISO bias estimate. Standardized methods for evaluating these characteristics are presented herein. Any or all three of these characteristics can be evaluated and used to describe the performance of an individual densitometer and will be useful in comparisons of the performance of densitometers.

The first two of these characteristics, ISO repeatability and ISO stability, are evaluated in such a way that, by use of suitable periodic sampling of production, a densitometer manufacturer can report average or typical repeatability and stability as specifications for a particular class, type or model of densitometer. However, ISO bias estimate cannot necessarily be meaningfully averaged over such a class, type or model, since by determining a mean bias estimate, any instruments that are biased positively will be offset by any that are biased negatively. Because of this, bias estimate for a class, type or model of densitometer (if determined as a simple arithmetic mean of the bias estimates determined for individuals of that class, type or model) is of limited (if any) value and should not be reported. If determined as such an arithmetic mean, it may only be meaningful if that entire class, type or model is fraught with a systematic design defect. There is currently no agreement as to the most meaningful way to provide an ISO bias estimate for a class, type or model of densitometer.

The standardized methods for determination of ISO repeatability and ISO stability provide manufacturers with a uniform basis for stating densitometer performance characteristics as specifications, thereby providing the customer with the most useful information.

To clarify and provide mutual understanding, a list of definitions applicable to the performance characteristics has been provided.

Photography — Transmission and reflection densitometers — Method for determining performance

1 Scope

This International Standard defines a common set of reporting parameters and describes the methods to be used in the determination and presentation of individual densitometer performance and manufacturer-reported performance specifications. This International Standard applies to transmission and reflection densitometers typically manufactured for and used by the photographic, graphic arts and radiographic trades.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 5-1:1984, *Photography — Density measurements — Part 1: Terms, symbols and notations*

ISO 5-2:2001, *Photography — Density measurements — Part 2: Geometric conditions for transmission density*

ISO 5-3:1995, *Photography — Density measurements — Part 3: Spectral conditions*

ISO 5-4:1995, *Photography — Density measurements — Part 4: Geometric conditions for reflection density*

ISO 554:1976, *Standard atmospheres for conditioning and/or testing — Specifications*

3 Terms and definitions

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

NOTE There are a number of terms that are commonly used in connection with the subject of measurement, such as bias, repeatability, stability and traceability. One can avoid confusion by using such terms in a way that is consistent with other international documents. Definitions of many such terms are given in the *International Vocabulary of Basic and General Terms in Metrology*[2] 1), the title of which is commonly abbreviated, as VIM. The VIM was developed by ISO Technical Advisory Group 4 (TAG 4).

3.1
true value (of a quantity)
value consistent with the definition of a given particular quantity

NOTE 1 This is a value that would be obtained by a perfect measurement.

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1) Throughout this International Standard, raised numbers in square brackets refer to informative documents listed in the bibliography.

NOTE 2 True values are by nature indeterminate.

NOTE 3 The indefinite article “a”, rather than the definite article “the”, is used in conjunction with “true value” because there may be many values consistent with the definition of a given particular quantity.

[VIM:1993, 1.19]

3.2
conventional true value (of a quantity)
value attributed to a particular quantity and accepted, sometimes by convention, as having an uncertainty appropriate for a given purpose

[VIM:1993, 1.20]

NOTE 1 “Conventional true value” is sometimes called **assigned value**, **best estimate** of the value, **conventional value** or **reference value**.

NOTE 2 An assigned value of a certified reference material is one type of conventional true value.

3.3
measurand
particular quantity subject to measurement

EXAMPLE Vapour pressure of a given sample of water at 20 °C.

NOTE The specification of a measurand may require statements about quantities such as time, temperature and pressure.

[VIM:1993, 2.6]

3.4
repeatability (of results of measurements)
closeness of the agreement between the results of successive measurements of the same measurand carried out under the same conditions of measurement

NOTE 1 These conditions are called **repeatability conditions**.

NOTE 2 Repeatability conditions include:

— the same measurement procedure

— the same observer

— the same measuring instrument, used under the same conditions

— the same location

— repetition over a short period of time.

NOTE 3 Repeatability may be expressed quantitatively in terms of the dispersion characteristics of the results.

[VIM:1993, 3.6]

3.5
experimental standard deviation
s
for a series of n measurements of the same measurand, the quantity s characterizing the dispersion of the results and given by the formula:

$$s = \sqrt{\frac{\sum_{i=1}^{n}\left(x_i - \overline{x}\right)^2}{n-1}}$$

x_i being the result of the ith measurement and $\overline{x}$ being the arithmetic mean of the n results considered

[VIM:1993, 3.8]

3.6
systematic error
mean that would result from an infinite number of measurements of the same measurand carried out under repeatability conditions minus a true value of the measurand

[VIM:1993, 3.14]

NOTE Like true value, systematic error and its causes cannot be completely known.

3.7
stability
ability of a measuring instrument to maintain constant its metrological characteristics with time

NOTE 1 Where stability with respect to a quantity other than time is considered, this should be stated explicitly.

NOTE 2 Stability may be quantified in several ways, for example:

— in terms of the time over which a metrological characteristic changes by a stated amount, or

— in terms of the change in a characteristic over a stated time.

[VIM:1993, 5.14]

3.8
error (of indication) of a measuring instrument
indication of a measuring instrument minus a true value of the corresponding input quantity

[VIM:1993, 5.20]

3.9
bias (of a measuring instrument)
systematic error of the indication of a measuring instrument

NOTE The bias of a measuring instrument is normally estimated by averaging the error of indication over an appropriate number of repeated measurements.

[VIM:1993, 5.25]

3.10
traceability
property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties

NOTE 1 The concept is often expressed by the adjective **traceable**.

NOTE 2 The unbroken chain of comparisons is called a **traceability chain**.

[VIM:1993, 6.10]

EXAMPLE If a ruler used to measure the width of a sheet of paper has been calibrated to a more accurate ruler and this, in turn, has been calibrated to precision gauge blocks, the measured value of the width of the paper would be **traceable** to the gauge blocks (provided the uncertainties of all steps are known).

3.11
calibration
set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards

[VIM:1993, 6.11]

3.12
reference material (RM)
material or substance one or more of whose property values are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials

[VIM:1993, 6.13]

3.13
certified reference material (CRM)
reference material, accompanied by a certificate, one or more of whose property values are certified by a procedure which establishes traceability to an accurate realisation of the unit in which the property values are expressed, and for which each certified value is accompanied by an uncertainty at a stated level of confidence

[VIM:1993, 6.14]

3.14
combined standard uncertainty
u_c
standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities, equal to the positive square root of a sum of terms, the terms being the variances or covariances of these other quantities weighted according to how the measurement result varies with changes in these quantities

[2.3.4 of the *Guide to the Expression of Uncertainty in Measurement*:1993 [1].]

3.15
coverage factor
k
numerical factor used as a multiplier of the combined standard uncertainty in order to obtain an expanded uncertainty

NOTE 1 A coverage factor, k, is typically in the range 2 to 3.

NOTE 2 The coverage factor is chosen based on the level of confidence desired. A coverage factor (k) of 2 generally will result in a level of confidence of approximately 95 %, and a coverage factor of 3 generally will result in a level of confidence of approximately 99 %. This association of confidence level and coverage factor is based on assumptions regarding the probability distribution of measurement results. For a more thorough explanation, the *Guide to the Expression of Uncertainty in Measurement*: 1993 [1] should be consulted.

[This definition and the first note are taken from 2.3.6 of the *Guide to the Expression of Uncertainty in Measurement*:1993 [1].]

3.16
expanded uncertainty
U
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

[2.3.5 of the *Guide to the Expression of Uncertainty in Measurement*:1993 [1].]

NOTE Expanded uncertainty is the product of the combined standard uncertainty (u_c) and the chosen coverage factor (k).

4 Sampling and handling

In determining any of the ISO performance characteristics of an individual densitometer, the densitometer shall be stored, handled and operated in accordance with the manufacturer's instructions. Alternatively, a user may wish to evaluate the performance of a densitometer when operated in conditions or by following methods not recommended by the manufacturer. In the latter case, though the evaluation may prove useful for a particular application, the results of such an evaluation shall not be reported as “ISO repeatability”, “ISO stability” or “ISO bias estimate”. In such a case, any deviation from the manufacturer's instructions should be reported.

In a manufacturer's determination of performance specifications of ISO repeatability and ISO stability, it is important that the densitometers evaluated yield results that may be expected by users. This will require evaluation of a statistically valid sampling of densitometers periodically, following the procedures set forth in this International Standard. During the time period from manufacture through evaluation, it is important that the densitometers are stored, handled and operated in accordance with the manufacturer's instructions in order that the results are representative of the performance obtained by a user when operating the densitometer according to normal procedures as set forth in the densitometer's operating manual.

5 Determination of performance

5.1 General

Colour densitometers have multiple spectral responses, or colour channels, (typically red, green, blue and visual) and as such have the possibility of different performance for each of these channels. To be inclusive, repeatability, stability and bias estimate should be determined for each colour channel.

For a colour densitometer, performance when measuring spectrally selective materials cannot be construed to be equivalent to performance assessed with spectrally non-selective reference materials. For such measurements, appropriate spectrally selective references shall be used.

In the evaluations carried out in 5.2, 5.3 and 5.4, it is extremely important to avoid confusion between the uniformity of the specimen and the characteristic of the instrument under evaluation. In order that specimen non-uniformity is not misconstrued as poor instrument performance, proper care should be taken to assure that the measurements are made at the same position on the specimen.

5.2 Repeatability determination

Stable specimens shall be selected with densities that cover at least 80 % of the stated operating range of the densitometer. There shall be at least three density levels, and they shall be roughly evenly spaced over the range.

Covering 80 % of the stated operating range means, for example, that for a densitometer with a stated operating range of 0,0 to 4,0, the densities of the lightest and darkest specimens selected should differ by no less than 0,80 × (4,0 – 0,0) or 3,2. See 6.2, example 1.

The densitometer and specimens shall be in equilibrium with the environmental conditions in a room where the air is maintained at 23 °C ± 2 °C (see ISO 554) and (50 ± 20) % relative humidity. Following warm-up, calibration and other normal starting procedures (as provided to users in the operating instructions), repeatability shall be assessed by making several independent measurements of the density of each specimen over a short period of time, and calculating the experimental standard deviation, s, of these measurements. The number of measurements, n, shall be large enough to ensure that additional measurements do not significantly affect s. The arithmetic mean of the measurements, $\bar{x}$, and the experimental standard deviation, s, shall be recorded for each specimen. The time period within which these measurements are performed shall be short enough that the measurement results are not affected by any changing conditions or instrument drift.

5.3 Stability determination

Stability shall be determined by performing the tests of 5.3.1 and 5.3.2 while operating the densitometer in accordance with the manufacturer's instructions (see clause 4).

Some manufacturer's instructions may recommend recalibrating, rezeroing, or otherwise adjusting the densitometer at a specific time interval or after a specific number of measurements. Additionally, some densitometers automatically recalibrate, rezero or otherwise automatically adjust at a pre-programmed time interval. In order for the stability determination(s) to be indicative of the performance that the user should expect, the manufacturer's normal operating instructions regarding recalibrating, rezeroing and otherwise adjusting shall be adhered to. For any densitometers that employ automatic recalibration, rezeroing or other automatic adjusting features, such features shall be fully operational during testing.

In cases wherein such operating instructions or the use of such automatic features is optional for the normal user according to the manufacturer, pertinent details of the stability determination procedure shall be reported with the results.

Some users may wish (for experimental purposes) to evaluate densitometer stability without following the manufacturer's instructions regarding recalibrating, rezeroing or otherwise adjusting. Similarly, some users may wish to evaluate densitometer stability with automatic features turned off or disabled. The procedures of 5.3.1 and 5.3.2 may be useful for such evaluations, but results shall not be reported as "ISO 8 h stability" or "ISO 7 day stability".

NOTE In 5.3.1 and 5.3.2, standard deviations are determined in order to quantify the dispersion of the means of small groups of measurement results over the specified time periods. It is recognized that, when considered individually, these standard deviations give little if any information regarding stability. However, when they are compared to each other and to values reported for other densitometers, the standard deviations are expected to be useful for comparing densitometers' stabilities.

5.3.1 8 h stability determination

Stable specimens shall be selected with densities that cover at least 80 % of the stated operating range of the densitometer. There shall be at least three density levels, and they shall be roughly evenly spaced over the range. The densitometer and specimens shall be in equilibrium with the environmental conditions in a room where the air is maintained at 23 °C ± 2 °C (see ISO 554) and (50 ± 20) % relative humidity.

Following warm-up, calibration and other normal starting procedures (as provided to users in the operating instructions), five density measurements of each specimen shall be made over a short period of time at the start of a period of 8 h. This "short period of time" (during which the five measurements are made), shall be small enough to ensure that, within the short period, the results are not affected by any changing conditions or instrument drift. The arithmetic mean of this initial set of five measurements shall be determined.

Without manually recalibrating, rezeroing or otherwise adjusting (except as directed by the manufacturer's instructions), and without changing any conditions in the interim, similar sets of five density measurements of each specimen shall be made repeatedly at equally spaced time intervals over a period of 8 h. As was done for the initial set of five measurements, the arithmetic mean shall be determined for each of these subsequent sets of five measurements.

Next, determine and record the experimental standard deviation of these mean values.

The number of sets of measurements shall be large enough (and thus, the time interval between sets shall be small enough) to ensure that additional sets of measurements do not significantly affect the standard deviation of the means.

5.3.2 7 day stability determination

Stable specimens shall be selected with densities that cover at least 80 % of the stated operating range of the densitometer. There shall be at least three density levels, and they shall be roughly evenly spaced over the range.

The densitometer and specimens shall be in equilibrium with the environmental conditions in a room where the air is maintained at 23 °C ± 2 °C (see ISO 554) and (50 ± 20) % relative humidity.

Following warm-up, calibration and other normal starting procedures (as provided to users in the operating instructions), five density measurements of each specimen shall be made over a short period of time at the start of a period of 7 days. This “short period of time” (during which the five measurements are made), shall be small enough to ensure that, within the short period, the results are not affected by any changing conditions or instrument drift. The arithmetic mean of this initial set of five measurements shall be determined.

Without manually recalibrating, rezeroing or otherwise adjusting (except as directed by the manufacturer's instructions), and without changing any conditions in the interim, similar sets of five density measurements of each specimen shall be made repeatedly at equally spaced time intervals over a period of 7 days. As was done for the initial set of five measurements, the arithmetic mean shall be determined for each of these subsequent sets of five measurements.

Next, determine and record the experimental standard deviation of these mean values.

The number of sets of measurements shall be large enough (and thus, the interval between sets shall be small enough) to ensure that additional sets of measurements do not significantly affect the standard deviation of the means.

NOTE It is expected that in most determinations, the 8 h stability test would be conducted concurrently with the first 8 h of the 7 day stability test.

5.4 Bias estimate determination

NOTE 1 Since bias is defined in terms of systematic error, and since systematic error cannot, by definition, be completely known, one cannot completely determine bias. Bias can, however, be estimated (see the note in 3.9).

Neutral and/or non-neutral certified reference materials (CRMs) should be selected with densities that cover at least 80 % of the stated operating range of the densitometer. There shall be at least three density levels, and they shall be roughly evenly spaced over the range. The densitometer and CRMs shall be in equilibrium with the environmental conditions in a room where the air is maintained at 23 °C ± 2 °C (see ISO 554) and (50 ± 20) % relative humidity.

Following warm-up, calibration and other normal starting procedures (as provided to users in the operating instructions), bias estimates are determined as follows. Several density measurements shall be taken at each of the density levels and the mean measurement result, $\overline{x}$, and experimental standard deviation, s, shall be determined and recorded for each. The number of measurements, n, shall be large enough to ensure that additional measurements do not significantly affect $\overline{x}$. The assigned value (see note 2 of 3.2) and expanded uncertainty of the assigned value (from the CRM's certificate) shall be recorded.

For thorough guidance concerning measurement uncertainty, it is recommended that one refer to the *Guide to the Expression of Uncertainty in Measurement* [1].

The bias estimate (the mean measurement result minus the assigned value) shall be calculated for each level assessed.

Bias estimates depend greatly on the degree of conformance of the densitometer’s spectral product(s) to the specifications of ISO 5-3 and on the spectral characteristics of the specimens whose densities are measured. As a result, generally, bias when measuring densities of spectrally non-selective specimens will be lower than when measuring densities of spectrally selective specimens. Similarly, an instrument which exhibits low bias in measurement of specimens produced with one set of colorants, even though these may be highly spectrally selective (printing inks, for example), will not necessarily exhibit low bias in measurement of specimens produced with other colorants (photographic dyes, for example). For this reason, it is important that the CRM used be identified when bias estimates are reported. Users should be aware that no single reference material can be used to estimate bias for all possible applications.

Finally, the uncertainty (u_b) of the bias estimate shall be estimated by a statistical combination of the experimental standard deviation (s) and the expanded uncertainty (U) and coverage factor (k) of the assigned value of the CRM as follows:

$$u_b = \sqrt{(U/k)^2 + s^2}$$

6 Reporting (individual instrument performance)

6.1 General

Acknowledging that colour densitometers have multiple spectral responses, or colour channels, the following characteristics should be reported for each channel. Alternatively, the worst-case channel data shall be reported for the entire instrument. When reporting ISO repeatability, ISO stability and ISO bias estimate, a description of the measurement (transmittance or reflectance, influx and efflux geometries, and influx and efflux spectra) shall be included with the reported data, using the functional notation of terms and symbols given in ISO 5-1 and exemplified in ISO 5-2, ISO 5-3, and ISO 5-4.

In no cases shall any of the terms “ISO Repeatability”, “ISO 8 h Stability”, “ISO 7 Day Stability” and “ISO Bias Estimate” be used for reporting performance unless they have been determined in accordance with the requirements of this International Standard.

6.2 Repeatability reporting

Repeatability assessed according to the requirements of this International Standard shall be reported as “ISO Repeatability”. The mean density measurement results, $\bar{x}$, and experimental standard deviations, s, determined in 5.2 shall be reported.

NOTE The following examples are for illustrative purposes only. It is not a requirement of this International Standard that results be reported in the format given in these examples, as long as all required values are reported.

EXAMPLE 1 For ISO standard diffuse status A blue transmission density; assessment of a densitometer with a stated operating range of 0 to 4:

ISO Repeatability for D_T(90° opal; S_H: ⩽ 10°; A_B)	
$\bar{x}$ = 0,039	s = 0,006
$\bar{x}$ = 1,625	s = 0,010
$\bar{x}$ = 3,851	s = 0,016

EXAMPLE 2 For ISO standard status E green reflection density; assessment of a densitometer with a stated operating range of 0 to 2,5:

ISO Repeatability for D_R(40° to 50°; S_A: 5°; E'_G)	
$\bar{x}$ = 0,022	s = 0,004
$\bar{x}$ = 0,985	s = 0,012
$\bar{x}$ = 2,106	s = 0,021

6.3 Stability reporting

Stability assessed according to the requirements of this International Standard shall be reported as “ISO 8 h Stability” and “ISO 7 Day Stability”. The initial means and the standard deviation of the mean values shall be reported.

NOTE The following examples are for illustrative purposes only. It is not a requirement of this International Standard that results be reported in the format given in these examples, as long as all required values are reported.

EXAMPLE 1 For ISO standard diffuse status A blue transmission density; assessment of 8 h stability of a densitometer with a stated operating range of 0 to 4:

ISO 8 h Stability for D_T(90° opal; S_H: ⩽ 10°; A_{B})	
initial mean	standard deviation of means
0,041	0,003
1,625	0,006
3,851	0,009

EXAMPLE 2 For ISO standard diffuse status A blue transmission density; assessment of 7 Day stability of a densitometer with a stated operating range of 0 to 4:

ISO 7 Day Stability for D_T(90° opal; S_H: ⩽ 10°; A_{B})	
initial mean	standard deviation of means
0,041	0,005
1,625	0,009
3,851	0,010

6.4 Bias estimate reporting

A bias estimate determined according to the requirements of this International Standard shall be reported as “ISO Bias Estimate”. The CRM shall be clearly identified, and its assigned value and expanded uncertainty of the assigned value shall be reported. The mean measurement result, $\overline{x}$, experimental standard deviation, s, and uncertainty of the bias estimate, u_{b}, as determined in 5.4 shall be reported.

For thorough guidance concerning measurement uncertainty, it is recommended that one refer to the *Guide to the Expression of Uncertainty in Measurement* [1].

NOTE The following example is for illustrative purposes only. It is not a requirement of this International Standard that results be reported in the format given in this example, as long as all required values are reported.

EXAMPLE For ISO standard visual diffuse transmission density; assessment of a densitometer with a stated operating range of 0 to 4:

ISO Bias Estimate for D_T(90° opal; S_H: ⩽ 10°; V_{T})					
CRM used: steps 1, 8 and 16 of NIST Standard Reference Material 1001 X-Ray Film Step Tablet					
CRM assigned value:	Expanded uncertainty (± U) of CRM assigned value:	Mean measurement result ($\overline{x}$):	Experimental standard deviation (s):	ISO Bias Estimate:	Uncertainty of bias estimate (u_{b}):
0,192	± 0,006 (k = 3)	0,182	0,003	– 0,010	0,004
2,061	± 0,006 (k = 3)	2,061	0,006	0,000	0,006
3,882	± 0,006 (k = 3)	3,866	0,009	– 0,016	0,009

7 Reporting (performance specifications)

After having evaluated repeatability and stability for a statistically valid sampling of densitometers of a particular class, type or model, a manufacturer may report the mean values for ISO repeatability and ISO stability as performance specifications. Performance specifications shall be reported according to the requirements of 6.1, 6.2 and 6.3.

In no cases shall any of the terms “ISO Repeatability”, “ISO 8 h Stability” and “ISO 7 Day Stability” be used for reporting performance specifications unless they have been determined in accordance with the requirements of this International Standard.

NOTE There is no requirement set forth by this International Standard that all aspects of densitometer performance be determined and reported. For example, a densitometer manufacturer may choose to report “ISO Repeatability” (see 6.2) without reporting “ISO Stability” (see 6.3). Similarly, “ISO 8 h Stability” may be reported without reporting “ISO 7 Day Stability” (see 6.3).

Bibliography

[1] BIPM/IEC/IFCC/ISO/IUPAC/IUPAP/OIML, *Guide to the Expression of Uncertainty in Measurement*, first edition (International Organization for Standardization, Geneva, Switzerland, 1993, corrected and reprinted in 1995).[2)]

[2] BIPM/IEC/IFCC/ISO/IUPAC/IUPAP/OIML, *International Vocabulary of Basic and General Terms in Metrology*, second edition (International Organization for Standardization, Geneva, Switzerland, 1993).[3)]

2) This document was prepared by ISO Technical Advisory Group 4 (TAG 4), Working Group 3 (WG 3). ISO/TAG 4 has as its sponsors the BIPM (Bureau International des Poids et Mesures), IEC (International Electrotechnical Commission), IFCC (International Federation of Clinical Chemistry), ISO (International Organization for Standardization), IUPAC (International Union of Pure and Applied Chemistry), IUPAP (International Union of Pure and Applied Physics), and OIML (International Organization for Legal Metrology). The document is published by ISO in the name of all seven organizations.

3) This document (the title of which is commonly abbreviated VIM) was prepared by ISO Technical Advisory Group 4 (TAG 4), Working Group 1 (WG 1). ISO/TAG 4 has as its sponsors the BIPM (Bureau International des Poids et Mesures), IEC (International Electrotechnical Commission), IFCC (International Federation of Clinical Chemistry), ISO (International Organization for Standardization), IUPAC (International Union of Pure and Applied Chemistry), IUPAP (International Union of Pure and Applied Physics), and OIML (International Organization for Legal Metrology). The document is published by ISO in the name of all seven organizations.

ICS 37.040.20

Price based on 11 pages