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☒ Comments by: **15 January 2019**

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INTERNATIONAL RECOMMENDATION

OIML R 129-1
Edition 201x (E)

Multi-dimensional Measuring Instruments

Part 1: Metrological and technical requirements

Instruments de mesure multidimensionnels

Partie 1: Exigences métrologiques et techniques

ORGANISATION INTERNATIONALE

DE METROLOGIE LEGALE

INTERNATIONAL ORGANIZATION

OF LEGAL METROLOGY

Table of Contents

Foreword

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Additionally, the OIML publishes or participates in the publication of **Vocabularies (OIML V)** and periodically commissions legal metrology experts to write **Expert Reports (OIML E)**. Expert Reports are intended to provide information and advice, and are written solely from the viewpoint of their author, without the involvement of a Technical Committee or Subcommittee, nor that of the CIML. Thus, they do not necessarily represent the views of the OIML.

This publication – reference OIML R 129-1, edition 201x (E) – was developed by Project Group 1 in the OIML Technical Subcommittee TC 7/SC 5 Dimensional Measuring Instruments. It was approved for final publication by the International Committee of Legal Metrology at its xx meeting in 201x.

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Bureau International de Métrologie Légale
11, rue Turgot - 75009 Paris - France
Telephone: 33 (0)1 48 78 12 82
Fax: 33 (0)1 42 82 17 27
E-mail: biml@oiml.org
Internet: www.oiml.org

Part 1: Metrological and technical requirements

1   Scope

This Recommendation specifies the metrological and technical requirements for the type evaluation of multi-dimensional measuring instruments used to determine the dimensions and/or dimensional volume of an object for the purpose of calculating charges for postage, freight or storage.

The instruments may be used in conjunction with a weighing instrument also used in the determination of charges in which case the procedure is usually for the dimensional volume to be calculated, a conversion factor applied and the resulting dimensional weight of the object compared to its weight to establish which quantity (the largest of measured weight or dimensional weight) will be used to determine the charges. In some cases dimensions other than volume (for example length plus girth) are used for determining charges. The Recommendation also includes type evaluation procedures, verification procedures and test procedures.

The requirements of this Recommendation apply to automatic and semi-automatic instruments, but they do not apply (for example) to simple linear measures such as tape measures. The instruments measure the length, width and height of a rectangular box and in some cases determine the dimensional volume of that box. If the object is not in the form of a rectangular box, the volume of the smallest rectangular box which fully encloses the object is determined (see 2.2.1).

Instruments may include two different measurement devices, each using a different method to measure one or two separate dimensions of an object. The instrument may measure the object whilst there is relative motion between the instrument and the object.

If the multi-dimensional measuring instrument is associated with a weighing instrument, which is also used for determining the charges, the requirements for the weighing instrument are included found in other the following OIML Recommendations:

(a) OIML R 76 *Nonautomatic weighing instruments* for nonautomatic weighing instruments; and

(b) OIML R 51 *Automatic catchweighing instruments* for automatic weighing instruments.

The requirements of this Recommendation may also be used, where applicable, for type evaluation and verification of other instruments which measure the dimensions and/or the volume of objects for applications other than for determining postage, freight or storage charges.

2   Terminology

The following terminology includes terms applicable to those instruments covered by this Recommendation and some general terms included in the International Vocabulary of Basic and General Terms in Metrology (VIM, OIML V2-200 Edition 2012) [1], and the International vocabulary of terms in legal metrology (VIML, OIML V1, Edition 2013) [2] and in some cases the Alphabetical list of 2.1.1 terms defined in OIML Recommendations and Documents (OIML G 18:2010) [3].

2.1   General terms

multi-dimensional measuring instrument

instrument that measures the dimensions of an object and determines the length (L), width (W) and height (H) of the smallest rectangular parallelepiped (rectangular box) which fully encloses that object.

2.1.1.1   length (L)

a linear measured dimension that is measured horizontally relative to the instrument

2.1.1.2   width (W)

a linear measured dimension that is measured horizontally relative to the instrument and at 90 degrees relative to the length

2.1.1.3   height (H)

a linear, measured dimension that is oriented 90 degrees ~~vertically above the~~relative to the length and width dimensions

<mark>Question: Is the PG happy with these definitions for length (L), width (W) and height (H)? Should each term include "the maximum linear dimension . . ."?</mark>

device

identifiable instrument or part of an instrument or family of instruments that performs a specific function or functions.

Note: A device may be a stand-alone and complete measuring instrument (for example: counter scale, electricity meter) or part of a measuring instrument (for example: printer, indicator) (OIML D 11, 2.1.2 3.3 [3])

measuring instrument

device used for making measurements, alone or in conjunction with one or more supplementary devices

Note: A measuring instrument that can be used alone is a measuring system [VIM 3.1]

2.1.3

processor

a device that contains all the necessary information and receives all the necessary signals from the 2.1.4 measuring device to enable it to calculate the volume or other associated quantities.

Note: It may also store information, provide checking facilities for the information and communicate with auxiliary devices.

indicator

2.1.5 a device that displays the measured dimensions and the associated quantities calculated by the processor.

2.1.6   **ancillary device**

device intended to perform a particular function, directly involved in elaborating, transmitting or displaying measurement results (OIML VIML 5.06)

Note 1 An ancillary device may or may not be subject to legal metrological control according to its function in the measuring system or to national regulations

Note 2 Main ancillary devices are:
- zero setting device;
- repeating indicating device;
- printing device;
- memory device;
- price indicating device;
2.1.7
- totalizing indicating device;
- pre-setting device;
- self-service device
2.1.8

semi-automatic instrument

instrument requiring the intervention of an operator to carry out the measurements but automatically 2.1.9 determines the results.

automatic instrument

instrument that measures without the intervention of an operator ~~and follows a pre-determined program of automatic processes characteristic of the instrument.~~

multi-interval instrument

measuring instrument having one dimensional measuring range for each axis which is divided into partial measuring ranges each with different scale intervals, with the measuring range determined automatically according to the dimension being measured.

~~**2.1.10 electronic device**~~

~~device employing electronic sub-assemblies and performing a specific function, usually manufactured as a separate unit and is capable of being independently tested.~~

~~*Note:*   An electronic device as defined above, may be a complete measuring instrument or part of a measuring instrument.~~

~~**2.1.11 electronic sub-assembly**~~

~~part of an electronic device employing electronic components and having a recognizable function of its own. (OIML G 18:2010 (E) [ID 01636]~~

maximum measuring speed (V_{max})

the maximum speed at which the instrument will measure correctly.

Note: Only applicable to instruments where measurements are affected by means of relative movement between the object and the instrument

~~2.1.15~~2.1.10   **minimum measuring speed (V_{min})**

the minimum speed at which the instrument will measure correctly.

~~2.1.16~~2.1.11 *Note:*   Only applicable to instruments where measurements are affected by means of relative movement between the object and the instrument

indication

quantity value provided by a measuring instrument or measuring system [VIM 4.1].
~~2.1.12~~

2.2   Measurement terms

~~2.2.1~~   **rectangular box (rectangular parallelepiped)**

polyhedron having six faces that are parallel in pairs having dihedral angles as right angles.

~~2.2.2~~   **irregular shaped object**

object other than a rectangular box.
~~2.2.3~~
measured dimensions

length (L), width (W) or height (H), measured by the measuring instrument, of the smallest rectangular
~~2.2.4~~ box which fully encloses the object.

dimensional volume (Dim Vol or DV)

volume of the smallest rectangular box which fully encloses the object, ~~that is calculated using the measured dimensions~~and is the product of the indicated values of length (L), width (W) and height (H)
~~2.2.6~~2.2.5 ~~(= L x W x H)~~.

~~Note this change from "volume" to "dimensional volume". Do members of the PG agree with this change?~~

~~2.2.7~~2.2.6   **maximum dimension (max)**

~~2.2.8~~2.2.7 maximum measurable dimension for each axis as specified by the manufacturer for the measuring instrument.

minimum dimension (min)

value of the smallest measured dimension for each axis, ~~determined as a function of the division size.~~

dimensional weight (Dim Wt or DW)

calculated value obtained by applying a conversion factor to the object's dimensional volume (see 2.2.4) or measured dimensions (see 2.2.3).

conversion factor (F)

factor applied to the volume or dimensions of an object to determine its dimensional weight.

scale interval (d)

~~a~~ value, expressed in units of the measured quantity, of the difference between the values corresponding to two consecutive scale marks for analog indication, or two consecutive indicated values for digital indication.

~~2.2.9~~2.2.8

2.3   Performance terms

~~2.2.10~~2.2.9

error of indication

indicated value minus a reference quantity value [VIML 0.04].

2.3.1 **intrinsic error**

error of a measuring instrument determined under reference conditions [VIML 0.06].

2.3.2 **initial intrinsic error**

intrinsic error of a measuring instrument as determined prior to performance tests [VIML 5.11]

2.3.3 **maximum permissible error (mpe)**

extreme value (positive and negative) of the error of indication permitted by specifications,
2.3.4 Recommendations, regulations etc.

Note: The absolute value of the mpe is the same value without sign [VIM 4.26].

2.3.5 **fault**

difference between the error of indication and the intrinsic error of a measuring instrument [VIML 5.12].

Note 1:   Principally a fault is the result of an undesired change of data contained in, or flowing through, an electronic measuring instrument.

Note 2:   From the definition it follows that a "fault" is a numerical value which is expressed either in a unit of measurement or as a relative value, for instance as a percentage.

2.3.6

fault limit

2.3.7 value specified in the applicable Recommendation delimiting non-significant faults.[VIML 5.13].

significant fault

fault ~~greater than one scale interval (d)~~exceeding the applicable fault limit value. [VIML 5.14]

Note: The following faults are not considered to be significant, even when they exceed the value defined above:

(a)   faults arising from simultaneous and mutually independent causes in the measuring instrument itself;

(b)   faults implying the impossibility to perform any measurement;

2.3.8   (c)   transitory faults being momentary variations in the indication, which cannot be interpreted, memorized or transmitted as a measurement result; and

(d)   faults giving rise to variations in the measurement result so serious that they are bound to be noticed by all those interested in the result of the measurement.

influence quantity

quantity that, in a direct measurement, does not affect the quantity that is actually measured, but affects the relation between the indication and the measurement result.[VIM 2.52].

2.3.8.1   influence factor

influence quantity having a value within the rated operating conditions of the measuring instrument, specified in this Recommendation.

2.3.8.2   disturbance

influence quantity having a value within the limits specified in this Recommendation, but outside the specified rated operating conditions of the measuring instrument.

Note: An influence quantity is a disturbance if for that influence quantity the rated operating conditions are not specified.

rated operating conditions

operating condition that must be fulfilled during measurement in order that a measuring instrument or measuring system perform as designed [VIM 4.9]

reference conditions

2.3.9 set of specified values of influence factors fixed to ensure valid intercomparison of results of measurements [VIM 4.11].

2.3.10   **performance**

ability of the measuring instrument to accomplish its intended functions.

2.3.11 **2.4   Testing terms**

test

series of operations intended to verify the compliance of the EUT with certain requirements.
2.4.1

test procedure

2.4.2 detailed description of the tests.

2.4.3   **test program**

description of a series of tests for a certain type of equipment.

2.4.4   **performance test**

test intended to verify whether the EUT is able to accomplish its intended functions.
2.4.5

test object

object whose dimensions are verified by appropriate reference standards and intended to verify the compliance of the EUT with certain metrological requirements.

2.5   Other definitions

2.5.1 This clause defines terms applicable to multidimensional measuring instruments, the assessment of multivariate calibrations and also includes definitions from OIML D 11 General requirements for electronic measuring instruments [3] and OIML D 31 General requirements for software controlled measuring instruments [4].

2.5.2   **cryptographic means**

encryption of data by the sender (storing or transmitting program) and description by the receiver (reading program) with the purpose of hiding information from unauthorised persons. Electronic signing of data with the purpose of enabling the receiver or user of the data to verify the origin of the data, i.e. to prove their authenticity [D 31, 3.1.11]

legally relevant

software/hardware/data or part of the software/hardware/data of a measuring instrument which interferes with properties regulated by legal metrology, e.g. the accuracy of the measurement or the correct functioning of the measuring instrument [D 31, 3.1.29]

open network

network of arbitrary participants (electronic devices with arbitrary functions). The number, identity and location of a participant can be dynamic and unknown to the other participants [D 31, 3.1.35]

universal computer

computer that is not constructed for a specific purpose but that can be adapted to the metrological task by software. In general this software is founded on an operating system that permits loading and
2.5.3 execution of software for specific purposes [D 31, 3.1.54]

(software) validation

2.5.4 confirmation by examination and provision of objective evidence (i.e. information that can be proved true, based on facts obtained from observations, measurement, test, etc.) that the particular requirements for the specific intended use are fulfilled [D 31, 3.1.56]

2.5.5 _____

3   Units of measurement

The following units of measurement and their symbols shall be used:

Table 1: Units of measurement and their symbols

	Unit	Symbol
Length:	metre	m
	centimetre	cm
	millimetre	mm
Volume:	cubic metre	m^3
	cubic decimetre	dm^3
	cubic centimetre	cm^3

4   Metrological Requirements

4.1.1
4.1   Maximum permissible errors and minimum dimension

Scale intervals, minimum dimension

The lower limit of the minimum dimension for all values of the scale interval is given in Table 12.

Table 12: Scale intervals and minimum dimension

Scale interval (d)	Minimum dimension (min) (lower limit)
d ≤ 2 cm	10 d
2 cm < d ≤ 10 cm	20 d
10 cm < d	50 d

4.1.3 4.1.2

Note: Where an instrument can meet a lower minimum dimension limit, it can be specified by the national authority according to 5.3.1.

Value of mpe

The mpe applicable to the measurement by the instrument of any of the three dimensions for initial and subsequent verification is ± 1.0 d.

Value of the fault limit

The value of the fault limit is one scale interval (d).

Maximum permissible variation between indicators

There shall be no difference between the indications of the same quantity on different digital indicators.

Multi-interval instruments

4.1.44.1.3 For multi-interval instruments with scale intervals of d_1, d_2...d_r, the ~~mpes~~mpe are ± 1 d_1, ± 1 d_2... ± 1 d_r for the applicable range and axis.

4.1.54.1.4

Calculated quantities

4.1.64.1.5 For all calculated quantities included in the transaction, the indicated quantity shall equal the quantity obtained by using the indicated values included in the calculation together with any rounding applied. If the indicated, calculated quantity, is rounded it shall be rounded to ± 0.5 scale intervals.

4.1.84.1.6

Rules for the determination of errors

The rules for the determination of errors are as follows:

4.1.94.1.7 (a) ~~When a test is conducted, t~~The expanded uncertainty (coverage factor k = 2) of the determination of the errors on indications of dimensions shall not be greater than one-~~fifth~~ third of the mpe specified (see GUM).

(b) The mpe~~s~~ appl~~ies~~y to all instruments irrespective of their principles of operation. Limitations of use as marked on the instrument may apply, for example with respect to the position, shape and material of the object.

(c) The mpe specification in 4.1.2 to 4.1.5 is applicable to all indications included in the transaction as appropriate.

(d) The initial intrinsic error is found at reference conditions of 20 ºC ± 5 ºC, ambient atmospheric pressure, nominal voltage and 50 % ± 15 % relative humidity.

4.2   ~~4.2~~ Influence factors

4.2.1

~~Influence factors under r~~Rated operating conditions

Instruments shall be designed and manufactured such that they do not exceed the mpe~~s~~ when exposed to the following ranges of environmental conditions:

(a) mains power voltage variations: – 15 % to + 10 % of nominal voltage;

(b) air temperature variations if no temperature limits are stated in the descriptive markings: – 10 ºC to + 40 ºC

(b)(c)   relative humidity of 85% at high temperature limit.

An electronic instrument powered by direct current shall either continue to function correctly or not indicate any quantity when the voltage is below the manufacturer's specified nominal voltage.

~~The indication for the same input shall remain within the mpesmpe when applied to reference conditions before and after the test (see 4.1.6(d)) and when applied to the test conditions specified in (a) A.2.4 and (b) A.2.2.~~

If special temperature limits are stated in the descriptive markings, the range shall be at least 30 degrees Celsius.

~~**4.2.2 Humidity**~~

~~All measuring instruments shall be subjected to the damp heat steady state test described in A.2.2.~~

~~The indication for the same input shall remain within the mpes when applied at reference conditions before and after the test (see 4.1.6(d)) and when applied at the test conditions specified in A.2.2 after 48 h at these conditions.~~

~~<mark>Question: Does the PG agree with the proposal to add:</mark>~~

"(c) relative humidity of 85% at high temperature limit"

as an additional condition in 4.2.1 and to delete the requirement for this test as suggested in comment #47 of the combined comments?

4.3   Disturbances

4.3.1 Disturbance applied to measuring instrument

An instrument shall be designed and manufactured such that, when exposed to disturbances, either:

(a) significant faults do not occur; or

(b) significant faults are detected and acted upon.

4.3.1 *Note:*   A fault equal to, or smaller than, d is allowed during the disturbance irrespective of the value of the error of indication prior to the disturbance.

Disturbance applied to devices

The requirement in 4.3.1 may be applied separately:

4.3.2 (a) to each individual cause of significant fault; and/or

(b) to each part of the electronic instrument.

The choice whether (a) or (b) is applied is left to the manufacturer.

Tests for disturbances; severity levels

4.3.3 Instruments shall be tested so as to determine if they will withstand the appropriate disturbances as listed in Table A.1 when subject to the applicable severity levels given in A.3.

4.3.4   Light and acoustic effects

Instruments based on light or acoustic measuring techniques shall remain within the mpe when subjected to the applicable light or acoustic disturbances described in A.4.

5   Operational requirements

5.1.1 5.1   General

Fraudulent use

5.1.2 Instruments shall not facilitate fraudulent use, either by accidental or by deliberate means when using the instrument in the normal manner.

5.1.3   Suitability of construction

Instruments shall be constructed so that all controls, indicators, etc. are suitable for operation under normal conditions of use.

Suitability for verification

5.1.4 Instruments shall be constructed so that the performance requirements of this Recommendation can be applied.

If in normal operation the instrument indicates the volume and not the dimensions, a test mode shall be provided to display or print out the dimensions.

Zero or ready adjustment

Instruments shall be provided with facilities to set the instrument to, and maintain it at, zero or ready condition. This shall only be possible without an object in the measurement area and shall be indicated by a zero indication, a ready light or a similar display. Either this condition is met automatically for each measurement or the instrument is automatically inhibited.

Tare device

a) The tare function shall only operate subtractively.

b) The value of the tare scale interval shall be the same as the scale interval of the respective axis and range.

c) Operation of tare shall be indicated.

5.1.5   **Warm-up**

As soon as the instrument indicates or transmits the measurement results after the warm-up period following switch-on, the indications shall be within ~~mpes~~mpe.

5.2   Indicators and printing devices

5.1.6
          General

(a) An instrument shall have either:

- an indicator which displays the measurement results

5.2.1
- a printer which prints the measurement results

(b) It may also have a device to transmit, store and preserve measurement results so that they can durably be reconstructed from the stored data. Printing or storage of indications for subsequent indication, data transfer, totalising etc. shall be inhibited when the instrument equilibrium is not stable.

(c) In the case of an instrument used for direct sales to the public, all indications shall be available to the customer.

(d) The indication shall be automatically displayed or printed out following each step in the process or be readily available by a simple action of the operator, for example by pressing a key.

(e) Other indications such as dimensional weight, weight conversion factors etc. may be displayed or printed out. Indications may either be automatically displayed or printed out following an appropriate step in the process, or be readily available by a simple action of the operator.

(f) The ~~indications~~ indicated measurements for an object must persist long enough so that they may be easily read by an observer. The indications should be clearly assignable to a specific object. ~~shall remain until the next new object is detected. The previous displayed indications shall not persist for longer than 1 s after a new object is detected in the measurement area.~~

(g) When an instrument is fitted with an extended indication device, displaying the indication with a scale interval smaller than d shall be possible only:

- while pressing a key; or

- for a period not exceeding 5 s after a manual command by the operator.

Printing and data transmission shall be restricted while the extended indicating device is in
5.2.2   operation. ~~In any case printing out of extended indication shall not be possible.~~

~~(i)~~(h)   Instruments used for direct sales to the public shall not have any extended indicating device.

~~(j)~~(i)All indications shall be identified either by the full name or abbreviations (see 5.2.9).

Presentation of indications

Printed and displayed indications shall be reliable, clear and unambiguous and printing shall be indelible. Figures forming the results shall be of a size, shape and clarity for reading to be easy.

Digital indications shall be stable around the changeover point. All digits on displays and tickets shall be oriented in the normal viewing position and shall permit reading by simple juxtaposition.

Units of measurement

All printed and displayed indications shall include the name or symbol of the unit of measurement. On tickets, the name or symbol may be printed out by the printer or pre-printed on the ticket.

For each indication of a quantity only one unit of measurement for that quantity shall be used, for example cm only, not m and cm, and the unit of measurement shall be the same for each axis.

5.2.3 **Value of the scale interval**

The value of all scale intervals shall be in the form 1, 2 or 5 x 10^n where n is a positive or negative whole number or zero.

The value of the scale interval shall be:

5.2.4 (a) the same for each axis; or

(b) different for one axis from the other two provided that instructions are marked on the instrument specifying any limitations of use; alternatively indication of incorrect use shall be given; or

(c) variable (for example multi-interval) on one or more axes provided that:

- if all three axes are multi-interval, then $d_{x1} = d_{y1} = d_{z1}$, $d_{x2} = d_{y2} = d_{z2}$, ... , $d_{xr} = d_{yr} = d_{zr}$;

- if two axes are multi-interval, for example x and y, and z is fixed, then $d_{x1} = d_{y1}$, $d_{x2} = d_{y2}$, ... , $d_{xr} = d_{yr}$, and instrument limitations such as object size, placement, etc. are clearly marked to define how to operate the instrument; and

- if only one axis is multi-interval, for example x, and y and z are fixed, then $d_y = d_z$ and instrument limitations such as object size, placement, etc. are clearly marked to define how to operate the instrument.

5.2.5 **Decimal numbers**

If the indication is expressed in a decimal form, there shall be ~~at least~~ one zero preceding the decimal mark for values less than one.

The decimal mark on tickets shall be printed out with the measured value by the printer, with ~~at least~~ one zero preceding the decimal mark for values less than one.

One or more fixed zeros may be used to the right of the variable numbers for values greater than one. Please note that all the decades to the right of the decimal point or comma must be active and the least significant digit should correspond to the scale interval.

5.2.6 Printed numbers and symbols shall be at least 2 mm high.

Limits of indication

~~Indications~~ Displaying or printing ~~of~~ the quantity value of any dimension ~~must~~ shall either be inhibited, or ~~indicate~~ an error message shall be included together with ~~its~~ the measurement indication, if the axis being measured:

5.2.7 (a) is ~~smaller~~ shorter than the minimum dimension marked on the device; or

(b) is larger than the maximum dimension marked on the device plus 9d; or

(c) has dimensions that exceed the measurement capability of the instrument.

5.2.8 **Multi-interval instruments**

For each partial measuring range, the following apply:

(a) scale intervals $d_1 < d_2 < d_3 ... < d_r$; and

(b) min = min1, max = max r, max1 = min2, etc.

Multi-instrument system

A number of measuring devices may be connected to one indicating device to form a multi-instrument system. The following requirements apply.

If the indicator is not within adequate proximity to each measuring device to allow easy testing, a test indicator shall be provided. It shall be possible for the test indicator to be readily connected to each measuring device without affecting the performance of that device. The test indicator shall agree exactly with the common indicator in regard to the indications being tested.

The indication from each measuring device shall be clearly identified with the device on the common indicator.

Printed and display information

5.2.9.1 Any printed ticket or displayed indication shall include sufficient information to identify the transaction, for example:

(a) dimensions: length (*L*), width (*W*) and height (*H*);

5.2.9   (b) dimensional volume (Dim Vol … L of DV … L);

(c) weight (Wt) if the instrument includes a weighing instrument;

(d) dimensional weight (Dim Wt ... kg or DW ... kg);

(e) dimensional tare (DT ... kg) or linear tare (LT…..cm);

(f) conversion factor (F);

(g) quantity for charging, for example dimensions, vol or DW ... kg;

(h) price rate and price; and

(i) date, transaction number or other identification of the object.

When the customer is not present during the measurement process the above information need not be displayed or printed out at the time but shall be available on request, e.g. retrievable from a data storage device.

Note 1: Icons may be used to identify indications.

Note 2: ~~When the customer is not present during the measurement process the above information need not be displayed or printed out at the time but shall be available on request, e.g. retrievable from a data storage device (which shall have sufficient storage capacity for the intended purpose).~~

Note 2~~3~~: The price interval and the price rate shall comply with the national regulations applicable for trade.

5.2.9.2 A printed ticket shall also contain the following printed or pre-printed information:

(a) that the dimensions and/or volume shown are those of the smallest rectangular box that fully encloses the object; and

(b) that the dimensional weight is a calculated value obtained by applying a conversion factor to the object's volume or dimensions.

~~5.2.10 Stability~~

5.3.1   ~~Printing or storage of indications for subsequent indication, data transfer, totalizing, etc., shall be inhibited when the equilibrium is not stable. Stable equilibrium is considered to be achieved when, over a period of 5 s before printout, calculation of dimensional volume or data storage, no more than two adjacent values are indicated, one of which is the printed or stored value~~.

5.3 Markings

Nameplate

Instruments shall be clearly and permanently marked on a permanently attached nameplate in the vicinity of the indicating device with the following information:

(a) manufacturer's name or mark;

(b) model designation;

(c) serial number of instrument and year of manufacture;

(d) type evaluation mark;

(e) the maximum and minimum dimensions for each axis in the form max = …   min = ... ;

(f) if measurements are affected by means of relative movement between the object and the instrument the maximum and minimum measuring speeds for which the instrument will measure correctly in the form V_{max} = ... m/s, V_{min} = … m/s;

(g) scale interval(s) for each axis and range (multi-interval) in the form d = ... ;and

(h) temperature limits (if other than – 10 ºC to + 40 ºC);

~~Notices~~Technical specifications

Any ~~special notice~~specifications or limitation of use relating to the instrument or the objects being measured shall be ~~clearly marked on a notice visible~~visibly and clearly presented to the operator on the instrument and/or in an operator's manual~~., for example~~Such specifications or limitations could include, but not be limited to:

5.3.2

(a) special application if used for a purpose other than determining postage, freight or storage charges;

(b) minimum spacing between successive objects;

(c) ~~if~~ whether the instrument can measure only rectangular boxes;

(d) ~~if~~ whether the box has to be located in a particular position;

(e) any limitation of the surface characteristics of the objects being measured;

(f) that the dimensions and/or volume shown are those of the smallest rectangular box that fully encloses the object; and

(g) that the dimensional weight is a calculated value obtained by applying a conversion factor to the object's volume or dimensions.

5.4   ~~VERIFICATION MARK AND SEALING~~Verification mark

5.4.1   **Verification mark**

Provision shall be made for the application of a verification mark either on a nameplate, a stamping plug or on an adhesive label. The following requirements apply:

(a) the mark shall be easily affixed without affecting the metrological properties of the instrument;

(b) the mark shall be visible without moving or dismantling the instrument when in use;

(c) the part on which the mark is located shall not be removable from the instrument without damaging the mark; and

(d) the size of the space shall be sufficient to contain the marks applied by the verifying authority: for example an area of at least 200 mm^2.

Note: If technical reasons restrict or limit the verification mark(s) to be fixed only in a "hidden" place (e.g. when
~~5.4.2~~1.1.1   an instrument – in combination with another device – is integrated in other equipment) this can be accepted if these marks are easily accessible, and if there is a legible notice provided on the instrument ~~in~~ at a clearly visible place that ~~points~~provides direction to these marks or if its location is defined in the operation manual, the OIML Certificate and OIML Test Report.

~~Sealing~~

~~Provision shall be made for sealing those devices and parameters that have a metrologically significant effect and that determine the measurement result. This may include devices and parameters which affect the configuration of the instrument as well as those which affect the calibration.~~

~~Sealing may be by mechanical or electronic means. Mechanical means include those where access to an electronic means of changing the parameters (for example via a keyboard) is prohibited by a mechanical seal.~~

~~The requirements for applying a mark to a mechanical seal are the same as those for 5.4.1.~~

~~The requirements for electronic seals are as follows:~~

(a) Access by authorized persons shall be protected by some form of physical key or a password or access code (for example a four digit code).

(b)(a) Any access to alter protected parameters shall be automatically recorded (for example by means of a counter which automatically increments when access is initiated).

(c)(a) The record shall be readily accessible by a simple action (for example by display of the counter when a button identified as being for this purpose is pressed, or during the indication check).

(d)(a) The record shall be readily identifiable as such and shall not be easily confused with other indications of the instrument.

(e)(a) A reference record in the same form as the incremental record shall be permanently marked on the instrument to indicate that the parameters have been accessed since the last verification (for example the reference record could be associated with the verification mark).

(f)(a) The record shall not repeat in a sequence of less than 999 alterations. It shall also persist reliably for a period of at least two years (unless it is overwritten by a further alteration).

(g)(a) The record shall persist through tests for influence factors and disturbances specified in this Recommendation.

5.5   Instrument construction

General

5.5.1 Measuring instruments shall be constructed so that they comply with the following metrological and technical requirements and will thus be suitable for use.

5.5.2   Interfaces for peripheral devices

An instrument may be equipped with interfaces permitting the coupling of any ~~ancillary~~peripheral devices or other instruments.

An interface shall not allow the metrological functions of the instrument and its measurement data to be affected by the operation of the ~~ancillary~~ peripheral devices or connected instruments or by disturbances acting on the interface.

If instructions or data can be introduced through the interface into the measuring instrument which alters the parameters that determine the measurement result, the interface shall be sealed as described in ~~5.4.2~~6.4.1.

5.6.1

5.6   Checking facilities

Acting upon significant faults

5.6.2 When a significant fault has been detected, the instrument shall either be made inoperative automatically or a visual or audible indication shall be provided automatically and shall continue until such time as the user takes action or the fault disappears. For automatic instruments the instrument shall be made inoperative automatically.

Indication check

If the failure of an indicator display element can cause a false indication, then the instrument shall have a display test facility which when turning on the power and on demand, shows all relevant elements of the indication display in both active and non-active states, for sufficient time to allow the operator to check them.

This is not applicable for displays on which failure becomes evident, e.g. non-segmented displays, screen-displays, matrix-displays, etc.

6   Requirements for software controlled devices and security

The software requirements are based on OIML D 31 [4].

The risk associated with the software of multi-dimensional measuring instruments is level I. Validation in accordance with Procedure A in clauses 6.3 and 6.4 of D 31 are adequate for solutions implemented to fulfill requirements at the normal severity level.

6.1   Specification of software requirements

(a) For instruments and modules operated by software, the manufacturer shall describe or declare how the software is implemented within the instrument or module, i.e. if it is installed in a fixed hardware and software environment (embedded) or on an universal computer system (implemented into the housing or external).

(b) Legally relevant software shall be clearly identifiable via a unique software version or a checksum. In the normal operation mode of the instrument, the software version or the checksum shall be displayed or printed out on command or shall be displayed during the start-up procedure of the instrument.

(c) Legally relevant measuring algorithms and functions shall be appropriate and functionally correct as evidenced by the instrument correctly displaying and recording the measurement result and the required accompanying information. It shall be possible to validate algorithms and functions where required by metrological tests.

(d) The conformity of the legally relevant software on each instrument to that in the approved type shall be at level (b) described in D 31 clause 5.2.5. In types where selected functions or parts of the source code can be modified, it shall be possible to detect software variations, e.g. via checksum values.

(e) Further measurements shall not be possible when a significant fault is detected.

(f) If the software of the instrument is separated into legally relevant and non-relevant parts, the requirements of D 31 clause 5.2.1.2 have to be fulfilled.

(g) For instruments/ measuring systems using an internal or external universal computer, the legally relevant software shall be operated only in the environment specified for its correct functioning. If necessary to secure the correct functioning of the legally relevant software, the operating system shall be fixed to a defined invariant configuration.

(h) NOTE: A fixed environment for software is also required for instruments where cryptographic data protection is implemented or when software changes on a verified instrument is permitted without an appointed verifier onsite (i.e. the 'Traced Updates' described in D 31 clause 5.2.6.3).

(i) The national responsible body may require instruments to be equipped with an internal recording element and/or a communication interface that permits interfacing with an external recording element, for example, a printer. In this case, correspondence between displayed information and remote recording element shall be verified.

(j) The national responsible body may apply the requirements in clause 6.3, if measurement data has to leave the measuring instrument and be stored or transmitted in an insecure environment before it is used for commercial purposes.

6.2   Data storage

(a) If storage of legally relevant data is required by the national responsible body, the measurement data must be stored automatically when the measurement is finished.

(b) NOTE: A recording element shall not record any dimensional values before the end of the measurement cycle. The storage device must have sufficient permanency to ensure that the data are not corrupted under normal storage conditions and there shall be sufficient memory storage for any particular application.

(c) The measurement value stored shall be accompanied by all relevant information necessary for future legally relevant use. The measurement records shall include as a minimum: unambiguous identifier of the measurement, measurement date and time, unique identification of the instrument,

dimensional measurements and units, calibration version identification, error messages and constituent labels (on multi-constituent meters). Acceptable examples of a measurement identifier include consecutive numbers enabling assignment to values printed on an invoice, or a test sample ID.

6.3   Data transmission

(a) Where the transmission of legally relevant measurement data in open networks presents opportunities for fraud or misuse with serious consequences for an important market of the country, the following additional requirements may be applied:

(b) The data shall be protected by software means described in D 31 clause 5.2.3.2 to guarantee the authenticity and integrity.

(c) If cryptographic protection of data as indicated in D 31 clause 5.2.3.3 is employed to achieve protection at the severity II level, Procedure B methods are recommended for validating this aspect of the software.

(d) The measurement shall not be inadmissibly influenced by a transmission delay.

(e) If a transmission interruption occurs because the network services become unavailable, no measurement data shall be lost. The measurement process should be stopped to avoid the loss of measurement data.

6.4   Provision for software and calibration security

Sealing

6.4.1 Provision shall be made for sealing those devices and parameters that have a metrologically significant effect and that determine the measurement result. This may include devices and parameters which affect the configuration of the instrument as well as those which affect the calibration.

Sealing may be by mechanical or electronic means. Mechanical means include those where access to an electronic means of changing the parameters (for example via a keyboard) is prohibited by a mechanical seal.

The requirements for applying a mark to a mechanical seal are the same as those for 5.4.1.

The requirements for electronic seals are as follows:

(a) Access by authorized persons shall be protected by some form of physical key or a password or access code (for example a four digit code).

(b) Any access to alter protected parameters shall be automatically recorded (for example by means of a counter which automatically increments when access is initiated).

(c) The record shall be readily accessible by a simple action (for example by display of the counter when a button identified as being for this purpose is pressed, or during the indication check).

(d) The record shall be readily identifiable as such and shall not be easily confused with other indications of the instrument.

~~A reference record in the same form as the incremental record shall be permanently marked on the instrument to indicate that the parameters have been accessed since the last verification (for example the reference record could be associated with the verification mark).~~

6.4.2

(e) The record shall not repeat in a sequence of less than 999 alterations. It shall also persist reliably for a period of at least two years (unless it is overwritten by a further alteration).

(f) The record shall persist through tests for influence factors and disturbances specified in this Recommendation.

Safeguards against fraudulent use

(a) For protection against fraudulent use, the following requirements shall be fulfilled.

(b) The legally relevant software shall be secured against unauthorised modification, loading or changes by swapping of the memory device. In addition to mechanical sealing, technical means may be necessary to secure measuring instruments that have an operating system or an option to load software.

(c) Only clearly documented functions are allowed to be activated by the user interface, which shall be realised in such a way that it does not facilitate fraudulent use.

(d) Parameters that fix the legally relevant characteristics of the measuring instrument shall be secured against unauthorised modification. It shall be possible to display or print the current parameter settings.

(e) National responsible bodies may restrict the access to any of the device-specific parameters.

NOTE: Device-specific parameters may be adjustable or selectable only in a special operational mode of the instrument.

Type-specific parameters have identical values for all specimens of a type and are fixed at type approval.

Software Documentation

The manufacturer shall submit the software documentation as given in Table 3.

6.4.3 Table 3: Examples of software documentation and application notes

Documentation	Application notes and/or examples
Description of the legally relevant software, incorporating how the requirements are met	
Description of the operating system security	For e.g. password protection
Description of the software sealing method(s)	
Overview of the system hardware, highlighting any hardware components that are deemed legally relevant or performing legally relevant functions	For e.g. topology block diagram, type of computer(s), type of network
Description of the accuracy of the algorithms	Example algorithms – filtering of A/D conversion results, rounding algorithms
Declaration of the hardware and software environment, including minimum resources and configuration necessary for correct functioning of the instrument	Applicable for types of instrument requiring a universal computer
Description of the user interface, menus and dialogues	
Description of the software identification which has to be clearly assigned to the legally relevant functions	If applicable, include a description of all encryption means
Clear instructions on how to check the actual software identification against the reference number as listed in the type approval certificate	This reference may be additionally marked on or displayed by the instrument
List of commands of each hardware interface of the measuring instrument/electronic device/sub-assembly	Include a statement of completeness
List of durability errors that are detected by the software, e.g. for a spectrometer – an alert for the user to clean lenses/windows or to replace LED	If necessary, include a description of the detecting algorithms

when radiation intensities fall below threshold values.	
Description of data sets stored or transmitted	
List of significant faults that are detected and a description of the detecting algorithm	Applicable where fault detection is achieved by software means
Operating manual which clearly identifies all operational controls, indications, and features	Example features – switches, lights, displays and push buttons

Annex A
Guidelines on object limitations
(Informative)

A.1 General

Multi-dimensional measuring instruments use a number of technologies to measure the dimensions of an object and thereby determine the volume of the smallest rectangular box which would fully enclose the object. All technologies have a limited ability to measure all objects correctly. These limitations have to be recognized and instruments have to be marked accordingly and/or have appropriate instructions in the user's manual for the operator to follow. The following guidelines give information on known limitations associated with the objects to be measured.

Characteristics of the object which can affect the measurement are:

(a) shape;

(b) surface characteristics such as colour (uniform and non-uniform), contrast of surface colour with the background colour of the measuring plane, reflectivity and absorption of sound and light, transparency, roughness and protrusions;

(c) uniformity of density; and

(d) orientation and position in the measuring instrument.

Instruments are tested with test objects to determine if they measure within the ~~mpes~~mpe specified. Test objects have to be of a known shape and size and constructed from a suitable material so that there is a high probability that any errors found are due to the instrument and not to the test objects. It is essential that the dimensions of the test objects are traceable to national measurement standards.

However in practice not all objects are of ideal shape or material, or have dimensions which are easily traceable to national standards. Therefore there may be errors of measurement due to the non-ideal characteristics of the object as well as errors due to the instrument.

This Recommendation requires that the instrument be marked with any limitations of use (or instructions included in a user's manual) and it is therefore necessary for tests to be carried out to justify these limitations. Reliance is also placed on the operator of the instrument to ensure that the limitations are adhered to.

It must be recognized, however, that it is highly improbable that all these precautions will totally eliminate the measurement of unsuitable objects. Features can be built into the instrument to guard against some of the more obvious misuses but it is also essential to train operators and establish good work practices.

Clauses A.2 to A.4 list the known limitations of objects and Table A.1 specifies which limitations apply to the different technologies used for measuring the object.

Table A.1 Applicable object limitations

Applicable clause in Annex A	Principle of operation			
	Reflection of sound (1)	Reflection of light (2)	Cutting a light beam (3)	Mechanical (4)
A.2 Shape	x	x	x	x
A.3.1 Uniform surface colour		x		
A.3.2 Non-uniform surface colour		x		
A.3.3 Contrast of surface colour with background colour		x		
A.3.4 Surface reflectivity and absorption of sound	x			
A.3.5 Surface reflectivity and absorption of light		x		

A.3.6 Uniformity of density	x			
A.3.7 Transparency		x	x	
A.3.8 Surface roughness	x	x	x	x
A.3.9 Protrusions of the surface	x	x	x	x
A.4 Orientation and position	x	x	x	x

Examples:

(1) Ultrasonic unit that transmits and receives sound waves which are reflected from an object.

(2) Laser or LED unit that transmits and receives light waves which are reflected from an object.

(3) LED unit that transmits a light beam, and an opposing light sensor that detects when the beam is cut by an object.

(4) A mechanical wheel device that rolls a wheel along the surface of the object.

A.2 Shape of the object

Some instruments can only measure a rectangular box while others can measure irregular shaped objects and determine the dimensions of the smallest rectangular box which fully encloses the object. Instruments which only measure rectangular boxes shall be so marked.

If an instrument can measure irregular shapes in some, but not all, of the dimensions, the instrument shall be marked that it is only to be used for measuring rectangular boxes.

A.3 Surface characteristics

A.3.1 Uniform colour

The surface colour of an object only affects instruments which use light as the principle of measurement. Light coloured objects are more easily measured than dark objects due to better reflectivity or contrast. Suitable test objects with surfaces varying from shiny white to matt black can be used to determine if the specified limits marked on the instrument are correct.

A.3.2 Non-uniform colour

The non-uniformity of surface colour of an object means that different intensities of light are reflected from different parts of the object, for example if black tape is wrapped around a white box, or if a shiny plastic invoice sleeve is fixed to a low light reflective surface. Suitable test objects of non-uniform colour can be used to determine if the instrument is affected by such variations.

A.3.3 Contrast of surface colour with the background colour

Some instruments measure by contrasting the surface colour of the object against the background colour of the measuring plane. The contrast may be a light colour against a dark colour or a shiny surface against a matt surface. The surface of the background plane has to be chosen to accommodate most objects to be measured. Test objects of varying contrasting colour to the colour of the measuring plane can be used to determine limits of contrast.

A.3.4 Reflectivity and absorption of sound

Some instruments use sound to measure objects. The sound reflective qualities of an object relate to its density and smoothness. The more dense and smooth the object is, the better reflector it is. The following examples are arranged in order of best to worse reflective properties:

  (a) smooth, flat steel;

  (b) smooth, flat plywood;

  (c) smooth, flat, corrugated cardboard; and

  (d) polystyrene foam.

Test objects of polystyrene foam can be used to test the instrument.

A.3.5 Reflectivity and absorption of light

For instruments which use light waves to measure objects, a shiny, smooth, white surface reflects better than a rough, matt, black surface. Also instruments may not perform as well if there is a mixture of surfaces, for example if shiny sealing tape is wrapped around a matt surface or if there is a plastic cover over documents attached to the surface. Additionally, a mixture of light and shadow on the surface may degrade performance. Suitable test objects and light conditions can be used to determine if the instrument is affected by these characteristics.

A.3.6 Uniformity of density

The object being measured may not be uniformly dense. For example if a metal container is inside a polystyrene foam box, sound waves may be absorbed and reflected from the metal. A test object can be constructed to check this feature.

A.3.7 Transparency

Solid objects wrapped in a transparent material such as "bubble plastic" may not be measured correctly by instruments which use light as the measuring technology. A suitable test object can be prepared to check this feature.

A.3.8 Roughness

An object with a rough surface may degrade the measuring performance of an instrument using any of the technologies for the measurement. A test object with rough surfaces can be used to check this characteristic.

A.3.9 Protrusions

Instrument which only measure rectangular boxes are not able to measure protrusions on the surface. Instruments which measure irregular shaped objects measure protrusions but only above a minimum size. Labels, handles or similar small protrusions on rectangular boxes need not be measured by either type of instrument.

Larger protrusions which could occur on irregular shaped objects need to be measured and included in the determination of the smallest rectangular box which fully encloses the object. Therefore the smallest specified protrusion which can be measured by the instrument needs to be tested with a suitable test object.

A.4 Orientation and position of the object on the measuring instrument

Any limitations on the orientation or placement of the object on the measuring plane need to be determined and precautions should be taken to ensure that the limitations are adhered to. For example physical or displayed guides can be used to control the limits. In some cases two sets of guides may be needed for the smallest and largest sizes, for example if the object must always be placed in the centre of the measuring plane.

Annex B
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