ORGANISATION INTERNATIONALE

DE MÉTROLOGIE LÉGALE

INTERNATIONAL RECOMMENDATION

Non-automatic weighing instruments

Part 1 : Metrological and technical requirements - Tests

Instruments de pesage à fonctionnement non automatique
Partie 1 : Exigences métrologiques et techniques - Essais

OIML R 76-1

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FOREWORD

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PREFACE

This International Recommendation " Non-automatic weighing instruments " compiles and replaces the former International Recommendations :

R 3 Metrological regulations for non-automatic weighing instruments

R 28 Technical regulations for non-automatic weighing instruments.

New or additional requirements have been included to account for the technical possibilities brought forth by electronics, and those parts of the International Recommendation R 74 " Electronic weighing instruments " that pertain to non-automatic weighing instruments have been incorporated.

This Recommendation is to be used by itself, without reference to other International Recommendations. It covers any non-automatic weighing instrument of conventional, mechanical design as well as of modern, electronic design.

The contents has been grouped so as to facilitate application of the Recommendation to either mechanical or electronic instruments.

The section headed Terminology and the first three main sections (from R 3) apply to all instruments. Section 4 (in part from R 28) applies basically to all instruments, but well-established solutions for mechanical instruments have been included in the general requirements. Section 5 (from R 74) applies only to electronic instruments, Section 6 (from R 28) only to simple, mechanical instruments. Administrative matters, applicable to all instruments, are dealt with in Sections 7 and 8.

This Recommendation contains procedures for testing and examining instruments during pattern evaluation. Annexes A and C, applicable to all instruments, have been prepared by a Working Group of the Nordic Countries under the responsibility of SP 7, whereas annex B, applicable only to electronic instruments, was taken from R 74. Annex C is published as a separate booklet, to facilitate its practical use.

The terminology takes into account definitions given by VIM, VML and the IEC Vocabulary which, in some cases, have had to be adapted to technical particularities of weighing instruments.

The International Working Group and the Reporting Secretariat SP 7-Sr 4 are aware of the rapid changes in the field of electronics, and hence feel that frequent updating of this Recommendation will be necessary, particularly to keep tests in annex B in conformity with the corresponding IEC Publications.

TERMINOLOGY

The terminology used in this Recommendation conforms to the " International Vocabulary of basic and general terms in metrology " (1984 edition) and the " Vocabulary of legal metrology " (1978 edition). In addition, for the purposes of this Recommendation, the following definitions apply.

T.1. General definitions

T.1.1. Weighing instrument

Measuring instrument that serves to determine the mass of a body by using the action of gravity on this body.

The instrument may also be used to determine other quantities, magnitudes, parameters or characteristics related to mass.

According to its method of operation, a weighing instrument is classified as an automatic or non-automatic instrument.

T.1.2. Non-automatic weighing instrument

Instrument that requires the intervention of an operator during the weighing process, for example to deposit on or remove from the receptor the load to be measured and also to obtain the result.

The instrument permits direct observation of the weighing results, either displayed or printed ; both possibilities are covered by the word " indication ".

Note : Terms like " indicate ", " indicating component " etc., do not include printing.

A non-automatic weighing instrument may be :

— graduated or non-graduated,

— self-indicating, semi-self-indicating or non-self-indicating.

Note : In this Recommendation a non-automatic weighing instrument is called an " instrument ".

T.1.2.1. Graduated instrument

Instrument allowing the direct reading of the complete or partial weighing result.

T.1.2.2. Non-graduated instrument

Instrument not fitted with a scale numbered in units of mass.

T.1.2.3. Self-indicating instrument

Instrument in which the position of equilibrium is obtained without the intervention of an operator.

T.1.2.4. Semi-self-indicating instrument

Instrument with a self-indication weighing range, in which the operator intervenes to alter the limits of this range.

T.1.2.5. Non-self-indicating instrument

Instrument in which the position of equilibrium is obtained entirely by the operator.

T.1.2.6. Electronic instrument

Instrument equipped with electronic devices.

T.1.2.7. Instrument with price scales

Instrument that shows the price to pay by means of price charts or scales related to a range of unit prices.

T.1.2.8. Price computing instrument

Instrument that calculates the price to pay on the basis of the indicated mass and the unit price.

T.1.2.9. Price labelling instrument

Price computing instrument that prints the weight value, unit price and price to pay for prepackages.

T.1.2.10. Self-service instrument

Instrument that is intended to be operated by the customer.

T.1.3. Indications provided by an instrument

T.1.3.1. Primary indications

Indications, signals and symbols that are subject to requirements of this Recommendation.

T.1.3.2. Secondary indications

Indications, signals and symbols that are not primary indications.

T.2. Construction of an instrument

In this Recommendation the term " device " is used for any means by which a specific function is performed, irrespective of the physical realization, e.g. by a mechanism or a key initiating an operation ; the device may be a small part or a major portion of an instrument.

T.2.1. Main devices

T.2.1.1. Load receptor

Part of the instrument intended to receive the load.

T.2.1.2. Load transmitting device

Part of the instrument for transmitting the force produced by the load acting on the load receptor, to the load measuring device.

T.2.1.3. Load measuring device

Part of the instrument for measuring the mass of the load by means of an equilibrium device for balancing the transmitted force and an indicating or printing device.

T.2.2. Electronic parts

T.2.2.1. Electronic device

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

Note : An electronic device, as defined above, may be a complete instrument (for example, instrument for direct selling to the public) or part of an instrument (for example, printer or indicator).

T.2.2.2. Electronic sub-assembly

A part of an electronic device, employing electronic components and having a recognizable function of its own.

Examples : A/D converter, display matrix, ...

T.2.2.3. Electronic component

The smallest physical entity that uses electron or hole conduction in semiconductors, gases or in a vacuum.

T.2.3. Indicating device (of a weighing instrument)

Part of the load measuring device on which the direct reading of the result is obtained.

T.2.3.1. Indicating component

Component indicating the equilibrium and/or the result.

On an instrument with one position of equilibrium it indicates only the equilibrium (so called zero).

On an instrument with several positions of equilibrium it indicates both the equilibrium and the result. On an electronic instrument, this is the display.

T.2.3.2. Scale mark

A line or other mark on an indicating component corresponding to a specified value of mass.

T.2.3.3. Scale base

An imaginary line through the centres of all the shortest scale marks.

T.2.4. Auxiliary indicating devices

T.2.4.1. Rider

Detachable poise of small mass that may be placed and moved either on a graduated bar integral with the beam or on the beam itself.

T.2.4.2. Device for interpolation of reading (vernier or nonius)

Device connected to the indicating element and sub-dividing the scale of an instrument, without special adjustment.

T.2.4.3. Complementary indicating device

Adjustable device by means of which it is possible to estimate, in units of mass, the value corresponding to the distance between a scale mark and the index.

T.2.4.4. Indicating device with a differentiated scale division

Digital indicating device of which the last figure after the decimal sign is clearly differentiated from other figures.

T.2.5. Extended indicating device

A device temporarily changing the actual scale interval (d) to a value less than the verification scale interval (e) following a manual command.

T.2.6. Supplementary devices

T.2.6.1. Levelling device

Device for setting an instrument to its reference position.

T.2.6.2. Zero-setting device

Device for setting the indication to zero when there is no load on the load receptor.

T.2.6.2.1. Non-automatic zero-setting device

Device for setting the indication to zero by an operator.

T.2.6.2.2. Semi-automatic zero-setting device

Device for setting the indication to zero automatically following a manual command.

T.2.6.2.3. Automatic zero-setting device

Device for setting the indication to zero automatically without the intervention of an operator.

T.2.6.2.4. Initial zero-setting device

Device for setting the indication to zero automatically at the time the instrument is switched on and before it is ready for use.

T.2.6.3. Zero-tracking device

Device for maintaining the zero indication within certain limits automatically.

T.2.6.4. Tare device

Device for setting the indication to zero when a load is on the load receptor :

— without altering the weighing range for net loads (additive tare device) or

— reducing the weighing range for net loads (substractive tare device).

It may function as :

— a non-automatic device (load balanced by an operator),

— a semi-automatic device (load balanced automatically following a single manual command),

— an automatic device (load balanced automatically without the intervention of an operator).

T.2.6.4.1. Tare balancing device

Tare device without indication of the tare value when the instrument is loaded.

T.2.6.4.2. Tare weighing device

Tare device that stores the tare value and is capable of indicating or printing it whether or not the instrument is loaded.

T.2.6.5. Preset tare device

Device for subtracting a preset tare value from a gross or net weight value and indicating the result of the calculation. The weighing range for net loads is reduced accordingly.

T.2.6.6. Locking device

Device for immobilizing all or part of the mechanism of an instrument.

T.2.6.7. Auxiliary verification device

Device permitting separate verification of one or more main devices of an instrument.

T.2.6.8. Selection device for load receptors and load-measuring devices

Device for attaching one or more load receptors to one or more load measuring devices, whatever intermediate load-transmitting devices are used.

T.2.6.9. Indication stabilizing device

Device for maintaining a stable indication under given conditions.

T.2.7. Checking facility

A facility that is incorporated in an instrument and enables significant faults to be detected and acted upon.

T.2.8. Durability protection feature

A feature that is incorporated in an instrument and that enables significant durability errors to be detected and acted upon.

T.3. Metrological characteristics of an instrument

T.3.1. Weighing capacity

T.3.1.1. Maximum capacity (Max)

Maximum weighing capacity, not taking into account the additive tare capacity.

T.3.1.2. Minimum capacity (Min)

Value of the load below which the weighing results may be subject to an excessive relative error.

T.3.1.3. Self-indication capacity

Weighing capacity within which equilibrium is obtained without the intervention of an operator.

T.3.1.4. Weighing range

Range between the minimum and maximum capacities.

T.3.1.5. Extension interval of self-indication

Value by which it is possible to extend the range of self-indication within the weighing range.

T.3.1.6. Maximum tare effect (T^+, T^-)

Maximum capacity of the additive tare device or the substractive tare device.

T.3.1.7. Maximum safe load (Lim)

Maximum static load that can be carried by the instrument without permanently altering its metrological qualities.

T.3.2. Scale divisions

T.3.2.1. Scale spacing (instrument with analogue indication)

Distance between any two consecutive scale marks, measured along the scale base.

T.3.2.2. Actual scale interval (d)

Value expressed in units of mass of :

— the difference between the values corresponding to two consecutive scale marks, for analogue indication,

— the difference between two consecutive indicated values, for digital indication.

T.3.2.3. Verification scale interval (e)

Value, expressed in units of mass, used for the classification and verification of an instrument.

T.3.2.4. Scale interval of numbering

Value of the difference between two consecutive numbered scale marks.

T.3.2.5. Number of verification scale intervals (single-interval instrument)

Quotient of the maximum capacity and the verification scale interval :

$$n = \frac{Max}{e}$$

T.3.2.6. Multi-interval instrument

Instrument, the measuring range of which is divided into partial weighing ranges each with different scale intervals.

T.4. Metrological properties of an instrument

T.4.1. Sensitivity

For a given value of the measured mass, the quotient of the change of the observed variable l by the corresponding change of the measured mass M :

$$k = \frac{\Delta l}{\Delta M}$$

T.4.2. Discrimination

Ability of an instrument to react to small variations of load. The discrimination threshold, for a given load, is the value of the smallest additional load that, when gently deposited on or removed from the load receptor, causes a perceptible change in the indication.

T.4.3. Repeatibility

Ability of an instrument to provide results that agree one with the other for the same load deposited several times and in a practically identical way on the load receptor under reasonably constant test conditions.

T.4.4. Durability

The capability of an instrument to maintain its performance characteristics over a specified period of use.

T.4.5. Warm-up time

The time between the moment power is applied to an instrument and the moment at which the instrument is capable of complying with the requirements.

T.5. Indications and errors

T.5.1. Methods of indication

T.5.1.1. Balancing by weights

Value of metrologically controlled weights that balance the load (taking into account the reduction ratio of the load).

T.5.1.2. Analogue indication

Indication allowing the evaluation of the equilibrium position to a fraction of the scale interval.

T.5.1.3. Digital indication

Indication in which the scale marks are composed of a sequence of aligned figures that do not permit interpolation to fractions of the scale interval,

T.5.2. Weighing results

Note : The following definitions apply only when the indication has been zero before the load has been put on the instrument.

T.5.2.1. Gross value (G or B)

Indication of the weight of a load on an instrument, with no tare or preset tare device in operation.

T.5.2.2. Net value (N)

Indication of the weight of a load placed on an instrument after operation of a tare device.

T.5.2.3. Tare value (T)

The weight value of a load, determined by a tare weighing device.

T.5.3. Other weight values

T.5.3.1. Preset tare value (PT)

Numerical value, representing a weight, that is introduced into the instrument. " Introduced " includes procedures such as : keying in, recalling from a data storage, or inserting via an interface.

T.5.3.2. Calculated net value

Value of the difference between a gross or net weight value and a preset tare value.

T.5.3.3. Calculated total weight value

Calculated sum of more than one weight value and/or calculated net value.

T.5.4. Reading

T.5.4.1. Reading by simple juxtaposition

Reading of the weighing result by simple juxtaposition of consecutive figures giving the weighing result, without the need of calculation.

T.5.4.2. Overall inaccuracy of reading

The overall inaccuracy of reading of an instrument with continuous indication is equal to the standard deviation of the same continuous indication, the reading of which is carried out under normal conditions of use by several observers.

It is customary to make at least ten readings of the result.

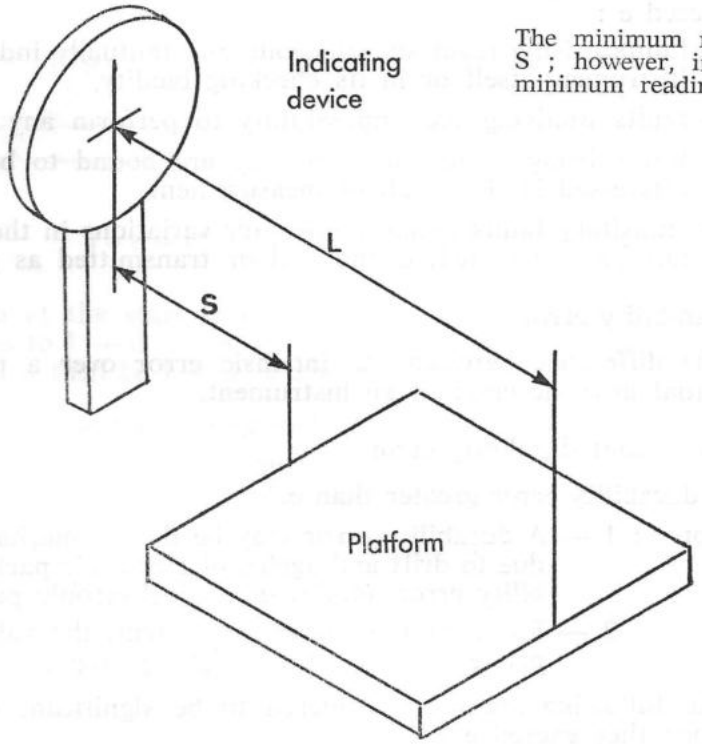
T.5.4.3. Rounding error of digital indication

Difference between the indication and the result the instrument would give with analogue indication.

T.5.4.4. Minimum reading distance

The shortest distance that an observer is able freely to approach the indicating device to take a reading under normal conditions of use.

This approach is considered to be free for the observer if there is a clear space of at least 0.8 m in front of the indicating device.



The minimum reading distance is S ; however, if S < 0.8 m, the minimum reading distance is L.

T.5.5. Errors

T.5.5.1. Error (of indication)

The indication of an instrument minus the true value of the mass.

T.5.5.2. Intrinsic error

The error of an instrument under reference conditions.

T.5.5.3. Initial intrinsic error

The intrinsic error of an instrument as determined prior to performance tests and durability evaluations.

T.5.5.4. Maximum permissible error

Maximum difference, positive or negative, allowed by regulation between the indication of an instrument and the corresponding true value, as determined by reference standard masses, with the instrument being at zero at no-load, in the reference position.

T.5.5.5. Fault

The difference between the error of indication and the intrinsic error of an instrument.

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

T.5.5.6. Significant fault

A fault greater than e.

Note : For a multi-interval instrument, the value of e is that appropriate to the partial weighing range.

The following are not considered to be significant faults, even when they exceed e :

— faults arising from simultaneous and mutually independent causes in the instrument itself or in its checking facility,

— faults implying the impossibility to perform any measurement,

— faults being so serious that they are bound to be noticed by all those interested in the result of measurement,

— transitory faults being momentary variations in the indication which cannot be interpreted, memorized or transmitted as a mesuring result.

T.5.5.7. Durability error

The difference between the intrinsic error over a period of use and the initial intrinsic error of an instrument.

T.5.5.8. Significant durability error

A durability error greater than e.

Notes : 1 — A durability error may be due to mechanical wear and tear or due to drift and ageing of electronic parts. The significant durability error applies only to electronic parts.

2 — For a multi-interval instrument, the value of e is that appropriate to the partial weighing range.

The following are not considered to be significant durability errors, even when they exceed e :

errors occurring after a period of instrument use that are clearly the result of a failure of a device/component, or of a disturbance and for which the indication :

— cannot be interpreted, memorized, or transmitted as a measurement result, or

— implies the impossibility to perform any measurement, or

— is so obviously wrong that it is bound to be noticed by all those interested in the result of measurement.

T.6. Influences and reference conditions

T.6.1. Influence quantity

A quantity that is not the subject of the measurement but which influences the values of the measurand or the indication of the instrument.

T.6.1.1. Influence factor

An influence quantity having a value within the specified rated operating conditions of the instrument.

T.6.1.2. Disturbance

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

T.6.2. Rated operating conditions

Conditions of use, giving the range of values of influence quantities for which the metrological characteristics are intended to lie within the specified maximum permissible errors.

T.6.3. Reference conditions

A set of specified values of influence factors fixed to ensure valid intercomparison of the results of measurements.

T.6.4. Reference position

Position of the instrument at which its operation is adjusted.

T.7. Tests

T.7.1. Performance test

A test to verify whether the equipment under test (EUT) is capable of performing its intended functions.

T.7.2. Durability test

A test to verify whether the instrument maintains its performance characteristics over a period of use.

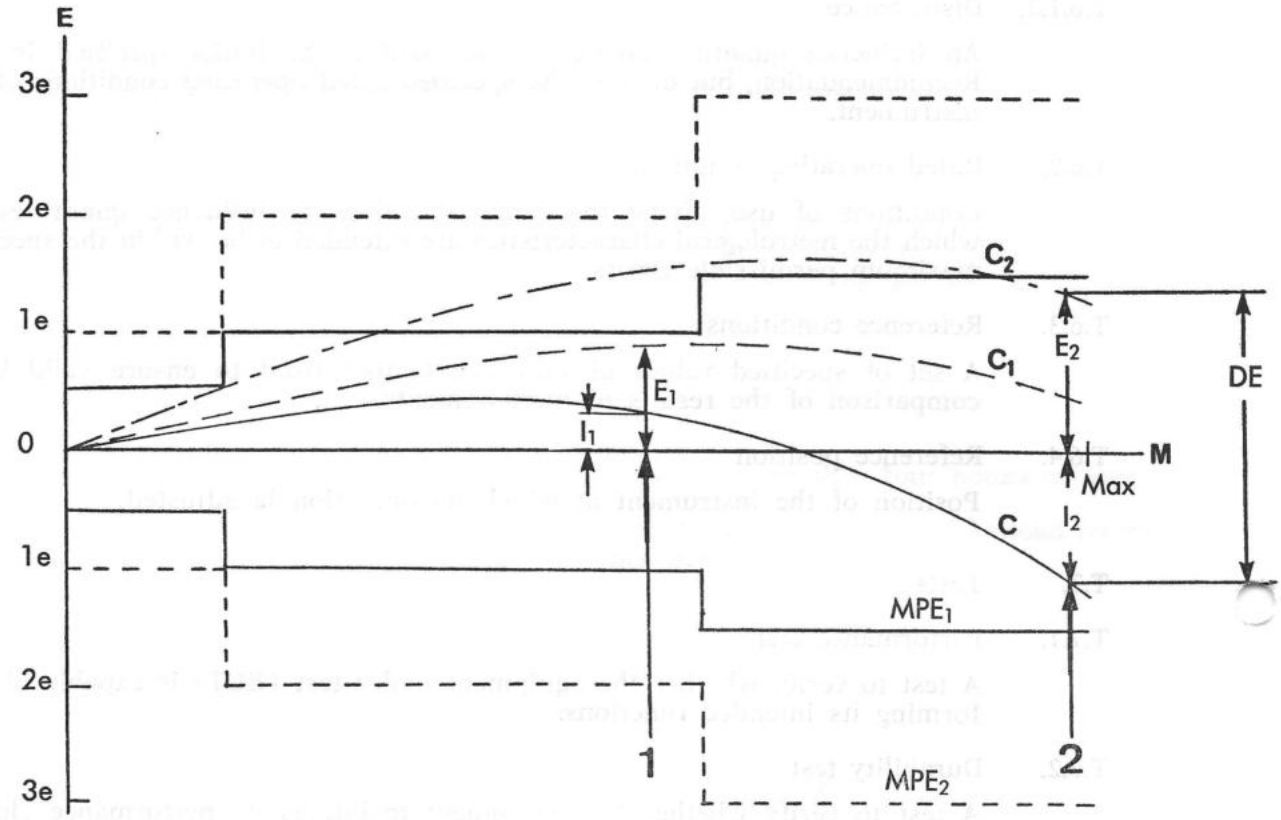


Illustration of certain terms used :

M = mass to be measured

E = error of indication (T.5.5.1)

MPE_1 = maximum permissible error on intial verification

MPE_2 = maximum permissible error in service

C = characteristic under reference conditions

C_1 = characteristic due to influence factor or disturbance (1)

C_2 = characteristic after durability tests

I = intrinsic error (T.5.5.2)

DE = durability error

Situation 1 — shows the error E_1 of an instrument due to an influence factor or a disturbance. I_1 is the intrinsic error. The fault (T.5.5.5) due to the influence factor or disturbance applied equals E_1 minus I_1.

Situation 2 — shows the error E_2 of an instrument after the durability test. I_2 is the initial intrinsic error. The durability error (T.5.5.7) equals E_2 minus I_2.

(1) For the purposes of this illustration it is supposed that the influence factor or the disturbance has an influence on the characteristic which is not erratic.

NON-AUTOMATIC WEIGHING INSTRUMENTS

1. Scope

This Recommendation specifies the metrological and technical requirements for non-automatic weighing instruments that are subject to official metrological control.

It is intended to provide standardized requirements and testing procedures to evaluate the metrological and technical characteristics in a uniform and traceable way.

2. Principles of the Recommendation

2.1. Units of measurement

The units of mass to be used on an instrument are the kilogramme (kg), the microgramme (μg), the milligramme (mg), the gramme (g), and the tonne (t).

For special applications, e.g. trade with precious stones, the metric carat (ct) (1 ct = 0.2 g) may be used as unit of measurement.

2.2. Principles of the metrological requirements

The requirements apply to all instruments independently of their principles of measurement.

Instruments are classified according to :

— the verification scale interval, representing absolute accuracy, and

— the number of verification scale intervals, representing relative accuracy.

The maximum permissible errors are in the order of magnitude of the verification scale interval.

A minimum capacity (Min) is specified to indicate that use of the instrument with light loads is likely to give rise to excessive relative errors.

2.3. Principles of the technical requirements

General technical requirements apply to all types of instruments, whether mechanical or electronic, and are modified with additional requirements for instruments used for specific applications or designed for a special technology. They are intended to specify the performance, not the design of an instrument, so that technical progress is not impeded.

In particular, functions of electronic instruments not covered by this Recommendation should be considered to be allowed if they do not interfere with the metrological requirements.

Testing procedures are provided to establish conformity of instruments with the requirements of this Recommendation. They should be applied, and the Pattern Evaluation Report should be used, to facilitate exchange and acceptance of test results by metrological authorities.

2.4. Application of requirements

The requirements of this Recommendation apply to all devices performing the relevant functions, whether they are incorporated in an instrument or manufactured as separate units.

Examples are : load-measuring device
indicating device
printing device
preset tare device
price-calculating device.

However, devices that are not incorporated in the instrument may, by national legislation, be exempted from the requirements for special applications.

3. Metrological requirements

3.1. Principles of classification

3.1.1. Accuracy classes

The accuracy classes for instruments and their symbols (2) are given in the following Table :

special accuracy (I)

high accuracy (II)

medium accuracy (III)

ordinary accuracy (IIII)

3.1.2. Verification scale interval

The verification scale interval for different types of instruments is given in the following Table :

Type of instrument	Verification scale interval
Graduated, without auxiliary indicating device	e = d
Graduated, with auxiliary indicating device	e is chosen by the manufacturer according to requirements in 3.2 and 3.4.2.
Non graduated	e is chosen by the manufacturer according to requirements in 3.2.

(2) Ovals of any shape, or two horizontal lines joined by two half-circles are authorized. A circle shall not be used because, in conformity with the International Recommendation N° 34 "Accuracy classes of measuring instruments", it is used for the designation of accuracy classes of measuring instruments of which the maximum permissible errors are expressed by a constant relative error in %.

3.2. Classification of instruments

The verification scale interval, number of verification scale intervals and the minimum capacity, in relation to the accuracy class of an instrument, are given in the following Table :

Accuracy class	Verification scale interval e	Number of verification scale intervals $n = \frac{Max}{e}$ minimum	maximum	Minimum capacity Min (Lower limit)
Special (I)	0.001 g ≤ e (3)	50 000 (4)	—	100 e
High	0.001 g ≤ e ≤ 0.05 g	100	100 000	20 e
(II)	0.1 g ≤ e	5 000	100 000	50 e
Medium	0.1 g ≤ e ≤ 2 g	100	10 000	20 e
(III)	5 g ≤ e	500	10 000	20 e
Ordinary (IIII)	5 g ≤ e	100	1 000	10 e

For special application that are clearly marked on the instrument, an instrument may have weighing ranges in classes (I) and (II) or in classes (II) and (III) . The instrument as a whole shall then comply with the more severe requirements of points 3.9 and 4.5 applicable to either of the two classes.

3.3. Additional requirements for a multi-interval instrument (5)

3.3.1. Partial weighing range

Each partial range (index i = 1,2 ...) is defined by :

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(3) It is not normally feasible to test and verify an instrument to e < 1 mg, due to the uncertainty of the test loads.

(4) See exception given in point 3.4.4.

(5) Example for a multi-interval instrument :
Maximum capacity Max = 15 kg class (III)
Verification scale intervals e_1 = 1 g from 0 to 2 kg
e_2 = 2 g from 2 kg to 5 kg
e_3 = 10 g from 5 kg to 15 kg

This instrument has one Max and one weighing range from Min = 20 g to Max = 15 kg. The partial weighing ranges are :
Min = 20 g, Max_1 = 2 kg, e_1 = 1 g, n_1 = 2 000
Min_2 = 2 kg, Max_2 = 5 kg, e_2 = 2 g, n_2 = 2 500
Min_3 = 5 kg, Max_3 = Max = 15 kg, e_3 = 10 g, n_3 = 1 500

The maximum permissible errors on initial verification (mpe) (see point 3.5.1.) are :
for m = 400 g = 400 e_1 : mpe = 0.5 g
for m = 1 600 g = 1 600 e_1 : mpe = 1.0 g
for m = 2 100 g = 1 050 e_2 : mpe = 2.0 g
for m = 4 250 g = 2 125 e_2 : mpe = 3.0 g
for m = 5 100 g = 510 e_3 : mpe = 10.0 g
for m = 15 000 g = 1 500 e_3 : mpe = 10.0 g

Whenever the variation of the indication due to certain influence factors is limited to a fraction or multiple of e, this means, in a multi-interval instrument, that e is to be taken according to the load applied ; in particular, at or near zero load e = e_1.

— its verification scale interval e_i, $e_{i+1} > e_i$
— its maximum capacity Max_i
— its minimum capacity $Min_i = Max_{i-1}$ (for i = 1 the minimum capacity is $Min_1 = Min$).

The number of verification scale intervals n_i for each partial range is equal to :

$$n_i = \frac{Max_i}{e_i}$$

3.3.2. Accuracy class

e_i and n_i in each partial weighing range, and Min_1 shall comply with the requirements given in the Table in 3.2 according to the accuracy class of the instrument.

3.3.3. Maximum capacity of partial weighing ranges

With the exception of the last partial weighing range, the requirements in the following Table shall be complied with, according to the accuracy class of the instrument :

class	(I)	(II)	(III)	(IIII)
Max_i/e_{i+1}	⩾ 50 000	⩾ 5 000	⩾ 500	⩾ 50

3.3.4. Instrument with a tare device

Requirements concerning the ranges of a multi-interval instrument apply to the net load, for every possible value of the tare.

3.4. Auxiliary indicating devices

3.4.1. Type and application

Only instruments of classes (I) and (II) may be fitted with an auxiliary indicating device, which shall be :
— a device with a rider, or
— a device for interpolation of reading, or
— a complementary indicating device, (6) or
— an indicating device with a differentiated scale division (7).

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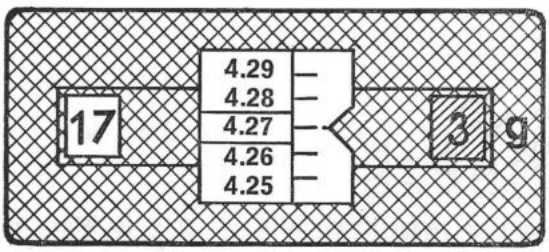
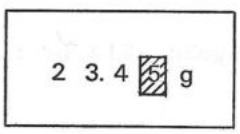
(6) Example of a complementary indicating device

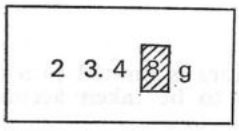


indication : 174.273 g
last figure : 3
d = 1 mg e = 10 mg

(7) Examples of indicating devices each with a differentiated scale division



last differentiated figure : 5
d = 0.01 g or 0.05 g
e = 0.1 g



last differentiated figure : 8
d = 0.01 g or 0.02 g
e = 0.1 g

These devices are permitted only behind the decimal mark.

A multi-interval instrument shall not be fitted with an auxiliary indicating device.

3.4.2. Verification scale interval

The verification scale interval e is determined by the expression :

$$d < e \leqslant 10\ d \quad (8)$$

$$e = 10^k \text{ kg}$$

k being a positive or negative whole number, or zero.

This requirement does not apply to an instrument of class (I) with $d < 1$ mg, where $e = 1$ mg.

3.4.3. Minimum capacity

The minimum capacity of the instrument is determined in conformity with the requirements in the Table in point 3.2. However, in the last column of this Table, the verification scale interval e is replaced by the actual scale interval d.

3.4.4. Minimum number of verification scale intervals

For an instrument of class (I) with $d < 0.1$ mg, n may be less than 50 000.

3.5. Maximum permissible errors (9)

3.5.1. Value of maximal permissible errors on initial verification

The maximum permissible errors for increasing or decreasing loads are given in the Table below.

Maximum permissible errors on initial verification	For loads m expressed in verification scale intervals e			
	Class (I)	Class (II)	Class (III)	Class (IIII)
± 0.5 e	$0 \leqslant m \leqslant 50\,000$	$0 \leqslant m \leqslant 5\,000$	$0 \leqslant m \leqslant 500$	$0 \leqslant m \leqslant 50$
± 1 e	$50\,000 < m \leqslant 200\,000$	$5\,000 < m \leqslant 20\,000$	$500 < m \leqslant 2\,000$	$50 < m \leqslant 200$
± 1.5 e	$200\,000 < m$	$200\,000 < m \leqslant 100\,000$	$2\,000 < m \leqslant 10\,000$	$200 < m \leqslant 1\,000$

3.5.2. Values of maximal permissible errors in service

The maximum permissible errors in service shall be twice the maximum permissible errors on initial verification.

(8) The values of e, calculated following this rule, are, for example :

d =	0.1 g	0.2 g	0.5 g
e =	1 g	1 g	1 g

(9) An example of application to multi-interval instruments is given in the note in point 3.3.

3.5.3. Basic rules concerning the determination of errors

3.5.3.1. Influence factors

Errors shall be determined under nominally constant test conditions with only one influence factor being varied, each of the other factors being fixed at its nominal value or at a given value within the rated operating conditions.

3.5.3.2. Elimination of rounding error

The rounding error included in any digital indication shall be eliminated if the actual scale interval is greater than 0.2 e.

3.5.3.3. Maximum permissible errors for net values

The maximum permissible errors apply to the net value for every possible tare load, except preset tare values.

3.5.3.4. Tare weighing device

The maximum permissible errors for a tare weighing device are the same, for any tare value, as those of the instrument, for the same value of load.

3.5.3.5. Apportioning of errors

Subject to agreement between the manufacturer and the verification authority, main devices may be tested separately.

The maximum permissible errors applicable for a main device are equal to 0.7 times the maximum permissible errors for the complete instrument (this fraction includes the errors attributable to the verification devices used).

In any case the instrument submitted for verification shall be tested as a whole.

3.6. Permissible differences between results

Regardless of what variation of results is permitted, the error of any single weighing result shall by itself not exceed the maximum permissible error for the given load.

3.6.1. Repeatability

The difference between the results of several weighings of the same load shall not be greater than the absolute value of the maximum permissible error of the instrument for that load.

3.6.2. Eccentric loading

The indications for different positions of a load shall remain within the maximum permissible errors, when the instrument is tested according to points 3.6.2.1 through 3.6.2.4.

3.6.2.1. Unless otherwise specified hereafter, a load corresponding to 1/3 of the sum of the maximum capacity and the corresponding maximum additive tare effect shall be applied.

3.6.2.2. On an instrument with a load receptor having n points of support, with $n > 4$, the fraction $1/(n - 1)$ of the sum of the maximum capacity and the maximum additive tare effect shall be applied to each point of support.

3.6.2.3. On an instrument with a special load receptor (tank, hopper, etc.) a test load corresponding to one-tenth of the sum of the maximum capacity and the maximum additive tare effect shall be applied to each point of support.

3.6.2.4. On an instrument used for weighing rolling loads, e.g. vehicle scale, rail suspension instrument, a rolling test load corresponding to the usual rolling load, the heaviest and the most concentrated one which may be weighed, but not exceeding 0.8 times the sum of the maximum capacity and the maximum additive tare effect, shall be applied at different points on the load receptor.

3.6.3. Multiple indicating devices

For a given load the difference between the indications of multiple indicating devices including tare weighing devices, shall be not greater than the absolute value of the maximum permissible error, but shall be zero between digital indicating or printing devices.

3.6.4. Different positions of equilibrium

The difference between two results obtained for the same load when the method of balancing the load is changed (in the case of an instrument fitted with a device for extending the self-indication capacity) in two consecutive tests, may not exceed the absolute value of the maximum permissible error for the applied load.

3.7. Verification standards

3.7.1. Weights

The standard weights or standard masses used for the verification of an instrument shall not have an error greater than 1/3 of the maximum permissible error of the instrument for the applied load.

3.7.2. Auxiliary verification device

When an instrument is fitted with an auxiliary verification device, or when it is verified with a separate auxiliary device, the maximum permissible errors of this device shall be 1/3 of the maximum permissible errors for the applied load. If weights are used, the effect of their errors shall not exceed 1/5 of the maximum permissible errors of the instrument to be verified for the same load.

3.8. Discrimination

3.8.1. Non-self-indicating instrument

An extra load equivalent to four-tenths of the absolute value of the maximum permissible error for the applied load when gently placed on or withdrawn from the instrument at equilibrium shall produce a visible movement of the indicating element.

3.8.2. Self- or semi-self-indicating instrument

3.8.2.1. Analogue indication

An extra load equivalent to the absolute value of the maximum permissible error for the applied load when gently placed on or withdrawn from the instrument at equilibrium shall cause a permanent displacement of the indicating element corresponding to not less than seven-tenths of the extra load.

3.8.2.2. Digital indication

An additional load equal to 1.4 times the actual scale interval, when gently placed on or withdrawn from the instrument at equilibrium shall change the initial indication.

3.9. Variations due to influence quantities and time

An instrument shall comply, unless otherwise specified, with the provisions of points 3.5, 3.6 and 3.8 under the conditions of points 3.9.2, 3.9.3 and 3.9.4.

3.9.1. Tilting

3.9.1.1. Tilting at no-load (instruments of classes (III) and (IIII))

For an instrument liable to be tilted, the instrument having been first adjusted to zero at no-load in its reference position (not tilted), the indication shall not vary by more than two verification scale intervals under the effect of lengthwise or transverse tilting equal to 2 in 1 000.

3.9.1.2. Tilting when loaded (instruments of classes (II), (III) and (IIII))

For an instrument liable to be tilted, the instrument having been first adjusted to zero at no-load in the tilted position, the indication shall not vary by more than one verification scale interval under the effect of lengthwise or transverse tilting equal to :

1 in 1 000 for instruments of class (II),

2 in 1 000 for instruments of classes (III) and (IIII),

the variations being observed at self-indication capacity and at maximum capacity.

3.9.2. Temperature (10)

3.9.2.1. Statutory temperature limits

If no particular working temperature is stated in the descriptive markings of an instrument, this instrument shall maintain its metrological properties within the following temperature limits : — 10 °C, + 40 °C.

3.9.2.2. Special temperature limits

An instrument for which particular limits of working temperature are stated in the descriptive markings shall comply with the metrological requirements within those limits.

The limits may be chosen according to the application of the instrument.

The ranges within those limits shall be at least equal to :

5 °C for instruments of class (I),

15 °C for instruments of class (II),

30 °C for instruments of classes (III) and (IIII).

3.9.2.3. Temperature effect on no-load indication

The indication at zero or near zero shall not vary by more than one verification scale interval for a difference in ambient temperature of 1 °C for instruments of class (I) and 5 °C for other classes.

3.9.3. Mains power supply

An instrument operated from a mains power supply shall comply with the metrological requirements if the power supply varies

— in voltage from — 15 % to + 10 % of the value marked on the instrument,

— in frequency from — 2 % to + 2 % of the value marked on the instrument, if AC is used.

3.9.4. Time

Under reasonably constant environmental conditions, an instrument of class (II), (III) or (IIII) shall meet the following requirements.

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(10) Tolerances for the temperature values are given in the testing procedures, Annexes A and B.

3.9.4.1. When any load is kept on an instrument, the difference between the indication obtained immediately after placing the load and any indication obtained during the following 4 hours, shall not exceed the absolute value of the maximum permissible error for the load applied.

3.9.4.2. The difference on returning to zero as soon as the indication has stabilized, after the removal of any load which has remained on the instrument for one half hour, shall not exceed ± 0.5 e.

For a multi-interval instrument, $e = e_1$.

3.9.4.3. The durability error due to wear and tear shall not be greater than the absolute value of the maximum permissible error.

Adherence to this requirement is assumed if the instrument has passed the endurance test specified in Annex A, point A.6.

3.9.5. Other influence quantities and restraints

Instruments shall comply with the requirements of points 3 and 4 even when other influence quantities or restraints occur, such as :

— vibrations,

— barometric pressure and drafts,

— mechanical constraints and restrictions,

either by being designed to operate correctly in spite of these influences, or by being protected against their action.

3.10. Pattern evaluation tests

Upon pattern evaluation, the tests given in Annexes A and B shall be performed, to verify adherence to the requirements in points 3.5, 3.6, 3.8, 3.9, 4.5, 4.6, 4.7, 5.4 and 6.1.

4. Technical requirements for a self- or semi-self-indicating instrument

The following requirements relate to the design and the construction of instruments which are suitable to give correct and unambiguous weighing results, under normal conditions of use and proper handling by unskilled users. They are not intended to prescribe solutions, but to define appropriate functioning of the instrument.

Certain solutions that have been tried over a long period have become accepted ; these solutions are marked " acceptable solution " ; while it is not necessary to adopt them, they are considered to comply with the mandatory provisions of this point.

4.1. General requirements of construction

4.1.1. Suitability

4.1.1.1. Suitability for application

An instrument shall be designed to suit its intended purpose of use.

4.1.1.2. Suitability for use

An instrument shall be solidly and carefully constructed in order to ensure that it maintains its metrological qualities during a period of use.

4.1.1.3. Suitability for verification

An instrument shall permit the tests set out in this Recommendation to be performed.

In particular, load receptors shall be such that the standard masses can be deposited on them easily and in total safety. If weights cannot be placed an additional support may be required.

4.1.2. Security

4.1.2.1. Fraudulent use

An instrument shall have no characteristics likely to facilitate its fraudulent use.

4.1.2.2. Accidental breakdown and maladjustment

An instrument shall be so constructed that an accidental breakdown or a maladjustment likely to disturb its correct functioning cannot take place without its effect being evident.

4.1.2.3. Controls

Controls shall be so designed that they cannot normally come to rest in positions other than those intended by design, unless during the manœuvre all indication is made impossible. Keys shall be marked unambiguously.

4.1.2.4. Sealing

It may be required by regulations that certain components may not be dismantled or adjusted by the user unless it becomes evident that such an event has occured.

To that end these components shall be provided with means to attach a seal or be enclosed in a housing which can be sealed.

On an instrument of class (I), devices to adjust sensitivity may remain un-sealed.

Acceptable solution

For application of the control marks, the stamping area should have a diameter of at least 5 mm.

4.1.2.5. Calibration

An instrument may be fitted with a semi-automatic calibration device. This device shall consist only of built-in calibration weights. External influence upon this device shall be practically impossible after stamping.

4.2. Indication of weighing results

4.2.1. Quality of reading

Reading of the results shall be reliable, easy and unambiguous under conditions of normal use :

— the overall inaccuracy of reading shall not exceed 0.2 e,

— the figures forming the results shall be of a size, shape and clarity for reading to be easy.

The scales, numbering and printing shall permit the figures which form the results to be read by simple juxtaposition.

4.2.2. Form of the indication

4.2.2.1. Weighing results shall contain the names or symbols of the unit of mass in which they are expressed.

For any one indication of weight, only one unit of mass may be used.

The scale interval shall be in the form 1×10^k, 2×10^k or 5×10^k units in which the result is expressed, the index k being a positive or negative whole number or equal to zero.

All indicating, printing and tare weighing devices of an instrument shall have the same scale interval for any given load.

4.2.2.2. A digital indication shall display at least one figure beginning at the extreme right.

A decimal fraction shall be separated from its integer by a decimal mark (point or comma), with the indication showing at least one figure to the left of the mark and all figures to the right.

Zero may be indicated by one zero to the extreme right, without a decimal mark.

The unit of mass shall be chosen so that weight values have not more than one non-significant zero to the right. For values with decimal mark, the non-significant zero is allowed only in the third position after the decimal mark.

4.2.3. Limits of indication

There shall be no indication above Max + 9e.

4.2.4. Approximate indicating device

The scale interval of an "approximate" indicating device shall be greater than Max/100 without being smaller than 20e. This "approximate" device is considered as giving secondary indications.

4.2.5. Extending the range of self-indication on a semi-self-indicating instrument

The extension interval of the range of self-indication shall not be greater than the value of the self-indication capacity.

Acceptable solution

a) The scale interval of extension of the range of self-indication should be equal to the capacity of self-indication (comparator instruments are excluded from this provision).

b) An extension device with accessible sliding poises is subject to the requirements of point 6.2.2.

c) On an extension device with enclosed sliding poises or mass switching mechanisms, each extension should involve an adequate change in the numbering. It should be possible to seal the housing and the adjusting cavities of the weights or masses.

4.3. Analogue indicating devices

The following requirements apply in addition to those in points 4.2.1 through 4.2.4.

4.3.1. Scale marks length and width

Scales shall be designed and numbered so that reading the weighing result is easy and unambiguous.

Acceptable solutions

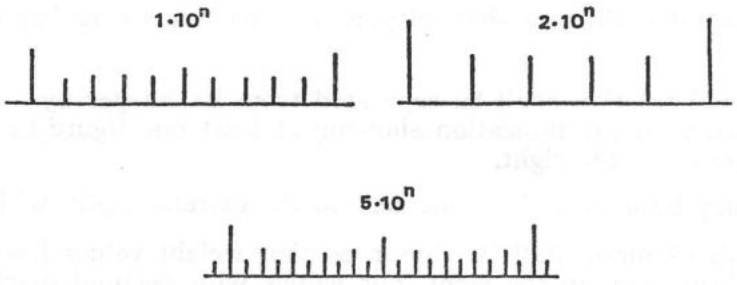
a) Form of scale marks

Scale marks should consist of lines of equal thickness ; this thickness should be constant and be between 1/10 and 1/4 of the scale spacing, without being less than 0.2 mm.

The length of the shortest scale mark should be at least equal to the scale spacing.

b) Arrangement of scale marks

Scale marks should be arranged in accordance with one of the sketches below (the line joining the end of the scale marks is optional) :



(examples of application to linear scales)

c) Numbering

On one scale, the scale interval of numbering should be :

— constant,

— in the form 1×10^k, 2×10^k, 5×10^k units (k being a positive or negative whole number or equal to zero),

— equal at most to 25 times the scale interval of the instrument.

If the scale is projected on a screen, at least two numbered scale marks should appear wholly in the projected zone.

The height of the numbers (real or apparent) expressed in millimetres should be not less than 3 times the minimum reading distance expressed in metres, without being less than 2 mm.

This height should be proportional to the length of the scale mark to which it relates.

The size of a number, measured parallel to the base of the scale, should be less than the distance between two consecutive numbered scale marks.

d) Reading index

The width of the reading index should be approximately equal to that of the scale marks and of a length such that the tip is at least level with the middle of the shortest mark.

The distance between the scale and the reading index should be at most equal to the scale spacing, without being greater than 2 mm.

4.3.2. Scale spacing

The minimum value i_o of the scale spacing is equal to :

— on an instrument of class (I) or (II) :

1 mm for indicating devices,

0.25 mm for complementary indicating devices ; in this case i_o is the relative movement between the index and the projected scale corresponding to the verification scale interval of the instrument,

— on an instrument of class (III) or (IIII) :

1.25 mm for dial indicating devices,

1.75 mm for optical projection indicating devices.

Acceptable solution

The scale spacing (real or apparent) " i ", in millimetres, should be at least equal to (L + 0.5) i_o, where :

i_o is the minimum scale spacing, in millimetres

L is the minimum reading distance, in metres ; at least, L = 0.5 m.

The greatest scale spacing should not exceed 1.2 times the smallest scale spacing of the same scale.

4.3.3. Limits of indication

Stops shall limit the movement of the indicating element whilst allowing it to pass below zero and above the capacity of self-indication. This requirement does not apply to multi-revolution dial instruments.

Acceptable solution

The stops limiting the movement of the indicating element should permit it to travel across zones of at least 4 scale spacings below zero and above the capacity of self-indication (these zones are not provided with a scale on fan charts and on dials with a single revolution pointer ; they are called " blank zones ").

4.3.4. Damping

The damping of the oscillations of the indicating element or of the movable scale shall be adjusted to a value slightly below " critical damping ", whatever the influence factors.

Acceptable solution

Damping should achieve a stable indication after 3, 4 or 5 simple oscillations.

Hydraulic damping elements sensitive to variations in temperature should be provided with a automatic regulating device or an easily accessible manual regulating device.

It should be impossible for the fluid of hydraulic damping elements on portable instruments to spill when the instrument is inclined at 45 °.

4.4. Digital indicating and printing devices

The following requirements apply in addition to those in points 4.2.1 through 4.2.5.

4.4.1. Extended indicating device

An extended indicating device shall not be used on an instrument with a differentiated scale division.

When an instrument is fitted with an extended indicating device, showing the indication with a scale interval smaller than e shall be possible only :

— during pressing a key, or

— for a certain time after a manual command.

In any case printing shall not be possible.

4.4.2. Multiple use of indicating devices

Indications other than primary indications may be displayed in the same indicating device, provided that :

— quantities other than weight values are identified by the appropriate unit of measurement, or symbol thereof, or a special sign,

— weight values that are not weighing results (T.5.2.1 through T.5.2.3) shall be clearly identified, or they may be displayed only temporarily on manual command and shall not be printed.

No restrictions apply if the weighing mode is made inoperative by a special key.

4.4.3. Printing devices

Printing shall be clear and permanent for the intended use. Printed figures shall be at least 2 mm high.

If printing takes place, the name or the symbol of the unit of measurement shall be either behind the value or above a column of values.

Printing shall be made impossible when the indication is not stable.

Printing shall not be possible when the variation in the position of the equilibrium device corresponds to a variation of more than plus or minus one scale interval including the rounding error.

4.5. Levelling device and level indicator

An instrument shall be fitted with a levelling device and a level indicator. The level indicator shall be fixed firmly on the instrument in a place clearly visible to the user.

The following, however, are exempt from this obligation :

— freely suspended instruments,

— instruments installed in a fixed position,

— instruments which comply with the requirements on tilting when tilted to 5 % in any direction.

4.5.1. Instrument of class (III) or (IIII)

The sensitivity of the level indicator shall be such that when the instrument is tilted longitudinally or transversely in such a way, that the moving indicating part of the level indicator shows a displacement of 2 mm :

a) zero load indication shall not vary by more than two verification scale intervals,

b) the variation between the results obtained for all loads, on the one hand in the reference position and on the other in the tilted position, shall not exceed the maximum permissible error for the load concerned (the indication having been adjusted to zero at no-load, both in the reference position and the tilted position, or the result is corrected for the deviation of zero).

4.5.2. Instrument of class (I) or (II)

The sensitivity of the level indicator shall be such that its moving indicating part shows a displacement of a least 2 mm for a tilt of 2/1000.

Point 4.5.1.b applies to instruments of class (II) .

4.6. Zero-setting and zero-tracking devices

An instrument may have one or more zero-setting devices and shall have not more than one zero-tracking device.

4.6.1. Maximum effect

The effect of any zero-setting device shall not alter the maximum weighing capacity of the instrument.

The overall effect of zero-setting and zero-tracking devices shall be not more than 4 %, and of the initial zero-setting device not more than 20 %, of the maximum capacity (11).

A wider range is possible for the initial zero-setting device if tests show that the instrument complies with points 3.5, 3.6, 3.8 and 3.9 for any load compensated by this device within the specified range.

4.6.2. Accuracy

After zero setting the effect of zero deviation on the result of the weighing shall be not more than 0.25 e ; however, on an instrument with auxiliary indicating devices this effect shall be not more than 0.5 d.

4.6.3. Control of the zero-setting device

An instrument — except an instrument according to points 4.14 and 4.15 — whether or not equipped with an initial zero-setting device, may have a combined semi-automatic zero-setting device, and a semi-automatic tare-balancing device operated by the same key.

If an instrument has a zero-setting device and a tare-weighing device the control of the zero-setting device shall be separate from that of the tare-weighing device.

A semi-automatic zero-setting device shall function only if it cancels any previous tare operation.

4.6.4. Zero indicating device on an instrument with digital indication

An instrument with digital indication shall have a device that displays a special signal when the deviation from zero is not more than 0.25 e. This device may work as well when zero is indicated after a tare operation.

This device is not mandatory on an instrument that has an auxiliary indicating or a zero tracking device.

4.6.5. Automatic zero-setting device

An automatic zero-setting device shall operate only when :

— the equilibrium is stable,

— the indication has remained stable below zero for at least 5 seconds.

4.6.6. Zero-tracking device

A zero-tracking device shall operate only when :

— the indication is at zero, or shows a negative net value when there is no load on the load receptor,

— the equilibrium is stable,

— the corrections are not more than 0.5 d within one second.

4.7. Tare devices

4.7.1. General requirements

Tare devices shall comply with the relevant provisions of points 4.1 through 4.4.

(11) This provision does not affect an instrument of class (IIII), except if it is used for commercial transactions.

4.7.2. Scale interval

The scale interval of a tare-weighing device shall be equal to the scale interval of the instrument for any given load.

4.7.3. Accuracy

A tare device shall permit setting the indication to zero with an accuracy better than :

± 0.25 e for electronic instruments and any instrument with analogue indication,

± 0.5 d for mechanical instruments with digital indication and instruments with auxiliary indicating devices.

On a multi-interval instrument e shall be e_1.

4.7.4. Operating range

The tare device shall be such that it cannot be used below its zero effect or above its maximum indicated effect.

4.7.5. Visibility of operation

Operation of the tare device shall be visibly indicated on the instrument. In the case of instruments with digital indication this shall be done by marking the indicated net value with the sign " NET " (12).

This is not required for an instrument with a combined semi-automatic zero-setting device and a semi-automatic tare-balancing device operated by the same key.

If gross and net can be indicated selectively while any tare device is in operation, the fact that this device is in use shall be shown on a separate tare indicator and the weight value shall be marked with the sign " G " or " B " or " NET " as selected.

Acceptable solution

The use of a mechanical tare adding device should be shown by the indication of the tare value, or by the display on the instrument of a sign, e.g. letter " T ".

4.7.6. Substractive tare device

When the use of a substractive tare device does not allow the value of the residual weighing range to be known, a device shall prevent the use of the instrument above its maximum capacity or indicate that this capacity has been reached.

4.7.7. Semi-automatic or automatic tare devices

These devices shall operate only when the instrument is in stable equilibrium.

4.7.8. Combined zero-setting and tare-balancing devices

If the semi-automatic zero-setting device and the semi-automatic tare-balancing device are operated by the same key, points 4.6.2, 4.6.4 and if appropriate 4.6.6 apply at any load.

4.7.9. Consecutive tare operations

Repeated operation of a tare device is permitted.

If more than one tare device is operative at the same time, tare weight values shall be clearly designated when indicated or printed.

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(12) NET may be displayed as " NET ", " Net " or " net ".

4.7.10. Printing of weighing results

Gross weight values may be printed without any designation. For a designation by a symbol, only " G " or " B " are permitted.

If only net weight values are printed without corresponding gross or tare values, they may be printed without any designation. A symbol for designation shall be " N ".

If net weight values are printed together with the corresponding gross and/or tare values, the net and tare values shall at least be designated by the corresponding symbols " N " and " T ".

If net weight values and tare values determined by different tare devices are printed separately, they shall be suitably identified.

4.8. Preset tare devices

4.8.1. Scale interval

Regardless of how a preset tare value is introduced into the device, its scale interval shall be equal to the scale interval of the instrument. For a multi-interval instrument, the maximum preset tare value shall not be greater than Max_1 and the indicated or printed calculated net value shall be rounded to the scale interval of the instrument for the same net weight value.

4.8.2. Modes of operation

A preset tare device may be operated together with one or more tare devices provided that :

— point 4.7.9 is respected and

— a preset tare operation cannot be modified or cancelled as long as any tare device operated after the preset tare operation is still in use.

Preset tare devices may operate automatically only if the preset tare value is clearly identified with the load to be measured (e.g. by bar code identification on the container).

4.8.3. Indication of operation

For the indicating device point 4.7.5 applies. It shall be possible to indicate the preset tare value at least temporarily.

Point 4.7.10 applies accordingly provided that :

— if the calculated net value is printed at least the preset tare value is printed as well, with the exception of an instrument covered by points 4.14, 4.15 or 4.17 ;

— preset tare values are designated at least by the symbol " PT ".

4.9. " Weigh " and " locked " positions

4.9.1. Prevention of weighing outside the " weigh " position

If an instrument has one or more locking devices, these devices shall only have two stable positions corresponding to " locked " and " weigh " and weighing shall only be possible in the " weigh " position.

A " preweigh " position may exist on an instrument of class (I) or (II), except those under points 4.14 through 4.17.

4.9.2. Indication of position

The " locked " and " weigh " positions shall be clearly shown.

4.10. Auxiliary verification devices (removable or fixed)

4.10.1. Devices with one or more platforms

The nominal value of the ratio between the weights to be placed on the platform to balance a certain load and this load shall not be less than 1/5000 (it shall be visibly indicated just above the platform).

The value of the weights needed to balance a load equal to the verification scale interval shall be an integer multiple of 0.1 gram.

4.10.2. Numbered scale devices

The scale interval of the auxiliary verification device shall be equal to or smaller than 1/5 of the verification scale interval for which it is intended.

4.11. Devices for selection (or switching) between various load receptors-load transmitting devices and various load measuring devices

4.11.1. Compensation of no-load effect

The selection device shall ensure compensation for the unequal no-load effect of the various load receptors-load transmitting devices in use.

4.11.2. Zero-setting

Zero-setting of an instrument with any multiple combination of various load measuring devices and various load receptors shall be possible without ambiguity and in accordance with the provisions of point 4.6.

4.11.3. Impossibility of weighing

Weighing shall not be possible while selection devices are being used.

4.11.4. Identification of the combinations used

Combinations of load receptors and load measuring devices used shall be readily identifiable.

4.12. " Plus " and " minus " comparator instrument

For the purposes of verification, a " plus " and " minus " comparator instrument is considered to be a semi-self-indicating instrument.

4.12.1. Distinction between " plus " and " minus " zones

On an analogue indicating device the zones situated on either side of zero shall be distinguished by " + " and " — " signs.

On a digital indicating device an inscription near the indicating device shall be given :

— range ± ... g (or kg), or

— range —...g/+...g (or kg).

4.12.2. Form of scale

The scale of a comparator instrument shall have at least one scale division d = e on either side of zero. The corresponding value shall be shown at either end of the scale.

4.13. Counting instrument with unit-weight receptor

For the purposes of verification a counting instrument is considered to be a semi-self-indicating instrument.

4.13.1. Counting instrument without scale

To permit verification, a counting instrument shall have a scale with at least one scale division d = e on either side of zero ; the corresponding value shall be shown on the scale.

4.13.2. Counting ratio

The counting ratio shall be shown clearly just above each counting platform or each counting scale mark.

4.14. Instrument for direct selling to the public

The following requirements apply to an instrument of class (II) (III) or (IIII), with a maximum capacity not greater than 100 kg designed to be used for direct selling to the public.

4.14.1. Primary indications

On an instrument for direct selling to the public the primary indications are the weighing result and information about correct zero position, tare and preset tare operations.

4.14.2. Counting ratio

The counting ratio on a mechanical counting instrument shall be 1/10 or 1/100.

4.14.3. Zero-setting device

An instrument for direct selling to the public shall not be fitted with a non-automatic zero-setting device which can be operated without a tool.

4.14.4. Tare devices

No mechanical instrument with a weight receptor shall be fitted with a tare device.

An instrument with one platform may be fitted with tare devices if they allow the public to see :

— whether they are in use and

— whether their setting is altered.

One or more consecutive operations of tare devices shall not be possible unless a previous tare operation is cancelled.

4.14.4.1. Non-automatic tare device

A displacement of 5 mm of a point of the control shall be at most equal to one verification scale interval.

4.14.4.2. Semi-automatic tare device

An instrument may be fitted with semi-automatic tare devices if :

— the action of the tare devices does not permit a reduction of the value of the tare,

— their effect can only be cancelled when there is no load on the load receptor.

In addition, the instrument shall comply with at least one of the following requirements :

1. the tare value is indicated permanently in a separate display,
2. the tare value is indicated with a sign "—" (minus), when there is no load on the load receptor, or

3. the effect of the device is cancelled automatically and the indication returns to zero when unloading the load receptor after a stable net weighing result greater than zero has been indicated.

4.14.4.3. Automatic tare device

An instrument shall not be fitted with an automatic tare device.

4.14.5 Preset tare device

A preset tare device may be provided if the preset tare value is indicated as a primary indication on a separate display which is clearly differentiated from the weight display. Point 4.14.4.2, first paragraph and second paragraph, n° 3, apply.

It shall not be possible to operate a preset tare device if a tare device is in use.

4.14.6. Impossibility of weighing

It shall be impossible to weigh or to guide the indicating element during the normal locking operation or during the normal operation of adding or substracting weights.

4.14.7. Visibility

All primary indications shall be visible clearly and simultaneously to both the vendor and the customer.

On digital devices that display primary indications, the numerical figures on either set shall be of the same dimension, at least 10 mm high, with a tolerance of 0.5 mm.

On an instrument to be used with weights it shall be possible to distinguish the value of the weights.

Acceptable solution

The primary indications should be grouped together in two sets of scales or displays.

4.14.8. Auxiliary and extended indicating devices

An instrument shall not be fitted with an auxiliary indicating device nor an extended indicating device.

4.14.9. Instrument of class (II)

An instrument of class (II) shall comply with the requirements given in point 3.9 for an instrument of class (III).

4.14.10. Significant fault and significant durability error

When a significant fault or a significant durability error has been detected, a visible or audible alarm shall be provided for the customer, and data transmission to any peripheral equipment shall be prevented. This alarm shall continue until such time as the user takes action or the cause disappears.

4.15. Additional requirements for an instrument for direct selling to the public with price indication

The following requirements are to be applied in addition to point 4.14.

4.15.1. Primary indications

On a price-indicating instrument the supplementary primary indications are unit price and price to pay and, if applicable, number, unit price and price to pay for non-weighed articles, prices for non-weighed articles and price totals. Price charts, such as fan charts, are not subject to the requirements of this Recommendation.

4.15.2. Instrument with price scales

For unit price and price-to-pay scales, points 4.2 and 4.3 through 4.3.3 apply accordingly ; however, decimal fractions shall be indicated according to national regulations.

Reading from price scales shall be so possible that the absolute value of the difference between the product of the indicated weight W and unit price U and the indicated price to pay P is not greater than the product of e and the unit price for that scale :

$$|W \cdot U - P| \leqslant e \cdot U$$

4.15.3. Price computing instrument

The price to pay shall be calculated and rounded to the nearest interval of price to pay, by multiplication of weight and unit price, both as indicated by the instrument. The device which performs the calculation is in any case considered a part of the instrument.

The interval of price to pay shall comply with the national regulations applicable to trade.

The indications of weights, unit price and price to pay shall remain visible after the weight indication is stable, and after any introduction of the unit price, for at least one second and while the load is on the load receptor.

These indications may remain visible for no more than 3 seconds after removing the load, provided that the weight indication has been stable before and the indication would otherwise be zero. As long as there is a weight indication after removing the load, it shall not be possible to introduce or change a unit price.

If transactions performed by the instrument are printed, weight, unit price and price to pay shall all be printed.

4.15.4. Special applications of a price computing instrument

Only if all transactions performed by the instrument or by connected peripherals are printed on a ticket or label intended for the customer, a price computing instrument may perform additional functions which facilitate trade and management. These functions shall not lead to confusion about the results of weighing and price computing.

Other operations or indications not covered by the following provisions may be performed, provided that no indication which could possibly be misunderstood as a primary indication is presented to the customer.

4.15.4.1. Non-weighed articles

An instrument may accept and record positive or negative prices to pay of one or several not weighed articles, provided that the weight indication is zero or the weighing mode is made inoperative. The price to pay for one or more of such articles shall be shown in the price-to-pay display.

If the price to pay is calculated for more than one equal articles, the number of articles shall be shown on the weight display, without being possibly taken for a

weight, and the price for one article on the unit price display, unless supplementary displays are used to show the number of articles and/or the article price.

4.15.4.2. Totalization

An instrument may totalize transactions on one or several tickets ; the price total shall be indicated on the price-to-pay display, and printed accompanied by a special word or symbol, either at the end of the price to pay column, or on a separate label or ticket with appropriate reference to the commodities whose prices to pay have been totalized ; all prices to pay that are totalized shall be printed, and the price total shall be the algebraic sum of all these prices as printed.

An instrument may totalize transactions performed on other instruments linked to it, directly or over metrologically controlled peripherals, under the provisions of point 4.15.4 and if the price-to-pay scale intervals of all connected instruments are identical.

4.15.4.3. Multi-vendor operation

An instrument may be designed to be used by more than one vendor or to serve more than one customer at the same time, provided that the connection between the transactions and the relevant vendor or customer is appropriately identified.

4.15.4.4. Cancellation

An instrument may cancel previous transactions provided each transaction is printed and the relevant price to pay cancelled is printed with an appropriate comment. If the transaction to be cancelled is displayed to the customer it shall be clearly differentiated from normal transactions.

4.15.4.5. Additional information

An instrument may print additional information if this is clearly correlated to the transaction and does not interfere with the assignment of the weight value to the unit symbol.

4.15.5. Self-service instrument

A self-service instrument need not have two sets of scales or displays.

If a ticket or a label is printed, the primary indications shall include a designation of the product when the instrument is used to sell different products.

4.16. Instrument similar to one normally used for direct selling to the public

An instrument similar to one normally used for direct selling to the public which does not comply with the provisions of points 4.14 and 4.15 shall carry, near the display, the indelible marking :

" Not to be used for direct selling to the public ".

4.17. Price labelling instrument

Points 4.14.9, 4.15.3 (§ 1 and 5), 4.15.4.1 (§ 1) and 4.15.4.5 apply.

A price labelling instrument shall have at least one display for the weight. It may be used temporarily for setup purposes like supervision of setting weight limits, unit prices, preset tare values, commodity names etc.

It shall be possible to verify, during use of the instrument, the actual values of unit price and preset tare value.

Printing below minimum capacity shall not be possible.

5. Requirements for electronic instruments

In addition to points 3 and 4, an electronic instrument shall comply with the following requirements.

5.1. General requirements

5.1.1. An electronic instrument shall be designed and manufactured such that, when it is exposed to disturbances :

either, a) significant faults do not occur, or

b) significant faults are detected and acted upon by means of a checking facility.

Note : A fault equal to or smaller than e is allowed irrespective of the value of the error of indication.

5.1.2. The requirements in points 3.5, 3.6, 3.8, 3.9 and 5.1.1 shall be met durably, in accordance with the intended use of the instrument. An electronic instrument shall either be provided with the durability protection features specified in point 5.3.1 or it shall undergo the durability tests specified in point 5.5.4. The choice between these two possibilities is left to the manufacturer. However, digital electronic devices shall be provided with the durability protection features specified in points 5.3.2 through 5.3.6.

5.1.3. A pattern of an electronic instrument is presumed to comply with the requirements in points 5.1.1, 5.1.2 and 5.4.1 if it passes the examinations and tests specified in point 5.5.

5.1.4. The requirements in point 5.1.1 may be applied separately to :

a) each individual cause of significant fault, and/or

b) each part of the electronic instrument.

The choice, whether point 5.1.1 (a) or point 5.1.1 (b) is applied, is left to the manufacturer.

5.2. Devices with checking facilities

5.2.1. When a significant fault has been detected, a visual or audible indication shall be provided automatically and shall continue until such time as the user takes action or the fault disappears.

5.2.2. It shall be possible during pattern evaluation to verify the presence and correct functioning of the checking facilities.

5.2.3. The requirements in points 5.2.1 and 5.2.2 do not apply to an electronic instrument or parts of an electronic instrument for which the manufacturer claims that they comply with the requirements in point 5.1.1 (a) even though they may be equipped with checking facilities.

5.3. Durability protection features

5.3.1. Means shall be provided so that one measuring process for which the electronic instrument is intended can be performed or simulated upon switch-on (in the case of an electronic instrument permanently connected to the mains power supply, at switch-on of indication), or at the discretion of the operator.

Such means could be a mechanical or electrical reference signal simulating a load and leading to a measurement result, or an external or built-in weight.

5.3.2. Upon switch-on (switch-on of indication), a special procedure shall be performed which shows all relevant signs of the indicator in their active and non-active state sufficiently long to be checked by the operator.

5.3.3. Upon switch-on (switch-on of indication), all data storage components shall be checked automatically to verify that :

a) the values of all permanently memorized instructions and data are correct ; through such means as :

— summing up all instruction and data codes and comparing the sum with a fixed value,

— line redundancy check — LRC — and vertical redundancy check — VRC — (ISO 1155, October 1973),

— cyclic redundancy check — CRC — (ISO 2111, June 1971),

— double storage of data, both in same code,

— double storage of data, second in inverse or shifted coding,

— storage of data in " safe coding ", e.g. protected by checksum, line and column parity bits ;

b) all procedures of internal transfer and storage of data relevant to the measuring result are performed correctly ; through such means as :

— write-read-routine,

— conversion and reconversion of codes,

— use of " safe coding " (check sum, parity bit),

— double storage.

5.3.4. All relevant measurement data shall be checked for correct value whenever they are stored internally or transmitted to peripherals by interface, through such means as : parity bit, check sum, double storage or handshake-routine with retransmission.

Note : The use of parity bit alone is not sufficient in case of storing or reading data which are relevant to the metrological characteristics of the electronic instrument.

5.3.5. When a significant durability error has been detected automatically, a visual or audible indication shall be provided and shall continue until such time as the user takes action or the error disappears.

5.3.6. It shall be possible during pattern evaluation to verify the presence and correct functioning of durability protection features.

5.4. Functional requirements

5.4.1. In addition to point 3.9, an electronic instrument shall comply with the requirements under a relative humidity of 93 % at the maximum high temperature specified for the instrument. This is not applicable to an electronic instrument of class (I), and of class (II) if e is less than 1 g.

5.4.2. When an electronic instrument is subjected to the disturbances specified in point 5.5.3, the difference between the weight indication due to the disturbance and the indication without the disturbance (intrinsic error), shall not exceed e or the instrument shall detect and react to a significant fault.

5.4.3. During the warm-up time of an electronic instrument there shall be no indication or transmission of the weighing result.

5.4.4. An electronic instrument may be equipped with an interface permitting the coupling of the instrument to external equipment. When external equipment is connected, the electronic instrument shall continue to function correctly and its metrological functions shall not be influenced.

5.4.5. A battery-operated electronic instrument shall indicate whenever the voltage drops below the manufacturer's specified minimum value and shall either continue to function correctly or automatically be put out of service.

5.5. Performance and durability tests

5.5.1. Test considerations

All electronic instruments of the same category, whether or not equipped with checking facilities shall be subjected to the same performance test programme.

5.5.2. State of instrument under test

Performance tests shall be carried out on fully operational equipment in its normal operational state. When connected in other than a normal configuration, the procedure shall be mutually agreed by the approval authority and the applicant.

5.5.3. Performance tests

Performance tests shall be performed according to Annex B, points B.2 and B.3.

Test	Characteristic under test
Static temperatures	Influence factor
Damp heat, steady state	Influence factor
Power voltage variations	Influence factor
Short time power reductions	Disturbance
Bursts (transients)	Disturbance
Electrostatic discharge	Disturbance
Electromagnetic susceptibility	Disturbance

5.5.4. Durability tests

Durability tests, if applicable, shall be performed according to Annex B, point B.4.

Test	Characteristic under test
Dry heat, steady state	Durability
Damp heat, steady state	Durability

6. Technical requirements for a non-self-indicating instrument

A non-self-indicating instrument shall comply with points 3 and 4, as far as applicable. This point gives complementary provisions corresponding to some of the requirements of point 4.

While the provisions of point 6.1 are mandatory, those of point 6.2 contain " acceptable solutions " as introduced in point 4.

Provisions for certain simple instruments that may be submitted directly for initial verification are given in points 6.3 through 6.9. These simple instruments are :

— simple equal arm and 1/10 ratio beams,

— simple steelyards with sliding poises,

— Roberval and Béranger instruments,

— instruments with ratio platforms,

— instruments of the steelyard type with accessible sliding poises.

6.1. Minimum sensitivity

An extra load equivalent to the absolute value of the maximum permissible error for the applied load, shall be placed on the instrument at equilibrium and shall cause a permanent displacement of the indicating element of at least :

1 mm for an instrument of class (I) or (II)

2 mm for an instrument of class (III) or (IIII) with Max $\leq$ 30 kg

5 mm for an instrument of class (III) or (IIII) with Max > 30 kg.

The sensitivity tests shall be carried out by placing extra loads with a slight impact, in order to eliminate the effects of discrimination threshold

6.2. Acceptable solutions for indicating devices

6.2.1. General provisions

6.2.1.1. Equilibrium index

Index of relative displacement in relation to another index : the two indices should be of the same thickness and the distance between them shall not exceed this thickness.

However, this distance may be equal to 1 mm, if the thickness of the indices is less than this value.

6.2.1.2. Sealing

It should be possible to seal the sliding poises, the removable masses and the adjusting cavities or the housings of such devices.

6.2.1.3. Printing

If the device permits printing, this should only be possible if sliding bars or poises or a mass switching mechanism are each in a position corresponding to a whole number of scale divisions. Except for accessible sliding poises or bars, printing should only be possible if the equilibrium index is in the reference position to within the nearest half scale interval.

6.2.2. Sliding poise devices

6.2.2.1. Form of scale marks

On bars on which the scale interval is the verification scale interval of the instrument, the scale marks should consist of lines of constant thickness. On other major (or minor) bars the scale marks should consist of notches.

6.2.2.2. Scale spacing

The distance between scale marks should not be less than 2 mm and be of sufficient length so that the normal machining tolerances for notches or scale marks do no cause an error in the weighing result exceeding 0.2 of the verification scale interval.

6.2.2.3. Stops

The displacement of sliding poises and minor bars should be limited to the graduated part of major and minor bars.

6.2.2.4. Reading index

Each sliding poise should be provided with a reading index.

6.2.2.5. Accessible sliding poise devices

There should be no moving parts in sliding poises, except sliding minor bars.

There should be no cavity on sliding poises that could accidentally hold foreign bodies.

It should be possible to seal parts that are detachable.

The displacement of sliding poises and minor bars should require a certain effort.

6.2.3. Indication by use of metrologically controlled weights

The reduction ratios should be in the form 10^k, k being an integer or zero.

On an instrument intended for direct selling to the public, the height of the raised edge of the weights receptor platform should not exceed one tenth of the greatest dimension of the platform, without being more than 25 mm.

6.3. Conditions of construction

6.3.1. Equilibrium index

An instrument shall be provided with two moving indices or one moving index and a fixed datum mark, the respective position of which indicates the reference position of equilibrium.

On an instrument of class (III) or (IIII) designed to be used for direct selling to the public, the indices and scale marks shall allow equilibrium to be seen from the opposite sides of the instrument.

6.3.2. Knives, bearings and friction plates

6.3.2.1. Types of connection

Levers shall be fitted with knives only ; these shall be pivoted on bearings.

The line of contact between knives and bearings shall be a straight line.

Counter-beams shall be pivoted on knife-edges.

6.3.2.2. Knives

The knives shall be fitted to the levers in such a way that the invariability of the ratios of the lever arms is ensured. They shall not be welded or soldered.

The edges of the knives of one and the same lever shall be practically parallel and shall be situated in one plane.

6.3.2.3. Bearings

The bearings shall not be welded or soldered to their supports or in their mountings.

It shall be possible for bearings of an instrument with ratio platforms and steelyards to oscillate in all directions on their supports or in their mountings. On such instruments anti-disconnection devices shall prevent the disconnection of articulated parts.

6.3.2.4. Friction plates

The longitudinal play of the knives shall be limited by friction plates. There shall be point contact between knife and friction plates and it shall be situated on the extension of the line(s) of contact between knife and bearing(s).

The friction plate shall form a plane through the point of contact with the knife and its plane shall be perpendicular to the line of contact between knife and bearing. It shall not be welded or soldered to the bearings or their support.

6.3.3. Hardness

Contact parts of knives, bearings, friction plates, interlevers, interlever supports and links shall have a hardness of at least 58 Rockwell C.

6.3.4. Protective coating

A protective coating may be applied to the parts in contact of jointed components, if this does not lead to changes of metrological properties.

6.3.5. Tare devices

No instrument shall be fitted with a tare device.

6.4. Simple equal arm beam

6.4.1. Symmetry of the beams

The beam shall have two planes of symmetry, longitudinal and transversal. It shall be in equilibrium with or without the pans. Detachable parts which may be used equally well on either end of the beam shall be interchangeable and of equal mass.

6.4.2. Zero setting

If an instrument of class (III) or (IIII) is provided with a zero setting device, this shall be a cavity below one of the pans.

This cavity may be sealed.

6.5. Simple 1/10 ratio beam

6.5.1. Indication of the ratio

The ratio shall be indicated legibly and permanently on the beam in the form 1:10 or 1/10.

6.5.2. Symmetry of the beam

The beam shall have a longitudinal plane of symmetry.

6.5.3. Zero setting

The provisions of point 6.4.2 apply.

6.6. Simple sliding poise instrument (steelyard)

6.6.1. General

6.6.1.1. Scale marks

The scale marks shall be lines or notches, either on the edge, or on the flat of the graduated shank.

The minimum scale spacing is 2 mm between notches and 4 mm between lines.

6.6.1.2. Pivots

The load per unit length on the knives shall be not more than 10 kg/mm.

The bores of bearings in the form of an annulus shall have a diameter at least equal to 1.5 times the largest dimension of the cross section of the knife.

6.6.1.3. Equilibrium index

The length of the equilibrium index, taken from the edge of the fulcrum knife-edge of the instrument, shall be not less than 1/15 of the length of the graduated part of the major sliding poise bar.

6.6.1.4. Distinctive mark

The head and the sliding poise of an instrument with detachable sliding poises shall bear the same distinctive mark.

6.6.2. Instrument with single capacity

6.6.2.1. Minimum distance between knife-edges

The minimum distance between knife-edges is :

25 mm for maximum capacities less than or equal to 30 kg,

20 mm for maximum capacities exceeding 30 kg.

6.6.2.2. Graduation

The graduation shall extend from zero to the maximum capacity.

6.6.2.3. Zero-setting

If an instrument of class (III) or (IIII) is provided with a zero-setting device, this shall be a captive screw or nut arrangement with a maximum effect of 4 verification scale intervals per revolution.

6.6.3. Instrument with dual capacity

6.6.3.1. Minimum distance between knife-edges

The minimum distance between the knife-edges is :

45 mm for the lower capacity,

20 mm for the higher capacity.

6.6.3.2. Differentiation of suspension mechanisms

The suspension mechanism of the instrument shall be differentiated from the load suspension mechanism.

6.6.3.3. Numbered scales

The scales corresponding to each of the capacities of the instrument shall permit weighing from zero to maximum capacity, without a break in continuity :

— either without the two scales having a common part,

— or with a common part of not more than 1/5 of the highest value of the lower scale.

6.6.3.4. Scale intervals

The scale intervals of each of the scales shall have a constant value.

6.6.3.5. Zero-setting devices

Zero-setting devices are not permitted.

6.7. Roberval and Béranger instruments

6.7.1. Symmetry

Detachable symmetrical parts occurring in pairs shall be interchangeable and of equal mass.

6.7.2. Zero-setting

If an instrument is provided with a zero-setting device, this shall be a cavity below the support of one of the pans.

This cavity may be sealed.

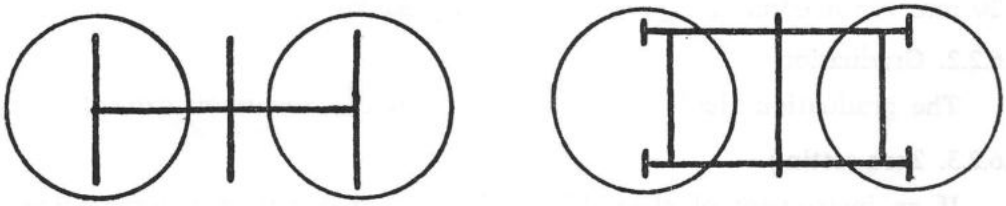
6.7.3. Length of the knife-edges

On an instrument having a simple beam :

— the distance between the outward ends of the load knife-edges shall be at least equal to the diameter of the bottom of the pan,

— the distance between the outward ends of the centre knife-edge shall be at least equal to 0.7 times the length of the load knife-edges.

A double beam instrument shall be assured a stability of the mechanism equal to that obtained with a simple beam instrument.



simple beam

double beam

6.8. Instruments with ratio platforms

6.8.1. Maximum capacity

The maximum capacity of the instruments shall be greater than 30 kg.

6.8.2. Indication of the ratio

The ratio between the weighed load and the equilibrium load shall be indicated legibly and permanently on the beam in the form 1:10 or 1/10.

6.8.3. Zero-setting

An instrument shall have a zero-setting device consisting :

— either of a cup with greatly convex cover,

— or of a captive screw or nut arrangement, with a maximum effect of 4 verification scale intervals per revolution.

6.8.4. Complementary balancing device

If an instrument is provided with a complementary device that avoids the use of weights which are of low value in relation to the capacity, this device shall be a graduated steelyard with a sliding poise, the effect being additive and not more than 10 kg.

6.8.5. Locking of the beam

An instrument shall have a manual device for locking the beam, the action of which prevents the equilibrium indices coinciding when at rest.

6.8.6. Provisions relating to wooden parts

If certain parts of an instrument, such as the frame, the platform or the board are of wood, this shall be dry and free from defects. It shall be covered with a paint or an effective protective varnish.

No nails shall be used for the final assembly of wooden parts.

6.9. Instrument with a load-measuring device with accessible sliding poises (of the steelyard type)

6.9.1. General

The provisions of point 6.2 relating to load measuring devices with accessible sliding poises shall be observed.

6.9.2. Range of numbered scale

The numbered scale of the instrument shall permit continuous weighing from zero to the maximum capacity.

6.9.3. Minimum scale spacing

The scale spacing i_x of the different bars ($x = 1,2,3..$) corresponding to the scale interval d_x of these bars, shall be :

$$i_x \geq \frac{d_x}{e} \cdot 0.05 \text{ mm, but } i_x \geq 2 \text{ mm}$$

6.9.4. Ratio platform

If an instrument is provided with a ratio platform for extending the indicating range of the numbered scale, the ratio between the value of the weights placed on the platform to balance a load and the load itself shall be 1/10 or 1/100.

This ratio shall be indicated legibly and permanently on the beam in a position close to the ratio platform, in the form 1:10, 1:100, or 1/10, 1/100.

6.9.5. Zero-setting

The provisions of point 6.8.3 apply.

6.9.6. Locking of the beam.

The provisions of point 6.8.5 apply.

6.9.7. Wooden parts

The provisions of point 6.8.6 apply.

7. Marking of an instrument

7.1. Descriptive markings (13)

An instrument shall carry, in order, the following markings.

7.1.1. Compulsory in all cases

— manufacturer's mark, or name written in full

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(13) Markings given by way of example but variable according to national regulations.

— indication of accuracy class in the form of a Roman number in an oval (14) :

for special accuracy	Ⓘ
for high accuracy	Ⓘⓘ
for medium accuracy	Ⓘⓘⓘ
for ordinary accuracy	Ⓘⓘⓘⓘ

— maximum capacity in the form Max ...

— minimum capacity in the form Min ...

— verification scale interval in the form e =

7.1.2. Compulsory if applicable

— name or mark of manufacturer's agent for an imported instrument

— serial number

— identification mark on each unit of an instrument consisting of separate but associated units

— pattern approval mark

— scale interval, if d < e	in the form d =
— maximum additive tare effect	in the form T = + ...
— maximum substractive tare effect, if different from Max	in the form T = — ...
— tare interval, only if $d_T \neq d$	in the form d_T =
— maximum safe load (if the manufacturer has provided for a maximum safe load of more than Max + T)	in the form Lim =
— the special temperature limits within which the instrument complies with the prescribed conditions of correct operation	in the form ...°C/...°C
— counting ratio on a counting instrument according to point 4.13	in the form 1:... or 1/...
— ratio between weight and load platform in the form specified in points 6.5.1, 6.8.2 and 6.9.4.	

7.1.3. Additional markings

Additional markings may, if necessary, be required on an instrument according to its particular use or to certain special characteristics, such as e.g.

— not to be used for direct selling to the public/commercial transactions

— to be used exclusively for : .....

— the stamp does not guarantee/guarantees only .....

— to be used only as follows : .....

7.1.4. Presentation of descriptive markings

The descriptive markings shall be indelible and of a size, shape and clarity allowing easy reading.

They shall be grouped together in a clearly visible place either on a descriptive plate fixed to an instrument, or on a part of the instrument itself.

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(14) See note to point 3.1.1.

The markings : Max ...
Min ...
e ...
and d if d ≠ e

shall also be shown near the display of the result if they are not already located there.

It shall be possible to seal the plate bearing the markings unless it cannot be removed without being destroyed ; in this case it shall be possible to apply to it a control mark.

Acceptable solutions

a) Markings in special cases

In special cases, some of the markings should be in the form of a table.

Examples

For a multi-interval instrument	
Max	2/5/15 kg
Min	20 g
e =	1/2/ 5 g

For an instrument with more than one weighing range (W_1, W_2)	W_1	W_2
Max	20 kg	100 kg
Min	200 g	1 kg
e =	10 g	50 g

For an instrument with weighing ranges in different classes	W_1 (II)	W_2 (III)
Max	1 000 g	5 000 g
Min	1 g	40 g
e =	0.1 g	2 g
d =	0.02 g	2 g

b) Dimensions

When several plates are placed one above the other (as for example in the case of an instrument consisting of several separate devices), they should be of the same width. This common width is fixed at 80 mm.

c) Fixing

The plate should be fixed by rivets or screws.

One of the rivets should be of red copper or material having qualities recognised as similar.

It should be possible to seal the head of one of the screws by means of a lead cap inserted in a device that cannot be dismantled.

The diameter of the rivet head or of the lead cap should be able to accomodate a stamp 4 mm in diameter.

The plate may be glued or consist of a transfer on condition that its removal destroys it ; it should therefore have a place to bear a stamp or a self-adhesive mark.

d) Dimensions of the letters

The height of capital letters should be at least 2 mm.

7.1.5. Specific cases

Points 7.1.1 through 7.1.4 apply in their entirety to a simple instrument made by one manufacturer.

When a manufacturer builds a complex instrument or when several manufacturers are involved in making a simple or complex instrument, the following additional provisions shall be applied.

7.1.5.1. Instrument having several load receptors and load measuring devices

Each load measuring device which is connected or can be connected to one or more load receptors, shall bear the descriptive markings relating to these, viz. :

— identification mark

— maximum capacity

— minimum capacity

— verification scale interval

and, if appropriate, maximum safe load and maximum additive tare effect.

7.1.5.2. Instrument consisting of separately-built main parts

If main parts cannot be exchanged without altering the metrological characteristics of the instrument, each unit shall have an identification mark which shall be repeated in the descriptive markings.

7.2. Verification marks

7.2.1. Position

An instrument shall have a place for the application of verification marks.

This place shall :

— be such that the part on which it is located cannot be removed from the instrument without damaging the marks,

— allow easy application of the mark without changing the metrological qualities of the instrument,

— be visible without the instrument having to be moved when it is in service.

7.2.2. Mounting

An instrument required to bear verification marks shall have a verification mark support, at the place provided for above, which ensures the conservation of the marks :

a) when the mark is made with a stamp this support may consist of a strip of lead or any other material with similar qualities, inserted into a place fixed to the instrument or a cavity bored in the instrument,

b) when the mark is of the self-adhesive type a space shall be provided on the instrument for the application of this mark.

Acceptable solution

For application of the verification marks a stamping area of at least 200 mm^2 is required.

If transfers are used as verification marks the space for these transfers shall have a diameter of at least 25 mm.

8. Metrological controls

8.1. Liability to metrological controls

States may, through legislation, impose metrological controls to verify the adherence of instruments to this Recommendation. Controls may consist of pattern-approval, initial verification, subsequent — e.g. periodic — verifications and in-service inspections. However, instruments according to points 6.4 through 6.9 of this Re-

commendation shall not be subject to pattern approval, and national legislation may provide for initial verification without pattern approval for other types of instruments.

8.2. Pattern approval

8.2.1. Application for pattern approval

The application for pattern approval shall include the submission to the approving authority of normally one instrument representative of the submitted pattern, and the following information and documents, as far as applicable.

8.2.1.1. Metrological characteristics :

— characteristics of the instrument, as per point 7.1

— specifications of the components of the measuring system, e.g. load cells.

8.2.1.2. Descriptive documents :

— drawings of general arrangement and details of metrological interest

— a short functional description of the instrument

— a short technical description of the method of operation in particular for checking facilities and durability protection features, including, if necessary, schematic diagrams.

8.2.2. Pattern evaluation

The submitted documents shall be examined to verify compliance with the requirements of this Recommendation.

Suitable spotchecks shall be performed to establish confidence that the functions are performed correctly in accordance with the submitted documents.

The instruments shall be submitted to the testing procedures of Annex A, and of Annex B if applicable. If testing of the complete instrument is not possible, tests may, as agreed by the approving authority and the applicant, be performed :

— on a simulated set-up

— on main devices separately.

It may be feasible to perform the tests on other premises than those of the authority.

The approving authority may, in special cases, require from the applicant to supply test loads, equipment and personnel to perform the tests.

The approving authorities are advised to consider the possibility of accepting, with the consent of the applicant, test data obtained from other national authorities, without repeating these tests (15).

They may, at their discretion and under their responsibility, accept test data provided by the applicant for the submitted pattern, and reduce their own tests accordingly.

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(15) This follows a Resolution adopted by the International Committee of Legal Metrology (CIML) in 1986, recognizing the interest which knowledge of the results of tests, that may have been carried out by other national metrology services, could have for certain national metrology services to which a submission for pattern approval of the same instrument was made, and urging the CIML Members to facilitate the exchange of such information, which in principle may only be provided with the agreement of the manufacturer, its representative or the importer of the instrument concerned.

8.3. Initial verification

Initial verification shall not be performed unless conformity of the instrument to the approved pattern and/or the requirements of this RI is established under the responsibility of either the manufacturer or the verifying authority. The correct indication of the instrument shall be tested when and where it is installed ready for use, unless it can be readily shipped and installed after initial verification.

8.3.1. Conformity

A declaration of conformity to the approved pattern and/or this Recommendation shall cover :

— correct functioning of all devices, e.g. zero-setting, tare, and calculating devices

— construction material and design, as far as they are of metrological relevance.

8.3.2. Visual inspection

Before testing, the instrument shall be visually inspected for :

— metrological characteristics, i.e. accuracy class, Min, Max, e, d,

— prescribed inscriptions and positions for verification and control marks.

If location and conditions of use of the instrument are known, it should be considered whether they are appropriate.

8.3.3. Tests

Tests shall be carried out to verify compliance with the following requirements :

— points 3.5.1, 3.5.3.3 and 3.5.3.4 : errors of indication (refer to Annex A, points A.4.3 to A.4.5, but 5 loading steps are normally sufficient),

— points 4.6.2 and 4.7.3 : accuracy of zero setting and tare devices (refer to Annex A, points A.4.1.3 and A.4.5.2),

— point 3.6.1 : repeatability (refer to Annex A, point A.4.9, but normally no more than 3 weighings on classes (III) and (IIII) or 6 weighings on classes (I) and (II) are necessary),

— point 3.6.2 : eccentric loading (refer to Annex A, point A.4.6),

— point 3.8 : discrimination (refer to Annex A. point A.4.7).

Other tests may be performed in special cases, e.g. extraordinary construction or doubtful results.

The approving authority may, in special cases, require from the applicant to supply test loads, equipment and personnel to perform the tests.

For all tests, the error limits to be respected shall be the maximum permissible errors upon initial verification. If the instrument is to be shipped to another location after initial verification, the difference in local gravity acceleration between the locations of testing and use shall be considered if appropriate.

8.3.4. Stamping

According to national legislation, initial verification may be testified by verification marks. These marks may indicate the month or year when initial verification took place, or when reverification is due. National legislation may also require sealing of components whose dismantling or maladjustment might alter the metrological characteristics of the instrument without the alterations being clearly visible.

8.4. Subsequent metrological control

8.4.1. Subsequent verification

Upon subsequent verification, normally only inspection and tests according to points 8.3.2 and 8.3.3 shall be performed, the error limits being those on initial verification. Stamping and sealing may take place according to point 8.3.4, the date being that of the subsequent verification.

8.4.2. In-service inspection

Upon in-service inspection normally only inspection and tests according to points 8.3.2 and 8.3.3 shall be performed, the error limits being twice those on initial verification. Stamping and sealing may remain unchanged, or renewed as per point 8.4.1.

ANNEX A

TESTING PROCEDURES FOR THE PATTERN EXAMINATION OF NON-AUTOMATIC WEIGHING INSTRUMENTS IN CLASSES (II), (III) AND (IIII)

A.1. Administrative examination (8.2.1)

Review the documentation that is submitted, including necessary photographs, drawings, relevant technical specifications of main components, etc., to determine if it is adequate and correct. Evaluate the operational manual.

A.2. Compare construction with documentation (8.2.2)

Examine the various devices of the instrument to ensure compliance with the documentation.

A.3. Initial examination

A.3.1. Metrological characteristics

Note metrological characteristics according to the "Evaluation Report" (see Annex C).

A.3.2. Descriptive markings (7.1)

Check the descriptive markings according to the check-list given in the Evaluation Report.

A.3.3. Stamping and sealing (4.1.2.4 and 7.2)

Check the stamping and sealing according to the check-list given in the Evaluation Report.

A.4. Performance tests

A.4.0. General conditions

A.4.0.1. Temperature

The tests shall be performed at a steady ambient temperature, usually normal room temperature unless otherwise specified.

The temperature is deemed to be steady when the difference between the extreme temperatures noted during the test does not exceed one-fifth of the temperature range of the given instrument without being greater than 5 °C (2 °C in the case of a four-hour test), and the rate of change does not exceed 5 °C per hour.

A.4.0.2. Power supply

Instruments using electric power shall normally be connected to the power supply and "on" throughout the tests.

A.4.0.3. Reference position before tests

For an instrument liable to be tilted, the instrument shall be levelled at its reference position.

A.4.0.4. Automatic zero-setting and zero-tracking

During the tests, the effect of the automatic zero-setting device or the zero-tracking device may be switched off or suppressed by starting the test with a load equal to say 10 e. Whether this is done shall be mentioned in the Evaluation Report.

In certain tests where the automatic zero-setting or zero-tracking must be in operation (or not), specific mention of this is made in those test descriptions.

A.4.0.5. Indication with a scale interval smaller than e

If an instrument with digital indication has a device for displaying the indication with a smaller (not greater than 1/5 e) scale interval, this device may be used to determine the error. If a device is used it should be noted in the Evaluation Report.

A.4.1. Checking of zero

A.4.1.1. Range of zero-setting (4.6.1)

A.4.1.1.1. Initial zero-setting

With the load receptor empty, set the instrument to zero. Place a test load on the load receptor and switch the instrument off and then back on. Continue this process until, after placing a load on the load receptor and switching the instrument on and off, it does not rezero. The maximum load that can be rezeroed is the positive portion of the zero-setting range.

Remove any load from the load receptor and set the instrument to zero. Then remove the load receptor (platform) from the instrument. If, at this point, the instrument can be reset to zero by switching it off and back on, the mass of the load receptor is used as the negative portion of the zero-setting range.

If the instrument cannot be reset to zero with the load receptor removed, add weights to any live part of the scale (like on the parts where the load receptor rests) until the instrument indicates zero again.

Then remove weights and, after each weight is removed, switch the instrument off and back on. The maximum load that can be removed while the instrument can still be reset to zero by switching it off and on is the negative portion of the zero-setting range.

The zero-setting range is the sum of the positive and negative portions. If the load receptor cannot readily be removed, only the positive part of the zero-setting range need be considered.

A.4.1.1.2. Non-automatic and semi-automatic zero-setting

This test is performed in the same manner as described in A.4.1.1.1., except that the zero-setting means is used rather than switching the instrument off and on.

A.4.1.1.3. Automatic zero-setting

Remove the load receptor as described in A.4.1.1.1 and place weights on the instrument until it indicates zero.

Remove weights in small amounts and after each weight is removed allow time for the automatic zero-setting device to function so as to see if the instrument is reset to zero automatically. Repeat this procedure until the instrument will not reset to zero automatically.

The maximum load that can be removed so that the instrument can still be reset to zero, is the zero-setting range.

If the load receptor cannot readily be removed, a practical approach can be to add weights to the instrument and use another zero-setting device if provided to set the instrument to zero. Remove then weights and check whether the automatic zero-setting still sets the instrument to zero. The maximum load that can be removed so that the instrument can still be reset to zero is the zero-setting range.

A.4.1.2. Zero indicating device (4.6.4)

For instruments with digital indication and without a zero-tracking device, adjust the instrument to about one scale interval below zero ; then by adding weights equivalent to say 1/10 of the scale interval, determine the range over which the zero indicating device indicates the deviation from zero.

A.4.1.3. Accuracy of zero-setting (4.6.2)

A.4.1.3.1. Non-automatic and semi-automatic zero-setting

The accuracy of the zero-setting device is tested by setting the instrument to zero and then determining the additional load at which the indication changes from zero to one scale interval above zero. The error at zero is calculated according to the description in A.4.3.4.

A.4.1.3.2. Automatic zero-setting or zero-tracking

The indication is brought out off the automatic range (e.g. by loading with 10 e). Then the additional load at which the indication changes from one scale interval to the next above is determined and the error is calculated according to the description in A.4.3.4. It is assumed that the error at zero load would be equal to the error at the load in question.

A.4.2. Setting to zero before loading

For instruments with digital indication the adjustment to zero, or determining the zero point is done as follows :

a) for instruments with non-automatic zero-setting, weights equivalent to half a scale interval are placed on the load receptor, and the instrument is adjusted until the indication alternates between zero and one scale interval. Then weights equivalent to half a scale interval are removed from the load receptor to attain a center of zero reference position ;

b) for instruments with semi-automatic or automatic zero-setting or zero-tracking, the deviation from zero is determined as described in A.4.1.3.

A.4.3. Determination of weighing performance

A.4.3.1. Preloading

Before the first weighing test the instrument shall be preloaded once to Max or to Lim if this is defined.

A.4.3.2. Weighing test

Apply test loads from zero up to and including Max, and similarly remove the test loads back to zero. When determining the initial intrinsic error, at least 10 different test loads are selected, and for other weighing tests at least 5 are selected. The test loads selected shall include Max and Min, and values at or near those at which the maximum permissible error (mpe) changes.

It should be noted that when loading or unloading weights the load must be respectively increased or decreased monotonically.

A.4.3.3. Supplementary weighing test (4.6.1)

For instruments with an initial zero-setting device with a range greater than 20 % of Max, a supplementary weighing test is performed using the upper limit of the range as zero point.

A.4.3.4. Calculation of error

For instruments with digital indication and without a device for displaying the indication with a smaller (not greater than 1/5 e) scale interval, the changeover points are used to determine the indication of the instrument, prior to rounding, as follows.

At a certain load, L, the indicated value, I, is noted. Additional weights of say 1/10 e are successively added until the indication of the instrument is increased unambiguously by one scale interval (I + e). The additional load ΔL added to the load receptor gives the indication, P, prior to rounding by using the following formula :

$$P = I + 1/2\ e - \Delta L$$

The error prior to rounding is :

$$E = P - L = I + 1/2\ e - \Delta L - L$$

Example : an instrument with a scale interval, e, of 5 g is loaded with 1 kg and thereby indicates 1 000 g. After adding successive weights of 0.5 g, the indication changes from 1 000 g to 1 0005 g at an additional load of 1.5 g. Inserted in the above formula these observations give :

$$P = (1\,000 + 2.5 - 1.5)\ g = 1\,001\ g$$

Thus the true indication prior to rounding is 1 001 g, and the error is :

$$E = (1\,001 - 1\,000)\ g = + 1\ g$$

Note : The above description and formulas are valid also for multi-interval instruments. Even if the indication I and the load L are in different weighing ranges the value of e in the formulas shall be the scale interval e_i between the indication I and the next indication $I + e_i$. However in this special case the additional weights ΔL are a multiple of 1/10 e_{i-1}, that is of the scale interval belonging to the lower range.

A.4.4. Instruments with more than one indicating device (3.6.3)

If the instrument has more than one indicating device, the indications of the various devices are compared during the tests described in point A.4.3.

A.4.5. Tare

A.4.5.1. Weighing test (3.5.3.3)

Weighing tests (loading and unloading according to A.4.3.2) are performed with at least two different tare values. At least 5 load steps are selected. The steps shall include values close to Min, the values at which the mpe changes and the value close to the maximum possible net load.

If the instrument is equipped with an additive tare device one of the weighing tests is performed with a tare value close to the maximum additive tare effect.

A.4.5.2. Accuracy of tare setting (4.7.3)

The accuracy of the tare device is tested in a manner similar to the test described in A.4.1.3 with the indication set to zero using the tare device.

A.4.5.3. Tare weighing device (3.5.3.4 and 3.6.3)

If the instrument has a tare weighing device, the results obtained for the same load (tare), by the tare weighing device and the indicating device, are compared.

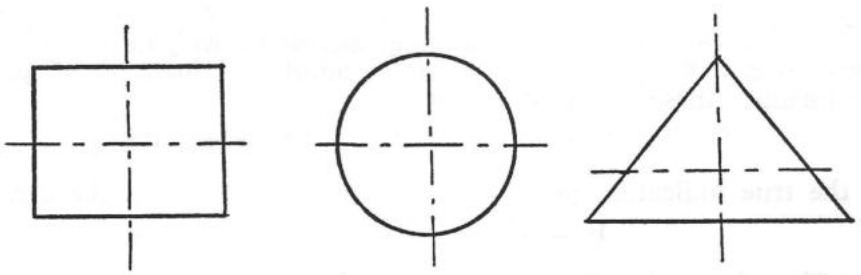
A.4.6. Eccentricity tests (3.6.2)

Preferably large weights are to be used rather than several small weights. Smaller weights may be placed on top of larger weights, but unnecessary stacking must be avoided within the segment to be tested. The load shall be applied centrally if a single weight is used, but applied uniformly over the segment, if several small weights are used.

The location of the load shall be marked on a sketch in the Evaluation Report.

A.4.6.1. Instruments with a load receptor having not more than four points of support

The four quarter segments roughly equal to 1/4 of the surface of the load receptor are loaded in turn (according to the sketches below or similar sketches).



A.4.6.2. Instrument with a load receptor having more than four points of support

The load shall be applied over each support on an area of the same order of magnitude as the fraction 1/n of the surface area of the load receptor, where n is the number of points of support.

Where two points of support are too close together for the above-mentioned test load to be distributed as indicated above, the load is doubled and distributed on twice the area on both sides of the axis connecting the two points of support.

A.4.6.3. Instruments with special load receptors (tank, hopper, etc.)

The load is applied to each point of support.

A.4.7. Discrimination test (3.8)

The following tests are performed with three different loads, e.g. Min, 1/2 Max and Max.

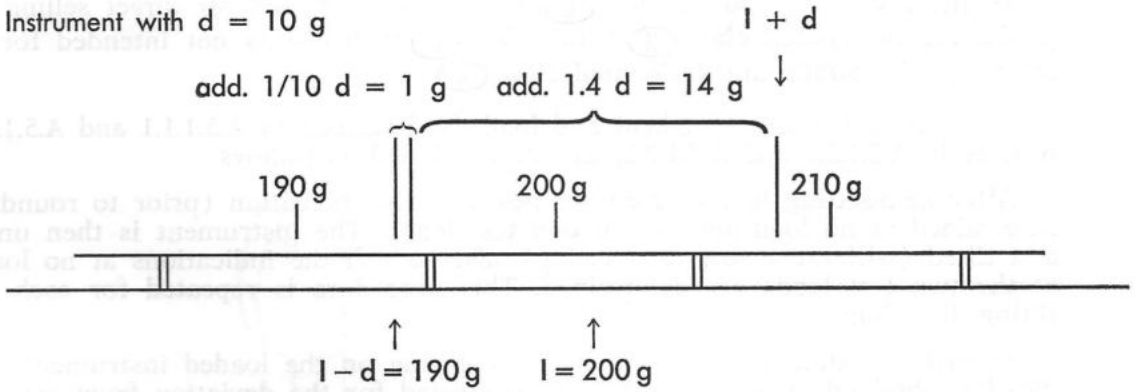
A.4.7.1. Non-self-indication and analogue indication

An extra load is placed gently on or removed from the load receptor while the instrument is at equilibrium. For a certain extra load the equilibrium mechanism shall assume a different position of equilibrium, as specified.

A.4.7.2. Digital indication

A load plus sufficient additional weights (say 10 times 1/10 d) are placed on the load receptor. The additional weights are then successively removed until the indication, I, is decreased unambiguously by one actual scale interval, I — d. One of the additional weights is replaced and a load equal to 1.4 d shall then be gently placed on the load receptor and give a result increased by one actual scale interval above the initial indication, I + d.

Example :



The indication at the start is I = 200 g. Remove additional weights until the indication changes to I — d = 190 g. Add 1/10 d = 1 g and thereafter 1.4 d = 14 g. The indication must then be I + d = 210 g.

A.4.8. Sensitivity of non-self-indicating instruments (6.1)

During this test the instrument must oscillate normally, and an extra load equal to the value of the mpe for the applied load is placed on the instrument while the load receptor is still oscillating. For damped instruments the extra load is applied with a slight impact. The linear distance between the middle points of this reading and the reading without the extra load is taken as the permanent displacement of the indication. The test is performed at least at two different loads, such as zero and Max.

A.4.9. Repeatibility test (3.6.1)

Two series of weighings are performed, one with a load of about 50 % and one with a load close to 100 % of Max. For instruments with Max less than 1 000 kg each series shall consist of 10 weighings. In other cases each series shall consist of at least 3 weighings. Readings are made when the instrument is loaded, and when the unloaded instrument has come to rest between weighings. In the case of a zero deviation between the weighings the instrument shall be reset to zero, or the deviation is taken into consideration by calculation.

If the instrument is provided with automatic zero-setting or zero-tracking it shall be in operation during the test.

A.4.10. Variation of indication with time

A.4.10.1. Four hour test (3.9.4.1)

Load the instrument close to Max. Take one reading as soon as the indication has stabilized and then note the indication while the load remains on the instrument for a period of four hours.

During this test the temperature should not vary more than 2 °C.

A.4.10.2. Half hour test (3.9.4.2)

The difference in the zero indication before and after a period of loading with a load close to Max for half an hour, is determined. The reading is taken as soon as the indication has stabilized.

A.5. Influence factors

A.5.1. Tilting

If the instrument is provided with automatic zero-setting or zero-tracking, it shall not be in operation during the following tests.

The instrument is tilted both forwards and backwards longitudinally, and from side to side, transversely.

In the text that follows, class (II) instruments intended for direct selling to the public are designated class (II)* and class (II) instruments not intended for direct selling to the public are designated class (II).

In practice the tests (no-load and loaded) described in A.5.1.1.1 and A.5.1.1.2, as well as in A.5.1.2.1 and A.5.1.2.2, can be combined as follows.

After zero-setting in the reference position, the indication (prior to rounding) is determined at no load and at the two test loads. The instrument is then unloaded and tilted (without a new zero-setting), after which the indications at no load and at the two test loads are determined. This procedure is repeated for each of the tilting directions.

In order to determine the influence of tilting on the loaded instrument, the indication obtained at each tilt shall be corrected for the deviation from zero which the instrument had prior to loading.

A.5.1.1. Tilting 0.2 % or 0.1 % (3.9.1)

A.5.1.1.1. Tilting at no-load (class (II)*, (III) and (IIII))

The instrument is set to zero in its reference position (not tilted). The instrument is then tilted longitudinally 0.2 % and the zero indication of the instrument is noted. The test is repeated with transverse tilting.

A.5.1.1.2. Tilting when loaded (class (II), (II)*, (III) and (IIII))

The instrument is set to zero in its reference position and two weighings are carried out at a load close to where the mpe changes, and at a load close to Max. The instrument is then unloaded and tilted longitudinally and set to zero. Instruments of class (II)*, (III) and (IIII) are tilted to 0.2 % and instruments of class (II) are tilted to 0.1 %. Weighing tests as described above are performed. The test is repeated with transverse tilting.

A.5.1.2. Level indicator (4.5)

A.5.1.2.1. Tilting at no load (class (III) and (IIII))

The instrument is set to zero in its reference position. The instrument is then tilted longitudinally such that the moving part of the level indicator shows a displacement of 2 mm from the reference position, and the zero indication of the instrument is noted. The test is repeated with transverse tilting.

A.5.1.2.2. Tilting when loaded (class (II), (II)*, (III) and (IIII))

The instrument is set to zero in its reference position and two weighings are carried out at a load close to where the mpe changes and at a load close to Max. The instrument is then unloaded and tilted longitudinally such that the moving part of the level indicator shows a displacement of 2 mm from the reference position and set to zero. Weighing tests as described above are performed. The test is repeated with transverse tilting.

A.5.1.2.3. Sensitivity of the level indicator (class Ⓘ and Ⓘ *)

For instruments liable to be tilted the sensitivity of the level indicator is checked. The instrument is tilted 0.2 % and the displacement of the moving part of the level indicator is observed.

A.5.1.3. Instruments without level indicator

For instruments liable to be tilted and not fitted with a level indicator the tests in A.5.1.1 are performed except that the instrument is tilted 5 % instead of 0.2 %.

A.5.2. Warm-up time test (5.4.3)

Instruments using electric power shall be disconnected from the supply for a period of at least 8 hours. Then the instrument is connected and switched on and as soon as the indication has stabilized, observations are made when the instrument is unloaded and then when loaded with a load close to Max. These observations are repeated after 5, 15 and 30 min.

A.5.3. Temperature tests

A.5.3.1. Static temperatures (3.9.2.1. and 3.9.2.2.)

The test consists of exposure of the equipment under test (EUT) to constant (16) temperatures within the range stated in point 3.9.2, under free air conditions, for a 2 hour period after the EUT has reached temperature stability.

The weighing tests (loading and unloading) are done according to point A.4.3.2 :

— at a temperature of 20 °C following conditioning,

— at the specified high temperature,

— at the specified low temperature,

— at a temperature of 5 °C, if the specified low temperature is below 10 °C, and

— after recovery of the EUT at the reference temperature of 20 °C.

The change of temperature shall not exceed 1 °C/min during heating and cooling down.

The absolute humidity of the test atmosphere shall not exceed 20 g/m³.

Reference to IEC Publications : see Bibliography /1/ (17).

A.5.3.2. Stability of zero indication (3.9.2.3)

The instrument is set to zero, the temperature is then changed 5 °C and after stabilization the new zero indication is noted. As a practical approach the zero may be set at for instance 20 °C and then read again when the ambient temperature is stabilized at one of the prescribed test temperatures, say + 40 °C, assuming that the change in zero indication is linear over this whole temperature range.

A.5.4. Voltage and frequency variations (3.9.3)

Stabilize the EUT under constant environmental conditions.

The test consists of subjecting the EUT to AC mains voltage and frequency variations.

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(16) See point A.4.0.1.

(17) See preliminary note to Annex B.

The test shall be performed with test loads of 10 e and a load between 1/2 Max and Max.

Test severity :

1 — Mains voltage : upper limit V + 10 %
lower limit V — 15 %

2 — Mains frequency : upper limit f + 2 %
lower limit f — 2 %

where V and f are the values marked on the instrument.

Maximum allowed variations : All functions shall operate as designed.

All indications shall be within the maximum permissible errors.

Note : In case of three phase supply, the voltage variations shall apply for each phase successively.

A.6. Endurance test (3.9.4.3)

Under normal conditions of use, the instrument is subjected to the repetitive loading and unloading of a load approximately equal to 50 % of Max. The load shall be applied 100 000 times. The frequency and speed of application shall be such that the instrument attains an equilibrium when loaded and when unloaded. The force of the load applied should not exceed the force attained in a normal loading operation.

A weighing test in accordance with the procedure in A.4.3.2 is performed before the endurance test is started to obtain the intrinsic error. A weighing test is performed after the completion of the loadings to determine the durability error due to wear and tear.

ANNEX B

ADDITIONAL TESTS FOR ELECTRONIC INSTRUMENTS

Preliminary note : The tests which are specific to electronic instruments, as described in this Annex, have been taken, to the possible extent, from the work of the International Electrotechnical Commission (IEC).

B.1. General requirements for electronic instruments under test (EUT)

Energize the EUT for a time period equal to or greater than the warm-up time specified by the manufacturer and maintain the EUT energized for the duration of the test, except for tests under point B.4.

Adjust the EUT as closely as practicable to zero prior to the test, and do not readjust it at any time during the test, except to reset it if a significant fault has been indicated. The deviation of the no-load indication due to any test condition shall be recorded and any load indication shall be corrected accordingly to obtain the weighing result.

The handling of the instrument shall be such that no condensation of water occurs on the instrument.

B.2. Performance tests for influence factors

B.2.1. Static temperatures : see A.5.3

B.2.2. Damp heat, steady state

(Not applicable to class (I) instruments or class (II) instruments where e is less than 1 gram).

Test procedure in brief : The test consists of exposure of the EUT to a constant (18) temperature and a constant relative humidity. The EUT shall be tested with at least five different test loads (or simulated loads) :

- at a reference temperature of 20 °C and a relative humidity of 50 % following conditioning,
- at the high temperature of the range specified in point 3.9.2 and a relative humidity of 93 %, four days following temperature and humidity stabilization, and
- after recovery of the EUT at a reference temperature of 20 °C and relative humidity of 50 %.

Maximum allowed variations : All functions shall operate as designed.

All indications shall be within maximum permissible errors.

Reference to IEC Publications : see Bibliography /2/.

B.2.3. Power voltage variations : see A.5.4.

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(18) See A.4.0.1.

B.3. Performance tests for disturbances

B.3.1. Short time power reductions

Test procedure in brief :

Stabilize the EUT under constant environmental conditions.

A test generator suitable to reduce the amplitude of one or more half cycles (at zero crossings) of the AC mains voltage is used. The test generator shall be adjusted before connecting the EUT. The mains voltage reductions shall be repeated ten times with an interval of at least 10 seconds.

The test shall be performed with test loads of 10 e and a load between 1/2 Max and Max.

Test severity

Reduction	100 %	50 %
Number of half cycles	1	2

Maximum allowed variations : The difference between the weight indication due to the disturbance and the indication without the disturbance either shall not exceed e or the instrument shall detect and react to a significant fault.

B.3.2. Bursts

Test procedure in brief :

Stabilize the EUT under constant environmental conditions.

The test consists of exposure to bursts of voltage spikes having a double exponential waveform. Each spike shall have a rise time of 5 ns and a half amplitude duration of 50 ns. The burst length shall be 15 ms, the burst period (repetition time interval) shall be 300 ms.

The transient generator shall have an output impedance of 50 Ω and shall be adjusted before connecting the EUT. At least 10 positive and 10 negative randomly phased bursts shall be applied to the mains cable. The cable shall have a length of 1 m if it is detachable from the EUT or the length specified for the pattern in all other cases. It shall be prevented that the burst energy be dissipated in mains or other connected instruments, e.g. by insertion of blocking filters or appropriate construction of the burst generator.

The test has to be performed with test loads of 10 e and a load between 1/2 Max and Max.

Test severity : Amplitude (peak value) 1kV

Maximum allowed variations : The difference between the weight indication due to the disturbance and the indication without the disturbance either shall not exceed e or the instrument shall detect and react to a significant fault.

Reference to IEC Publications : see Bibliography /3/

B.3.3. Electrostatic discharge

Test procedure in brief : Stabilize the EUT under constant environmental conditions.

A capacitor of 150 pF shall be charged by a suitable DC voltage source. The capacitor is then discharged through the EUT by connecting one terminal to ground (chassis) and the other via 150 Ω to surfaces which are normally accessible to the operator.

EUT not equipped with a ground terminal shall be placed on a grounded metallic plate which projects beyond the EUT by at least 0.1 m on all sides. The ground connection to the capacitor shall be as short as possible.

The discharge electrode shall approach the external parts of the EUT until discharge occurs and shall then be removed before the next discharge. At least 10 discharges shall be applied. The time interval between successive discharges shall be at least 10 second.

The test shall be performed with test loads of 10 e and a load between 1/2 Max and Max.

Test severity : DC voltage up to and including 8 kV.

Maximum allowed variations : The difference between the weight indication due to the disturbance and the indication without the disturbance either shall not exceed e or the instrument shall detect and react to a significant fault.

Reference to IEC Publications : see Bibliography /4/

B.3.4. Electromagnetic susceptibility

Test procedure in brief : Stabilize the EUT under constant environmental conditions.

The EUT shall be exposed to electromagnetic field strength as specified by the severity level.

The field strength may be generated in various ways :

— the strip line is used at low frequencies (below 30 MHz or in some cases 150 MHz) for small EUT's,

— transverse electromagnetic (TEM) cells for relatively small EUT's,

— dipole antennas or antennas with circular polarization placed 1 m from the EUT are used at high frequencies.

The specified field strength shall be established prior to the actual testing (without EUT in the field).

The field shall be generated in two orthogonal polarizations and the frequency range shall be scanned slowly. If antennas with circular polarization i.e. logspiral or helical antennas are used to generate the electromagnetic field a change in the position of the antennas is not required. When the test is carried out

in a shielded enclosure to comply with international laws prohibiting interference with radio communications, care needs to be taken to handle reflections from the walls. Anechoic shielding may be necessary.

At least 1 m of all external cables shall be included in the exposure by streching them horizontally from the EUT.

The test shall be performed with test loads of 10 e and a load between 1/2 Max and Max.

Test severity :

Frequency range :	0.1-27	27-500	500-1 000	MHz
Field strength :	3	3	1	V/m
Modulation :		50 % AM, 1 kHz square wave		

Maximum allowed variations : The difference between the weight indication due to the disturbance and the indication without the disturbance either shall not exceed e or the instrument shall detect and react to a significant fault.

Reference to IEC Publications : see Bibliography /5/

B.4. Durability tests

B.4.1. Dry heat, steady state

Test procedure in brief : The test consists of exposure of the EUT with power "off" to a constant temperature during a certain period. The EUT shall be tested with at least five different test loads (or simulated loads), chosen according to point A.4.3.2 :

— before exposure, at a reference temperature of 20 °C following conditioning of the EUT,

— after exposure and after recovery of the EUT at the reference temperature of 20 °C.

The humidity content of the test atmosphere shall not exceed 20 g/m³ (corresponding to approximately 50 % relative humidity at 35 °C).

Test severity :

1) Temperature : 55 °C

2) Test duration : 10 days.

Maximum allowed variations : All functions shall operate as designed.
No variation of indication shall exceed e.

Reference to IEC Publications : see Bibliography /1/

B.4.2. Damp heat, steady state

(Not applicable to class (I) instruments or class (II) instruments where e is less than 1 gram).

Test procedure in brief :	The test consists of exposure of the EUT with power " off " to a constant temperature and a constant relative humidity for a certain period of time. The EUT shall be tested with at least five different test loads (or simulated loads), chosen according to point A.4.3.2 : — before the exposure, at a reference temperature of 20 °C and a relative humidity of 50 % following conditioning of the EUT, — after the exposure and after recovery of the EUT at the reference temperature of 20 °C and relative humidity of 50 %.
Test severity :	
1) Temperature :	40 °C oberer Temperaturbereich d. Waage
2) Humidity :	93 % (non-condensing)
3) Test duration :	10 days.
Maximum allowed variations :	All functions shall operate as designed. No variation of indication shall exceed e.
Reference to IEC Publications :	see Bibliography /2/

BIBLIOGRAPHY

References are given below to Publications of the International Electrotechnical Commission, IEC, to which mention is made in some of the tests in Annexes A and B ; reference is also made to the corresponding Harmonization Documents of the European Committee for Electrotechnical Standardization, CENELEC.

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IEC Publication 68-2-2 (1974) : Basic environmental testing procedures, Part 2 : Tests, Test Bd : Dry heat, for heat dissipating equipment under test (EUT), with gradual change of temperature.

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