INTERNATIONAL RECOMMENDATION

OIML R 107-1

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Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers)

Part 1: Metrological and technical requirements - Tests

Instruments de pesage totalisateurs discontinus à fonctionnement automatique (peseuses totalisatrices à trémie)

Partie 1: Exigences métrologiques et techniques - Essais

ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE

INTERNATIONAL ORGANIZATION OF LEGAL METROLOGY

Contents

Foreword

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Terminology

(Terms and definitions)

The terminology used in this Recommendation conforms to the "International Vocabulary of Basic and General Terms in Metrology" (VIM: 1993) [1], the "International Vocabulary of Legal Metrology" (VIML: 2000) [2], the "OIML Certificate System for Measuring Instruments", OIML B 3: 2003 [3], and to the International Document "General requirements for electronic measuring instruments", OIML D 11: 2004 [4].

In addition, for the purposes of this Recommendation, the following definitions apply.

T.1 General definitions

T.1.1 Weighing instrument

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

Note: In this Recommendation "mass" (or "weight value") is preferably used in the sense of "conventional mass" or "conventional value of the result of weighing in air" according to OIML R 111 [5] and OIML D 28 [27], whereas "weight" is preferably used for an embodiment (or material measure) of mass that is regulated in regard to its physical and metrological characteristics.

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

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

T.1.2 Automatic weighing instrument

Instrument that weighs and follows a predetermined program of automatic processes characteristic of the instrument.

T.1.3 Non-automatic weighing instrument

Instrument that requires the intervention of an operator during the weighing process to decide that the weighing result is acceptable.

T.1.4 Discontinuous totalizing automatic weighing instrument (totalizing hopper weigher)

Automatic weighing instrument that weighs a bulk product by dividing it into discrete loads, determining the mass of each discrete load in sequence, summing the weighing results and delivering the discrete loads to bulk.

Note: In this Recommendation a discontinuous totalizing automatic weighing instrument is called an "instrument".

T.1.5 Control instrument

Weighing instrument used to determine the conventional true value of the mass of the test loads during material tests.

Control instruments used for testing may be:

- separate from the instrument being tested; or
- integral, when a non-automatic (static) weighing mode is provided by the instrument being tested, which allows the weighing cycle to be interrupted (see 6.3).

T.1.6 Conventional true value (of a quantity)

Value attributed to a particular quantity and accepted, by convention, as having an uncertainty appropriate for a given purpose. [VIM: 1993, 1.20]

T.1.7 Metrological authority

Legal entity designated or formally accepted by the government to be responsible for ascertaining that the automatic weighing instrument satisfies all or some specific requirements of this Recommendation.

T.1.8 Metrologically relevant

Any device, instrument, function or software of an instrument that influences the weighing result or any other primary indication is considered as metrologically relevant.

T.2 Construction

Note: 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 force coming from the load transmitting device, and an indicating or printing device for displaying the weighing result in units of mass.

T.2.2 Electronic instrument

Instrument equipped with electronic devices.

T.2.2.1 Electronic device

Device employing electronic sub-assemblies and performing a specific function. Electronic devices are usually manufactured as separate units and are capable of being tested independently. [OIML D 11: 2004, 3.2]

Note 1: An electronic device may be a complete measuring instrument (for example: counter scale, electricity meter) or a part of a measuring instrument (for example: printer, indicator).

Note 2: An electronic device can be a module in the sense that this term is used in OIML Publication B 3 "OIML Certificate System for Measuring Instruments" [3].

T.2.2.2 Electronic sub-assembly

Part of an electronic device employing electronic components and having a recognizable function of its own. [OIML D 11: 2004, 3.3]

Examples: A/D converter, display.

T.2.2.3 Electronic component

Smallest physical entity that uses electron or hole conduction in semiconductors, gases, or in a vacuum. [OIML D 11: 2004, 3.4]

Examples: Electronic tubes, transistors, integrated circuits. (See 3.4 of OIML D 11 [4].)

T.2.2.4 Digital device

Electronic device that only performs digital functions and that provides a digitized output or display.

Examples: Printer, remote display, terminal, data storage device, personal computer

T.2.3 Totalization device

Device that calculates the sum of consecutive loads weighed and discharged to bulk.

T.2.4 Zero-setting device

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

T.2.4.1 Non-automatic zero-setting device

Device for setting the indication to zero by an operator.

T.2.4.2 Semi-automatic zero-setting device

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

T.2.4.3 Automatic zero-setting device

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

T.2.4.4 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.2.4.5 Zero-tracking device

Device for maintaining the zero indication within certain limits automatically.

T.2.5 Printing device (printer)

Device to produce a printout (T.4.2.3) of the weighing result.

T.2.6 Air-enclosed integrated system

Instrument fitted with the appropriate safety and dust control features.

T.2.7 Module

Identifiable part of an instrument or device that performs a specific function or functions, and that can be separately evaluated according to the metrological and technical performance requirements in the relevant Recommendation. The modules of a weighing instrument are subject to specified partial error limits.

Note: Typical modules of an instrument are: load cell, indicator, analog or digital processors, weighing module, remote display, software.

T.2.7.1 Load cell

Force transducer, which after taking into account the effects of the acceleration of gravity and air buoyancy at the location of its use, measures mass by converting the measured quantity (mass) into another measured quantity (output).[OIML R 60: 2000 [6]]

Note: Load cells equipped with electronics including amplifier, analog-to-digital converter and data processing device (optionally) are called digital load cells.

T.2.7.2 Indicator

Electronic device of an instrument that may perform the analog-to-digital conversion of the output signal of the load cell, and that further processes the data, and displays the weighing result in units of mass.

T.2.7.3 Analog data processing device

Electronic device of an instrument that performs the analog-to-digital conversion of the output signal of the load cell, further processes the data, and supplies the weighing result in a digital format via a digital interface without displaying it. It may optionally have one or more keys (or mouse, touch-screen, etc.) to operate the instrument.

T.2.7.4 Digital data processing device

Electronic device of an instrument that further processes the data, and supplies the weighing result in a digital format via a digital interface without displaying it. It may optionally have one or more keys (or mouse, touch-screen, etc.) to operate the instrument.

T.2.7.5 Weighing module

Part of the weighing instrument that comprises all mechanical and electronic devices (i.e. load receptor, load-transmitting device, load cell, and analog data processing device or digital data processing device) but not having the means to display the weighing result. It may optionally have devices for further processing (digital) data and operating the instrument.

T.2.7.6 Remote display

Terminal without keys that can be used for the primary indications or for their repetition.

T.2.7.7 Software

T.2.7.7.1 Legally relevant software

Programs, data, type specific and device specific parameters that belong to the measuring instrument or module, and that define or fulfill functions which are subject to legal control.

Note: Examples of legally relevant software are: final results of the weighing including the decimal sign and the unit, identification of the weighing range and the load receptor (if several load receptors have been used).

T.2.7.7.2 Legally relevant parameter

Parameter of a measuring instrument or a module subject to legal control. The following types of legally relevant parameters can be distinguished: type-specific parameter and device-specific parameter.

T.2.7.7.3 Type-specific parameter

Legally relevant parameter with a value that depends on the type of instrument only. Type-specific parameters are part of the legally relevant software. They are fixed at type approval of the instrument.

Examples: Parameters used for weight value calculation, stability analysis or price calculation and rounding, software identification.

T.2.7.7.4 Device-specific parameter

Legally relevant parameter with a value that depends on the individual instrument. Device specific parameters comprise calibration parameters (e.g. span adjustments or other adjustments or corrections) and configuration parameters (e.g. maximum capacity, minimum capacity, units of measurement, etc.). They are adjustable or selectable only in a special operational mode of the instrument. Device specific parameters may be classified as those that should be secured (unalterable) and those that may be accessed (settable) by an authorized person.

T.2.7.7.5 Software identification

Sequence of readable characters of software that is inextricably linked to the software (e.g. version number, checksum).

T.2.8 Data storage device

Storage device used for keeping weighing data ready after completion of the weighing for later legally relevant purposes.

T.2.9 Interface

Electronic, optical, radio or other hardware or software that enables information to be automatically passed between instruments and modules.

T.2.10 User interface

Interface that enables information to be passed between a user and the instrument or its hardware or software components, as, e.g. switch, keyboard, mouse, display, monitor, printer, touch-screen.

T.2.11 Protective interface

Interface (hardware and/or software) which only allows the introduction of such data into the data processing device of an instrument, which cannot:

- display data which are not clearly defined and which could be taken as being a weighing result;
- falsify displayed, processed or stored weighing results or primary indications; or
- adjust the instrument or change any adjustment factor, except releasing an adjustment procedure with incorporated devices.

T.3 Metrological characteristics

T.3.1 Scale interval

Value expressed in units of mass that is the difference between:

- the values corresponding to two consecutive scale marks for analog indication; or
- two consecutive indicated values for digital indication.

T.3.1.1 Totalization scale interval, d_t

Scale interval of a principal totalization indicating device.

T.3.1.2 Control scale interval, d

Scale interval of a control indicating device.

T.3.2 Weighing cycle

Sequence of weighing operations that includes the following:

- one delivery of a load to the load receptor;
- a single weighing operation; and
- the discharge to bulk of a single discrete load.

T.3.3 Automatic weighing range

Range from minimum capacity to maximum capacity.

T.3.3.1 Maximum capacity, Max

Largest discrete load that can be weighed automatically.

T.3.3.2 Minimum capacity, Min

Smallest discrete load that can be weighed automatically.

T.3.3.3 Maximum safe load, Lim

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

T.3.3.4 Overload

Discrete load on the load receptor of more than Max plus 9 d_t.

T.3.4 Final weight value

Weight value that is achieved when an automatic operation is ended and the instrument is completely at rest and balanced, with no disturbances affecting the indication..

Note: This definition is only applicable to static weighing and not to dynamic weighing.

T.3.5 Stable equilibrium

Condition of the instrument such that the printed or stored weight values of each separate weighing test show no more than two adjacent values, with one of them being the final weight value.

T.3.6 Minimum totalized load, Σ_{min}

Value of the smallest bulk load that can be totalized without exceeding the maximum permissible error when the automatic operation is comprised of discrete loads, each within the automatic weighing range.

T.3.7 Warm-up time

Time between the moment that power is applied to an instrument and the moment at which the instrument is capable of complying with the requirements of this Recommendation.

T.3.8 Non-automatic (static) operation

Static weighing mode for test purposes.

T.3.9 Repeatability

Closeness of the agreement between the results of successive measurements of the same measurand carried out under the same conditions of measurement. [VIM: 1993, 3.6]

Note: For an instrument, this is its ability to provide weighing results that agree one with the other under the same or constant operating conditions.

T.3.10 Durability

Ability of an instrument to maintain its performance characteristics over a period of use. [OIML D 11: 2004, 3.17]

T.3.11 Automatic checking facility

Facility, operating without the intervention of an operator, which is incorporated in an instrument and which enables significant faults to be detected and acted upon. [OIML D 11: 2004, 3.18 and 3.18.1]

Note: An automatic checking facility performs securing and monitoring activities.

T.4 Indications and errors

T.4.1 Indication (of a measuring instrument)

Value of a quantity provided by a measuring instrument [VIM: 1993, 3.2].

Note: "Indication", "indicate" or "indicating" include both displaying, and/or printing.

T.4.1.1 Primary indications

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

T.4.1.2 Secondary indications

Indications, signals and symbols that are not primary indications.

T.4.2 Methods of indication

T.4.2.1 Analog indication

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

T.4.2.2 Digital indication

Indication providing the weighing results in a digitized form.

T.4.2.3 Printout

Hardcopy of the weighing result produced from a printer.

T.4.3 Totalization indicating device

Device that indicates the sum of the weight values of consecutive loads weighed and discharged to bulk.

T.4.3.1 Principal totalization indicating device

Totalization indicating device that indicates the sum of the weight values of all consecutive loads weighed and discharged to bulk. This device is not resettable to zero by the user.

T.4.3.2 Partial totalization indicating device

Totalization indicating device that indicates the sum of the weight values of a limited number of consecutive loads delivered to bulk. This device is resettable to zero by the user.

T.4.3.3 Supplementary totalization indicating device

Totalization indicating device with a scale interval greater than that of the principal totalization indicating device and indicating the sum of the weight values of consecutive loads weighed over a long period of time. This device may be resettable to zero by the user.

T.4.3.4 Control indicating device

Device indicating the value of the load on the load receptor and enabling the use of the instrument as a control instrument to weigh discrete loads for control purposes.

T.4.4 Reading

T.4.4.1 Reading by simple juxtaposition

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

T.4.4.2 Overall inaccuracy of reading

On an instrument with analog indication, this is equal to the standard deviation of the same indication, the reading of which is carried out under normal conditions of use by several observers.

T.4.5 Errors

T.4.5.1 Error (of indication)

Indication of an instrument minus the (conventional) true value of the mass.

T.4.5.2 Rounding error of digital indication

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

T.4.5.3 Intrinsic error

Error of an instrument, determined under reference conditions. [VIM: 1993, 5.24)

T.4.5.4 Initial intrinsic error

Intrinsic error of an instrument as determined prior to the performance and span stability tests.

T.4.5.5 Fault

Difference between the error of indication and the intrinsic error of an instrument. [OIML D 11: 2004, 3.9]

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

Note 2: From the definition it follows that in this Recommendation a "fault" is a numerical value.

T.4.5.6 Significant fault

Fault greater than 1 d_t.

The following are not considered to be significant faults:

- faults arising from simultaneous and mutually independent causes in the instrument or in its checking facilities (T.3.11);
- faults implying the impossibility to perform any weighing;
- transitory faults, momentary variations in the indications which cannot be interpreted, memorized or transmitted as a weighing result; and
- faults being so serious that they will inevitably be noticed by all those interested in the weighing result.

T.4.5.7 Span stability

Capability of an instrument to maintain the difference between the indication at maximum capacity and the indication at zero over a period of use within specified limits.

T.4.5.8 Maximum permissible error, mpe

Extreme values of an error permitted by specifications, regulations, etc. for a given instrument. [VIM: 1993, 5.21]

T.4.5.9 Audit trail

Historical record (or continuous data file) of the instrument data, adjustments and weighing operations. Checks can be made to ensure that adjustments and weighings have been carried out in accordance with the appropriate parts of this Recommendation. Every log entry has a unique time and date stamp.

T.5 Influences and reference conditions

T.5.1 Influence quantity

Quantity that is not the measurand but that affects the result of the measurement. [VIM: 1993, 2.10]

Note: An influence quantity does not affect the actual mass of the load being weighed, but affects the value (weighing result) indicated by the instrument.

T.5.1.1 Influence factor

Influence quantity having a value within the specified rated operating conditions of the instrument. [OIML D 11: 2004, 3.13.1]

T.5.1.2 Disturbance

Influence quantity having a value within the limits specified in this Recommendation but outside the specified rated operating conditions of the instrument. [OIML D 11: 2004, 3.13.2]

T.5.2 Rated operating conditions

Conditions of use for which specified metrological characteristics of an instrument are intended to lie within given limits. [VIM: 1993, 5.5]

Note: These conditions of use are the range of weight values and the range of influence quantity values for which the indication of an instrument is intended to lie within maximum permissible errors.

T.5.3 Reference conditions

Conditions of use prescribed for testing the performance of an instrument or for intercomparison of results of measurements. [VIM: 1993, 5.7]

T.5.4 Normal weighing conditions

Conditions of use prescribed for the instrument including types of material, site and method of operation.

T.6 Tests

T.6.1 Material test

Test carried out on a complete instrument using the type of material that it is intended to weigh.

T.6.2 Simulation test

Test carried out on a complete instrument or part of an instrument in which any part of the weighing operation is simulated.

T.6.3 Performance test

Test to verify whether the equipment under test (EUT) is capable of accomplishing its intended functions. [OIML D 11: 2004, 3.20.3]

T.6.4 Span stability test

Test to verify whether the EUT is capable of maintaining its performance characteristics over a period of use.

T.7 Abbreviations and symbols

Symbol	Meaning
I	indication
I_n	nth indication
L	load
ΔL	additional load to next changeover point
P	$I + 1/2\ d - \Delta L$ = indication prior to rounding (digital indication)
E	$I - L$ or $P - L$ = error
E%	$(P - L)/L$ %
E_0	error at zero load
d	control scale interval
d_t	totalization scale interval
p_i	fraction of the mpe applicable to a module of the instrument which is examined separately
mpe	maximum permissible error
EUT	equipment under test
sf	significant fault
Max	maximum capacity of the weighing instrument
Min	minimum capacity of the weighing instrument
U_{nom}	nominal voltage value marked on the instrument
U_{max}	highest value of a voltage range marked on the instrument
U_{min}	lowest value of a voltage range marked on the instrument
v_{min}	minimum operating speed
v_{max}	maximum operating speed
emf	electromotive force
I/O	input / output ports
RF	radio frequency
V/m	volt per meter
kV	kilovolt
DC	direct current
AC	alternating current
MHz	megahertz
A_{net}	net test load in automatic mode
S_{net}	net test load in non-automatic (static) mode
A_{gross}	gross weight value in automatic operation or alternatively discharged mass in discharged mode
A_{tare}	tare value in automatic operation or in discharge mode the indication of the instrument after subtractive tare of the filled receptor
S_{gross}	gross load in non-automatic (static) mode
S_{tare}	tare value in non-automatic (static) mode
E	error of measurement, $E = A_{net} - S_{net}$
E_{inst}	error of measurement of the control instrument

Discontinuous totalizing automatic weighing instruments (Totalizing hopper weighers)

1 General

1.1 Scope

This International Recommendation specifies the requirements and test methods for discontinuous totalizing automatic weighing instruments (totalizing hopper weighers), hereafter referred to as "instruments".

It is intended to provide standardized requirements and test procedures to evaluate the metrological and technical characteristics of an instrument in a uniform and traceable way. A standardized test report format is given as Part 2 of this Recommendation, OIML R 107-2.

1.2 Application

This Recommendation applies to discontinuous totalizing automatic weighing instruments having a load receptor in the form of a hopper.

This Recommendation does not apply to the following types of instrument:

- "weighing-in-motion" instruments;
- instruments that totalize the bulk load by multiplying the mass of a preset constant load by the number of weighing cycles.

In this Recommendation, instruments which in normal use could be operated in a non-automatic weighing mode shall also comply with the requirements of 3.2.6.

1.3 Terminology

The terminology given in chapter T, Terminology shall be considered as a binding part of this Recommendation.

2 Metrological requirements

2.1 Accuracy classes

Instruments are divided into four accuracy classes as follows:

0.2 0.5 1 2

The accuracy classes shall be specified in accordance with the maximum permissible errors in 2.2 and marked on the instrument in accordance with the descriptive markings in 3.9.2.

Accuracy classes shall be specified for intended usage, i.e. nature of the product(s) to be weighed, type of installation and other specified operating conditions in accordance with 5.1 and 5.2.

Note: The use of accuracy classes for certain applications may be determined by national prescription.

2.2 Maximum permissible errors

2.2.1 Automatic weighing

The maximum permissible errors for each accuracy class shall be the appropriate values in Table 1 rounded to the nearest totalization scale interval, d_t. Maximum permissible errors apply to loads not less than the minimum totalized load, Σ_{min}. (See the example in 2.5).

Table 1

Accuracy class	Percentage of the mass of the totalized load	
	Initial verification	In-service
0.2	±0.10 %	±0.2 %
0.5	±0.25 %	±0.5 %
1	±0.5 %	±1.0 %
2	±1.00 %	±2.0 %

2.2.2 Influence factors

The maximum permissible errors applied in tests to assess the effect of influence factors shall be as specified in Table 2.

Table 2

Load, m expressed in totalization scale intervals	Maximum permissible error
$0 \leq m \leq 500$	$\pm 0.5\ d_t$
$500 < m \leq 2\ 000$	$\pm 1.0\ d_t$
$2\ 000 < m \leq 10\ 000$	$\pm 1.5\ d_t$

Digital indications and printed results shall be corrected for the rounding error, and the error shall be determined with an accuracy of at least 0.2 d_t.

2.3 Form of the scale interval

The scale intervals of the indicating devices shall be in the form of 1×10^k, 2×10^k, or 5×10^k, "k" being a positive or negative whole number or zero.

2.4 Totalization scale interval, d_t

The totalization scale interval shall be:

a) not less than 0.01 % of the maximum capacity, and

b) not greater than 0.2 % of maximum capacity.

2.5 Value of minimum totalized load, Σ_{min}

The minimum totalized load shall:

a) not be less than the value of the load at which the maximum permissible error for automatic weighing on initial verification is equal to the totalization scale interval, d_t, and

b) not less than the minimum capacity, Min.

Therefore, using Table 1:

Accuracy class	Σ_{min} shall not be less than either of:
0.2	1 000 d_t, and Min
0.5	400 d_t, and Min
1	200 d_t, and Min
2	100 d_t, and Min

For example:

Instrument: accuracy class = 0.5,
maximum capacity, Max = 1000 kg,
minimum capacity, Min = 200 kg;
d_t = 0.2 kg (see 2.4);

To comply with 2.5 a): $\Sigma_{min} \geq 400\ d_t = 400 \times 0.2$ kg = 80 kg, and

To comply with 2.5 b): $\Sigma_{min} \geq$ Min = 200 kg.

Therefore, in this example, the value of minimum totalized load, Σ_{min} is 200 kg

2.6 Agreement between multiple indicating devices

For a given load the difference between the indications of multiple indicating devices shall not be greater than the absolute value of the maximum permissible error for automatic weighing for analog devices, but shall be zero between digital displaying and printing devices.

2.7 Influence factors

2.7.1 Temperature

2.7.1.1 Static temperatures

Instruments shall comply with the appropriate metrological and technical requirements at temperature limits from −10 °C to +40 °C.

Depending on local environmental conditions, however, the limits of the temperature range may differ from the above provided that they are specified in the descriptive markings. The limits can be combined using the following limits provided that the ranges within those limits shall be at least equal to 30 °C:

Temperature limits:					Unit
lower temperature	+5	−10	−25	−40	°C
higher temperature	+30	+40	+55	+70	

2.7.1.2 Temperature effect on no-load indication

The indication at zero or near zero shall not vary by more than one totalization scale interval, d_t, for a difference in ambient temperature of 5 °C.

2.7.2 Mains power voltage variation

An electronic instrument shall comply with the appropriate metrological and technical requirements, if the voltage varies from the nominal voltage, U_{nom} (if only one voltage is marked on the instrument), or from the upper and lower limits of the voltage range, U_{min}, U_{max}, marked on the instrument at:

- AC mains voltage:

  Lower limit is $0.85 \times U_{nom}$ or $0.85 \times U_{min}$, upper limit is $1.10 \times U_{nom}$ or $1.10 \times U_{max}$;

- DC mains voltage:

  Lower limit is minimum operating voltage, upper limit is $1.20 \times U_{nom}$ or $1.20 \times U_{max}$;

- Battery voltage DC (not mains connected):

  Lower limit is the minimum operating voltage, upper limit is U_{nom} or U_{max};

- 12 V or 24 V road vehicle battery power:

  Lower limit is 9 V (for 12 V battery) or 16 V (for 24 V battery), upper limit is 16 V (12 V battery) or 32 V (24 V battery).

Note: The minimum operating voltage is defined as the lowest possible operating voltage before the instrument is automatically switched off.

Battery-operated and DC mains powered instruments shall either continue to function correctly or shall not indicate any weight values if the voltage is below the manufacturer's specified value, the latter being larger than or equal to the minimum operating voltage.

2.8 Units of measurement

The units of mass to be used on an instrument are the:

- gram (g);
- kilogram (kg);
- tonne (t).

3 Technical requirements

3.1 Suitability for use

An instrument shall be designed to suit the method of operation and the loads for which it is intended. It shall be of adequately robust construction in order that it maintains its metrological characteristics.

3.2 Security of operation

3.2.1 Fraudulent use

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

3.2.2 Accidental breakdown and maladjustment

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

3.2.3 Purging of load receptor

The design of the load receptor and the operation of the instrument shall be such that the weighing results are not adversely affected by any variation in the quantity of the load remaining in the load receptor after discharge during a weighing cycle.

3.2.4 Overload and maximum safe load, Lim

The design and the operation of the instrument shall be such that the weighing results are not adversely affected by any load:

a) exceeding the maximum safe load (T.3.3.3) without its effect being evident; and/or

b) resulting in overload (T.3.3.4),

due to inconstant or abruptly increasing mass flow during a weighing cycle.

3.2.5 Automatic weighing conditions

An automatic operation shall be interrupted, recording and printing of results shall be prevented or marked with a clear warning, and a warning signal shall be given in the following cases:

a) if the maximum capacity, Max, in each weighing range has been exceeded by more than 9 d_t;

b) if the value of the load to be weighed and discharged to bulk is less than minimum capacity, Min, unless processed as the last discrete load of the transaction.

3.2.6 Use as a non-automatic weighing instrument

An instrument to be used as a non-automatic weighing instrument shall:

- be equipped with an enabling device for non-automatic operation that prevents automatic operation;
- comply with the appropriate requirements of 6.2; and
- comply with the requirements of OIML R 76-1: 2006 [7].

3.2.7 Operational adjustments

It shall neither be possible to make operating adjustments nor to reset the indicating devices during an automatic weighing operation, with the exception of the possibility to interrupt the weighing cycle in the case of 3.2.5 and during testing as described in 6.3.

3.2.8 Controls

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

3.2.9 Dust extraction

The operation of a dust extractor shall not affect the result of the measurement.

3.2.10 Stable equilibrium for static weighing

The condition of the instrument such that in the case of printing, the printed value of each separate weighing test does not deviate more than 1 d_t from the final weight value (see T.3.4), i.e. show no more than two adjacent values, and in the case of zero operations a correct operation of the device according to 3.8.1 within relevant accuracy requirements is achieved.

This condition is only valid for each separate weighing test and not for a group of tests.

3.2.11 Interlocks

Interlocks shall either prevent or indicate the operation of the instrument outside the specified operating conditions. Interlocks are required for:

- Minimum operating voltage (2.7.2);
- Maximum safe load (3.2.4);
- Zero-setting (3.8.3); and
- Automatic operation (3.2.5).

3.3 Securing of components, interfaces and pre-set controls

3.3.1 General

Components, interfaces and pre-set controls subject to legal requirements that are not intended to be adjusted or removed by the user shall be fitted with a securing means or shall be enclosed. When enclosed, it shall be possible to seal the enclosure. The seals shall, in all cases, be easily accessible.

Security shall be provided on all parts of the instrument which cannot be materially protected in any other way against operations liable to inadvertently affect its metrological properties. National regulations may specify the security that is required.

3.3.2 Means of security

a) Access to functions liable to affect metrological properties shall be restricted to authorized persons or the metrological authority by software and/or hardware means such as a hard key, identity scanner, etc);

b) It shall be possible for the interventions to be memorized and it shall be possible to access and display this information; the records shall include the date and a means of identifying the authorized person making the intervention (see a) above); the traceability of the interventions shall be assured for at least the period of time in between periodical verifications depending on national legislation. Records may not be overwritten, and if the storage capacities for records is exhausted, no further intervention shall be possible without breaking a physical seal;

c) Software functions shall be secured against intentional, unintentional and accidental changes in accordance with the requirements of 3.6;

d) Transmission of metrological data via interfaces shall be secured against intentional, unintentional and accidental changes in accordance with the requirements of 4.2.6.2;

e) The securing possibilities available in an instrument shall be such that separate securing of the settings may be possible;

f) Metrological data held on storage devices shall be secured against intentional, unintentional and accidental changes in accordance with the requirements of 3.4;

3.4 Indication and recording of weighing results

Instruments shall include a principal totalization indicating device and a recording device.

Instruments may include one or more supplementary totalization indicating devices, partial totalization indicating devices and data storage devices.

3.4.1 Quality of indication

Reading of the primary indications (see T.4.1.1) shall be reliable, easy and unambiguous under normal operating conditions:

- the overall inaccuracy of reading of an analog indicating device shall not exceed 0.2 d_t;
- the figures forming the primary indications 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 (see T.4.4.1).

3.4.2 Form of the indication

3.4.2.1 Unit of mass

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

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

The units of mass shall be indicated in small letters (lower case) as shown in 2.8.

3.4.2.2 Digital indication

A digital zero indication shall include the display of a zero for all places that are displayed to the right of a decimal sign and at least one place to the left. When no decimal values are displayed, a zero shall be displayed for each place of the displayed division, (i.e. at least one active decade plus any fixed zeros must be displayed).

Examples of the number of zeros required:

Max (kg)	d_t (kg)	Minimum zero indication (kg)
25	0.01	0.00
5 000	1	0
100 000	20	00

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

The decimal sign shall be in line with the bottom of the figures (*example*: 0.305 kg).

3.4.2.3 Scale interval

Except for a supplementary totalization indicating device, the scale intervals of all totalization indicating devices shall be the same.

The form of the scale interval shall be as specified in 2.3.

Where the scale interval is changed automatically the decimal sign shall maintain its position in the display.

3.4.3 Totalization indicating devices

The following shall apply:

a) A totalization indicating device shall allow reliable, clear and unambiguous reading of the results by simple juxtaposition and shall bear the symbol of the appropriate unit of mass;

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

c) In automatic operation it shall not be possible to reset any totalization device to zero;

d) It shall not be possible to reset the partial totalization indicating device to zero unless the last total indicated before resetting to zero is automatically recorded when the automatic operation is interrupted;

e) The indication of the control indicating device (T.4.3.4) is to a higher resolution (not greater than 0.2 d_t) than that of the principal totalization indicating device;

f) During static weighing in non-automatic operations, printing shall be inhibited if the stability criteria in 3.2.10 are not fulfilled.

3.4.4 Combined indicating devices

Two or more types of indicating device may be combined so that the indication required can be displayed on demand provided that it is clearly identified.

3.4.5 Instruments that tare weigh

For instruments used to receive (weigh-in), the no-load reference value shall be determined and recorded only at the beginning of each weighing cycle.

For instruments used to deliver (weigh-out), the no-load reference value shall be determined and recorded only after the gross load reference value for each weighing cycle has been indicated and recorded.

3.5 Data storage device

Metrological data may be stored in a memory of the instrument or on external storage for subsequent use (e.g. indication, printing, transfer, totalizing, etc.). In this case, the stored data shall be adequately protected against intentional and unintentional changes during the data transmission and/or storage process and shall contain all relevant information necessary to reconstruct an earlier weighing.

Data storage security:

a) The appropriate requirements of 3.3;

b) If software realizing the data storage can be transmitted to, or downloaded into the instrument these processes shall be secured in accordance with the requirements in 3.6;

c) External storage devices identification and security attributes shall be automatically verified to ensure integrity and authenticity;

d) Exchangeable storage media for storing measurement data need not be sealed provided that the stored data is secured by a specific checksum or key code;

e) When storage capacity is exhausted, new data may replace oldest data provided that the owner of the old data has given authority to overwrite the old data.

3.6 Software

The legally relevant software of an instrument shall be identified by the manufacturer, i.e., the software that is critical for measurement characteristics, measurement data and metrologically important parameters, stored or transmitted, and software programmed to detect system faults (software and hardware), is considered as an essential part of a discontinuous totalizing automatic weighing instrument and shall meet the requirements for securing software specified below.

3.6.1 Software information submitted with software controlled instruments

a) Description of the legally relevant software;

b) Description of the accuracy of the measuring algorithms (e.g. programming modes);

c) Description of the user interface, menus and dialogues;

d) The unambiguous software identification;

e) Description of the embedded software;

f) Overview of the system hardware, e.g. topology block diagram, type of computer(s), source code for software functions, etc, if not described in the operating manual;

g) Means of securing software;

h) Operating manual.

3.6.2 Security of legally relevant software

a) Legally relevant software shall be adequately protected against accidental or intentional changes. The appropriate requirements for securing given in 3.3 and 3.5 apply;

b) The software shall be assigned appropriate software identification (T.2.7.7.5). This software identification shall be adapted in the case of every software change that may affect the functions and accuracy of the instrument;

c) Functions performed or initiated via connected interfaces, i.e. transmission of legally relevant software, shall comply with the securing requirements for interfaces in 4.2.6;

d) National regulations may specify the requirements for securing software controlled instruments.

3.7 Instruments with a control indicating device

For instruments with a control indicating device, the load receptor shall have the facility to support a quantity of standard weights in accordance with Table 3.

Table 3

Maximum capacity, Max	Minimum quantity of standard weights
Max ≤ 5 t	Max
5 t < Max ≤ 25 t	5 t
25 t < Max ≤ 50 t	20 % Max
50 t < Max	10 t

3.8 Zero-setting devices

Instruments that do not tare-weigh after each discharge shall be provided with a zero-setting device.

National regulations shall specify the types and modes of zero-setting required on an instrument.

3.8.1 Accuracy of zero-setting

After zero-setting the effect of zero deviation on the result of the weighing shall be not more than ±0.25 *d*.

3.8.2 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.

3.8.3 Control of the zero-setting device

The operation of the zero-setting device shall be possible only when the instrument is in stable equilibrium (3.2.10), and the rate of correction of zero-tracking shall not be more than 0.5 d_t per second.

An interlock shall be provided to stop an automatic operation:

a) if the zero indication varies by or more than:

   i) 1 d_t on instruments with an automatic zero-setting device, or

   ii) 0.5 d_t on instruments with a semi-automatic or non-automatic zero-setting device.

b) if the instrument is not zeroed automatically following an automatic weighing cycle.

A description of the operation of the automatic zero-setting device (e.g. the maximum programmable time interval) shall be specified by the manufacturer.

The maximum programmable time interval specified by the manufacturer shall not be greater than the value necessary to ensure that the zero error is not greater than 0.5 d_t.

A non-automatic or semi-automatic zero-setting device shall not be operable during automatic operation.

3.8.4 Zero indicating devices on an instrument with digital indication

An instrument with digital indication shall have a device that:

a) provides an indication when the deviation from zero is not more than 0.25 d_t; and

b) complies with the requirement in 3.8.1.

3.9 Descriptive markings

Note: Markings are given by way of example, but may vary according to national regulations.

Instruments shall bear the following basic markings.

3.9.1 Markings shown in full

- identification mark or name of the manufacturer;
- identification mark or name of the importer (if applicable);
- serial number of the instrument;
- product description;
- control scale interval (if applicable) ..... g, kg or t;
- electrical supply voltage ..... V;
- electrical supply frequency (if applicable) ..... Hz;
- pneumatic/hydraulic pressure (if applicable) ..... kPa or bar;
- software identification (if applicable).

3.9.2 Markings shown in code

- type approval sign in accordance with national requirements;
- accuracy class 0.2, 0.5, 1 or 2;
- maximum capacity Max = ... g or kg or t;
- minimum capacity Min = ... g or kg or t;
- minimum totalized load Σ_{min} = ... g or kg or t;
- totalization scale interval d_t = ... g or kg or t;
- temperature range (if applicable) ..... °C / .....°C.

3.9.3 Supplementary markings

Depending upon the particular use of the instrument, supplementary markings may be required on type approval by the metrological authority issuing the type approval certificate (for example: securing code, date of manufacture).

Additional markings may be required on initial verification to specify types of products and related weighing conditions, for example: product density.

3.9.4 Presentation of descriptive markings

Descriptive markings shall be indelible and of a size, shape and clarity that permit legibility under normal operating conditions.

Descriptive markings may be either in the national language or in form of adequate, internationally agreed and published pictograms or signs.

They shall be grouped together in a clearly visible place on the instrument, either on a descriptive plate or sticker fixed permanently near the indicating device, or on a non-removable part of the instrument itself. In any case Max, Min and d_t shall be shown near the display. In case of a plate or sticker which is not destroyed when removed, a means of securing shall be provided, e.g. a non-removable control mark that can be applied.

It shall be possible to seal the plate bearing the markings, unless it cannot be removed without being destroyed.

As an alternative, all applicable markings above may be shown on a programmable display which is controlled by software provided that:

- at least Max, Min and d_t shall be displayed as long as the instrument is switched on;
- the other markings may be shown on manual command;
- the programmable display is described in the type approval certificate;
- the markings are considered as device-specific parameters and shall comply with the requirements for securing in 3.3 and 3.6.

The software controlled display markings need not be repeated on the data plate, if they are shown on or indicated near the display of the weighing result, with the exception of the following markings which shall be shown on the data plate:

- Max, Min and d_t shall be shown near the display;
- type approval sign in accordance with national requirements;
- name or identification mark of the manufacturer;
- voltage supply;
- voltage supply frequency, (if applicable);
- pneumatic/hydraulic pressure, (if applicable).

3.10 Verification marks

3.10.1 Position

Instruments 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 properties of the instrument;
- be visible without the instrument or its protective covers having to be moved when it is in service.

3.10.2 Mounting

Instruments required to bear verification marks shall have a verification mark support, at the place provided for above, which shall ensure the conservation of the marks. The type and method of sealing shall be determined by national prescription.

4 Requirements for electronic instruments

4.1 General requirements

Electronic instruments shall comply with the following requirements, in addition to the applicable requirements of all other clauses of this Recommendation.

4.1.1 Rated operating conditions

Electronic weighing instruments shall be so designed and manufactured that they do not exceed the maximum permissible errors under rated operating conditions.

4.1.2 Disturbances

Electronic instruments shall be so designed and manufactured that when they are exposed to disturbances, either:

a) significant faults do not occur, or

b) significant faults are detected and acted upon.

Note: A fault equal to or less than the value specified in T.4.5.6 (1 d_t) is allowed irrespective of the value of the error of indication.

4.1.3 Durability

The requirements in 4.1.1 and 4.1.2 shall be met durably in accordance with the intended use of the instrument.

4.1.4 Evaluation for compliance

A type of an electronic instrument is presumed to comply with the requirements in 4.1.1, 4.1.2, and 4.1.3 if it passes the examination and tests specified in Annex A.

4.1.5 Application of requirements for disturbances

The requirements in 4.1.2 may be applied separately to:

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

b) each part of the electronic instrument.

The choice of whether 4.1.2 a) or b) is applied is left to the manufacturer.

4.2 Functional requirements

4.2.1 Acting upon a significant fault

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

Means shall be provided to retain any totalized load information contained in the instrument when a significant fault occurs.

4.2.2 Indicator display test

Upon switch-on (switch-on of indication), a special procedure shall be performed that shows all relevant signs of the indicator in their active and non-active state sufficiently long to be checked by the operator. This is not applicable for non-segmented displays, on which failures become evident, for example screen-displays, matrix-displays, etc.

4.2.3 Influence quantities

An electronic instrument shall comply with the requirements of 2.7 and shall also comply with appropriate metrological and technical requirements at a relative humidity of 85 % at the upper limit of the temperature range.

4.2.4 Disturbances

When an electronic instrument is subjected to the disturbances specified in Annex A, either of the following shall apply:

a) the fault, i.e. the difference between error of indication when the disturbance is present and the intrinsic error shall not exceed the value specified in T.4.5.6 (1 d_t);

b) the instrument shall detect and react to a significant fault.

4.2.5 Warm-up time

During the warm-up time of an electronic instrument, there shall be no indication or transmission of the weighing result and automatic operation shall be inhibited.

4.2.6 Interfaces

An instrument may be equipped with interfaces (T.2.9) permitting the coupling of the instrument to external equipment and user interfaces (T.2.10) enabling the exchange of information between a human user and the instrument. When an interface is used, the instrument shall continue to function correctly and its metrological functions (including all metrologically relevant parameters and software) shall not be influenced.

4.2.6.1 Interfaces: information to be submitted with an instrument:

a) List of all commands (e.g. menu items);

b) Description of the software interface;

c) List of all commands together;

d) Brief description of their meaning and their effect on the functions and data of the instrument;

e) Other interface description.

4.2.6.2 Interface security

Interfaces shall not allow the legally relevant software and functions of the instrument and metrological data to be inadmissibly influenced by other interconnected instruments, or by disturbances acting on the interface.

An interface through which the functions mentioned above cannot be performed or initiated, need not be secured. Other interfaces shall be secured as follows:

a) Data is protected e.g., with a protective interface (T.2.11), against accidental or deliberate interference;

b) Hardware and software functions shall comply with the appropriate requirements for securing in 3.3 and 3.6;

c) It shall be easily possible to verify the authenticity and integrity of data transmitted to and from the instrument;

d) Other instruments required by national regulations to be connected to the interfaces of an instrument shall be secured to automatically inhibit the operation of the instrument for reasons of the non-presence or improper functioning of the required device.

4.2.7 AC mains voltage failure

An instrument that operates from the AC mains shall, in the event of a voltage supply failure, retain the metrological information contained in the instrument at the time of failure for at least 24 hours. A switch-over to an emergency supply voltage shall not cause a significant fault.

4.2.8 DC mains or battery-operated supply voltage

Battery-operated and DC mains powered instruments shall, whenever the voltage drops below the minimum operating level (see 2.7.2); either continue to function correctly, or show an error message, or be automatically put out of service.

5 Metrological controls

The metrological controls of instruments shall, in agreement with national legislation, consist of the following:

- type approval;
- initial verification;
- subsequent verification;
- in-service inspection.

Tests should be applied uniformly by the legal metrology services and should form a uniform program. Guidance for the conduct of type approval and initial verification is provided in OIML International Documents D 19 [8] and D 20 [9], respectively.

5.1 Type approval

5.1.1 Documentation

The application for type evaluation shall include documentation comprising:

- metrological characteristics of the instrument (2);
- standard set of specifications for the instrument;
- functional description of the components and devices;
- drawings, diagrams, photo of the instrument explaining the construction and operation;
- description and application of securing components, interlocks, adjustment devices, controls, etc. (3.2, 3.3, 3.6, 3.9);
- details of fractions p_i (modules tested separately) (5.1.4);
- recording and indication devices (3.4);
- data storage device (3.5);
- zero-setting devices (3.8);
- interfaces (types, intended use, immunity to external influences instructions) (4.2.6);
- for software controlled instruments: detailed software information (3.6);
- description of the stable equilibrium function of the instrument (3.2.11);
- drawing or photo of the instrument showing the principle and the location of control marks, securing marks, descriptive and verification marks (3.9, 3.10);
- operating instructions, operating manual;
- any document or other evidence demonstrating that the design and construction of the instrument complies with the requirements of this Recommendation;

  Note: Adherence to requirements for which no test is available, such as software-based operations, may be demonstrated by a specific declaration of the manufacturer (e.g. for interfaces as in 4.2.6, and for password protected access to set-up and adjustment operations as in 3.2.7.

5.1.2 General requirements

Type evaluation shall be carried out on one or more instruments that represent the definitive type submitted in a form suitable for simulation testing in a laboratory. Instruments may be tested on the premises of the metrological authority or in any other mutually agreed and suitable place. Influence factors shall be applied during simulation tests in a manner that will reveal an alteration of the measurement result for any weighing process to which the instrument could be applied. The evaluation shall consist of the tests specified in 5.1.2.2.

5.1.2.1 Type evaluation

The submitted documents shall be examined and tests carried out to verify that the instruments comply with:

- the metrological requirements in Clause 2, particularly with reference to maximum permissible errors, when the instrument is operated in accordance with the manufacturer's specifications for range and product(s);
- the technical requirements in Clause 3; and
- the requirements in Clause 4 for electronic instruments.

Tests shall be conducted in a manner that prevents unnecessary commitment of resources, and when the same instrument is involved the result of these tests may be assessed for initial verification.

Instruments used in static weighing in accordance with the integral verification method in A.5.1.2 shall comply with the requirements of 3.2.6.

The metrological characteristics of the instrument in accordance with 3.9 and the specifications for the modular approach of the modules of the instrument in accordance with 5.1.4 shall be examined.

The applicant may be required to supply equipment, personnel and a control instrument to perform the tests.

5.1.2.2 Material tests

In-situ material tests shall be conducted in accordance with either the separate verification method in A.5.1.1 or the integral verification method in A.5.1.2.

The control instrument used for conducting the material tests shall comply with the requirements of 6.2.

5.1.2.3 Simulation tests

Influence quantities shall be applied during simulation tests in a manner that will reveal an alteration of the weighing result for any weighing process to which the instrument could be applied, in accordance with 2.7, for all instruments; and Clause 4, for electronic instruments.

5.1.3 Type approval certificate and determination of classes

The type approval certificate shall state the appropriate accuracy classes 0.2, 0.5, 1 or 2, as specified at the type approval stage and shall be determined by compliance with the metrological requirements at initial verification of the instrument.

5.1.4 Modules

Subject to agreement with the metrological authority, the manufacturer may define and submit modules to be examined separately. This is particularly relevant in the following cases:

- where testing the instrument as a whole is difficult or impossible;
- where modules are manufactured and/or placed on the market as separate units to be incorporated in a complete instrument;
- where the applicant wants to have a variety of modules included in the approved type;
- when a module is intended to be used for various kinds of weighing instruments (in particular load cells, indicators, data storage).

5.1.4.1 Apportioning of errors

Where it is necessary to separately test modules of an instrument or system the following requirements apply.

The error limits applicable to a module which is examined separately are equal to a fraction p_i of the maximum permissible errors or the allowed variations of the indication of the complete instrument. The fractions for any module have to be taken for the same accuracy class as for the complete instrument incorporating the module.

The fractions p_i shall satisfy the following equation:

$$p_1^2 + p_2^2 + p_3^2 + ... \leq 1$$

The fraction p_i shall be chosen by the manufacturer of the module and shall be verified by an appropriate test, taking into account the following conditions:

- for purely digital devices p_i may be equal to 0;
- for weighing modules p_i may be equal to 1;
- for all other modules (including digital load cells) the fraction shall not exceed 0.8 and shall not be less than 0.3, when more than one module contributes to the effect in question.

For mechanical structures evidently designed and manufactured according to sound engineering practice, an overall fraction $p_i = 0.5$ may be applied without any test, e.g. when levers are made of the same material and when the chain of levers has two planes of symmetry (longitudinal and transversal).

If the metrological characteristics of the load cell or other major component have been evaluated in accordance with the requirements of OIML R 60 [6], or any other applicable OIML Recommendation, that evaluation shall be used to aid type evaluation if so requested by the applicant.

5.2 Initial verification

5.2.1 General requirements

Initial verification shall be carried out in accordance with national regulations by the appropriate metrological authority to establish conformity of the instrument to the approved type and/or the requirements of this Recommendation.

Instruments shall be tested to verify that they comply with the requirements in Clause 2 (except 2.7) and Clause 3 for any product(s) for which they are intended and when operated under normal weighing conditions.

Tests shall be carried out, in-situ, with the instrument fully assembled and fixed in the position in which it is intended to be used. The installation of an instrument shall be so designed that the weighing operation will be the same whether for the purposes of testing or for normal weighing operation.

5.2.2 Operational tests

Instruments shall be tested in their normal mode of automatic operation and in accordance with either the separate verification method as specified in A.5.1.1 or the integral verification method as specified in A.5.1.2.

Tests shall be conducted in a manner that prevents an unnecessary commitment of resources. In appropriate situations and to avoid duplicating tests previously performed on the instrument for type evaluation under 5.1.2.2, the authority may use the results of observed tests for initial verification.

The applicant may be required to supply the material, equipment, qualified personnel, and a control instrument to perform the tests.

Instruments used in static weighing in accordance with the integral verification method in A.5.1.2 shall comply with the requirements of 3.2.6.

5.2.3 Conformity

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

- compliance with the appropriate maximum permissible errors in 2.2.1;
- correct functioning of all devices, e.g. interlocks, indicating and recording devices;
- construction material and design, as far as they are of metrological relevance;
- if appropriate, a list of the tests performed.

5.2.4 Visual inspection

Before testing, the instrument shall be visually inspected for:

- metrological characteristics, i.e. scale interval, minimum capacity;
- prescribed inscriptions and positions for verification and control marks.

5.2.5 Marking and securing

According to national legislation, initial verification may be testified by verification marks as specified in 3.10. National legislation may also require securing of devices whose dismantling or maladjustment might alter the metrological characteristics of the instrument without the alterations being clearly visible. The provisions of 3.3 and 3.9 shall be observed.

5.2.6 Application of accuracy class

Accuracy class requirements shall be applied in accordance with the appropriate parts of 2.2.1 for initial verification.

Verify that the accuracy classes marked in accordance with 3.9 are equal to the accuracy class determined as above.

Note: The accuracy class that was achieved at type approval stage may not be achieved at initial verification if the loads used are significantly less stable or of different dimensions. In this case a lower accuracy class shall be marked in accordance with 2.2.1 and 3.9. Marking of a higher accuracy class than was achieved at type approval stage is not permitted.

5.3 Subsequent metrological control

Subsequent metrological control may be performed according to national regulations.

5.3.1 Subsequent verification

Subsequent verification shall be carried out in accordance with the same provisions as in 5.2 for initial verification with the error limits being those on initial verification. Marking and securing may take place according to 5.2.5, the date being that of the subsequent verification.

5.3.2 In-service inspection

In-service inspection shall be carried out in accordance with the same provisions as in 5.2 for initial verification, with the exception that the in-service maximum permissible errors in 2.2.1 Table 1 shall be applied. Marking and securing may remain unchanged, or renewed as in 5.3.1.

6 Test methods

6.1 General test procedure

In-situ material tests shall be carried out as follows:

a) in accordance with the descriptive markings;

b) under the rated operating conditions for the instrument;

c) in accordance with either the separate verification method in A.5.1.1, or the integral verification method in A.5.1.2 using the materials test procedure in A.5.2;

d) not less than three material tests shall be conducted, one at maximum capacity, Max, one at minimum capacity, Min, and one close to the minimum totalized load, Σ_{min}, marked on the instrument;

e) with a test load(s) that is representative of the range and type of products for which the instrument is likely to be used or product(s) for which the instrument is intended;

f) each test shall be conducted at the maximum rate of weighing cycles per hour;

g) a minimum of five weighing cycles per material test shall be conducted;

h) equipment near the instrument, including conveyors, dust collection systems, etc. that are in use when the instrument is in normal operation, shall be in use during the tests;

i) if the instrument can divert weighed material through alternative discharge facilities the test program shall be performed for each alternative unless it can be established that the weigh hopper is not affected for example by different air flow.

6.2 Control instruments and test standards

A control instrument and standard weights meeting the appropriate requirements in Clause 6 shall be available for determining the conventional true value of the mass of each test load. The control instrument may either be separate (A.5.1.1) or integral (A.5.1.2).

Where a control instrument is verified immediately before the tests its error and uncertainty shall be less than one-third of the maximum permissible error for automatic weighing in 2.2.1. If the control instrument is verified at any time other than immediately prior to the weighing tests, its error and uncertainty shall be less than one-fifth of the maximum permissible error for automatic weighing in 2.2.1.

Where the instrument under test is constructed for use as the integral control instrument it shall have an appropriate scale interval and shall comply with the requirements of 3.2.6 and A.5.1.2.

A control instrument may be re-verified immediately following completion of the weighing to ascertain whether or not its performance has changed. For re-verification tests the combined error and uncertainty shall be as specified for the appropriate control instrument.

6.2.1 Use of an appropriately designed control instrument

When a load receptor cannot be loaded with sufficient standard weights to verify and determine the rounding error of the control instrument indicating device or partial totalization indicating device, then the instrument shall be subjected to material tests by the separate verification method. For this method an appropriately designed control instrument shall be available so that the material tests can be effectively and efficiently conducted.

6.2.2 Standard weights

The reference standard weights or masses used for the type examination or verification of an instrument shall principally meet the metrological requirements of OIML R 111: 2004 [5]. The error of the additional weights used to determine the rounding error of the control instrument shall not exceed one-fifth of the maximum permissible error of the instrument to be verified for the load, as specified in 2.2.2 for initial verification.

6.2.3 Substitution of standard weights

The test shall be carried out only during verification and at the place of use taking A.5.1.2.2 into account.

When testing instruments at the place of use (application), instead of standard weights any other constant load may be used, provided that standard weights of at least 50 % of Max are used. Instead of 50 % of Max, the portion of standard weights may be reduced to:

- 35 % of Max if the repeatability error is $\leq 0.3\ d$;
- 20 % of Max if the repeatability error is $\leq 0.2\ d$.

The repeatability error has to be determined with a load (weights or any other load) of about the value where the substitution is made, by placing it three times on the load receptor.

6.3 Interruption of automatic operation (A.5.1.2.3)

The integral control instrument uses a test-stop program as part of the automatic weighing program to automatically interrupt the automatic weighing operation twice as specified in A.5.1.2.3 during each weighing cycle in order to weigh and discharge a subdivision of the test load.

If the integral control instrument is installed as an air-enclosed system (T.2.6) interruption of the automatic operation during consecutive weighing cycles may not be possible and tests shall be conducted as specified in A.5.1.2.7.

6.4 Conventional true value of the mass of the test load

a) With the separate verification method, the test load shall be weighed on a control instrument and the result shall be considered as the conventional true value of the mass of the test load.

b) With the integral verification method, for each discharge, the tare value subtracted from the gross value is the net value of the material discharged. A summation of the net values of all the discharges in the test load shall be the conventional true value of the mass of the test load.

Note: When using the integral control verification method, a subdivision of the test load is unavoidable and this may also be true when using the separate control verification method. When calculating the conventional true value of the mass of the test load, it is necessary to consider the increased uncertainty due to subdividing the test load.

6.5 Indicated mass

a) With the separate verification method, a test load shall be weighed as an automatic bulk to bulk weighing operation and the indicated mass on the principal totalization indicating device shall be observed and recorded.

b) With the integral verification method, a partial totalization indicating device and standard weights loaded incrementally on the load receptor can be used to assess the rounding error. Alternatively, an appropriately designed control indicating device (T.4.3.4) with a higher resolution (not greater than 0.2 d_t) shall be use to indicate the mass of the test load to at least ten times the resolution of the totalization scale interval, d_t.

6.6 Error for automatic weighing

The error for automatic weighing shall be the difference between the conventional true value of the mass of the test load as specified in 6.4 for the separate or the integral verification method as appropriate, and the indicated weight value observed and recorded as specified in 6.5 for the separate or the integral verification method as appropriate.

The maximum permissible error for automatic weighing shall be as specified in 2.2.1 Table 1 for initial verification and as appropriate for the class of instrument.

6.7 Examination and tests

The examination and testing of an electronic weighing instrument is intended to verify compliance with the applicable requirements of this Recommendation and especially with the requirements in Clause 4.

6.7.1 Examination

An electronic weighing instrument shall be examined to obtain a general appraisal of its design and construction.

6.7.2 Performance tests

An electronic weighing instrument or electronic device, as appropriate, shall be tested as specified in Annex A to determine its correct functioning.

Tests are to be conducted on the whole instrument except when the size and/or configuration of the instrument does not lend itself to testing as a unit. In such cases, the separate electronic devices shall be subjected to testing. It is not intended that electronic devices be further dismantled for separate testing of components. In addition, an examination shall be carried out on the fully operational weighing instrument or, if necessary, on the electronic devices in a simulated set-up that sufficiently represents the weighing instrument. The equipment shall continue to function correctly as specified in Annex A.

6.7.3 Span stability tests

For span stability testing the instrument shall be tested in non-automatic (static) operation. A single static test load near maximum capacity shall be used.

The instrument shall be subjected to span stability tests at various intervals, i.e. before, during and after being subjected to performance tests.

When the instrument is subjected to span stability test specified in Annex A.8:

- the maximum allowable variation in the errors of indication shall not exceed half the absolute value of the maximum permissible error in 2.2.2 Table 2 for the test load applied on any of the n measurements;
- where the differences of the results indicate a trend more than half the allowable variation specified above, the test shall be continued until the trend comes to rest or reverses itself, or until the error exceeds the maximum allowable variation.

Annex A
(Mandatory)

Test procedures for discontinuous totalizing automatic weighing instruments

A.1 Examination for type approval

A.1.1 Documentation (5.1.1)

Review the documentation that is submitted, including necessary photographs, drawings, diagrams, general software information, relevant technical and functional description of main components, devices, operational manual, etc. to determine if it is adequate and correct.

A.1.2 Comparing construction with documentation (5.1.1)

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

A.1.3 Metrological characteristics

Note metrological characteristics according to the checklist given in the test report format in OIML R 107-2.

A.1.4 Technical requirements

Check for conformity with the technical requirements according to the checklist given in the test report format in OIML R 107-2.

A.1.5 Functional requirements

Check for conformity with the functional requirements according to the checklist given in the test report format in OIML R 107-2.

A.2 Examination for initial verification

A.2.1 Compare construction with documentation

Examine the instrument for conformity with the approved type.

A.2.2 Descriptive markings (3.9)

Check the descriptive markings according to the requirements in 3.9, and if applicable of the type approval.

A.2.3 Securing and verification marks (3.3 and 3.10)

Check the arrangements for securing and for verification marks according to the checklist in the test report in OIML R 107-2.

A.3 General test requirements

A.3.1 Mains power

Unless otherwise specified for each test, power up the equipment under test (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.

A.3.2 Zero-setting

Adjust the EUT as closely as practicable to zero prior to each test and do not readjust at any time during the test, except to reset if a significant fault has occurred.

The status of the automatic zero-setting facilities shall be as specified for each test.

A.3.3 Temperature

Except for the temperature tests (A.7.3.1 and A.7.3.2) and the damp heat, steady state test (A.7.3.3), 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 differences between the extreme temperatures noted during the test do not exceed one-fifth of the temperature range of the instrument and the rate of change does not exceed 5 °C per hour.

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

A.3.4 Recovery

After each test, allow the instrument to recover sufficiently before the following test.

A.3.5 Pre-loading

Before each weighing test, the instrument shall be pre-loaded to Max, except for the tests in A.5.3 (warm-up) and A.7.3.2 (temperature effect on no-load).

A.3.6 Test standards (6.2)

A.3.6.1 Control instruments

A control instrument meeting the requirements of 6.2 shall be used to perform the material tests. Where necessary, standard weights meeting the requirements of 6.2.2 may be used to assess the rounding error.

A.3.6.2 Use of standard weights to assess rounding error

A.3.6.2.1 General method to assess error prior to rounding

For instruments with digital indication having a scale interval d, changeover points may be used to interpolate between scale intervals, i.e. 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 for example 0.1 d are successively added until the indication of the instrument is increased unambiguously by one scale interval ($I + d$). The additional load, ΔL, added to the load receptor gives the indication, P, prior to rounding by using the following formula:

$$P = I + 0.5\ d - \Delta L$$

The error, E, prior to rounding is:

$$E = P - L = I + 0.5\ d - \Delta L - L$$

Example: An instrument with a scale interval, d, of 1 kg is loaded with 100 kg and thereby indicates 100 kg. After adding successive weights of 0.1 kg, the indication changes from 100 kg to 101 kg at an additional load of 0.3 kg. Inserted in the above formula these observations give:

$$P = (100 + 0.5 - 0.3)\ \text{kg} = 100.2\ \text{kg}$$

Thus, the true indication prior to rounding is 100.2 kg, and the error is:

$$E = (100.2 - 100) \text{ kg} = +0.2 \text{ kg}$$

A.3.6.2.2 Correction for error at zero

Evaluate the error at zero load, E_0, and the error at load L, E, by the method of A.3.6.2.1.

The corrected error prior to rounding, E_c, is:

$$E_c = E - E_0$$

Example: If, for the example in A.3.6.2.1, the error calculated at zero load was:

$$E_0 = +0.4 \text{ kg},$$

the corrected error is:

$$E_c = +0.2 \text{ kg} - (+0.4 \text{ kg}) = -0.2 \text{ kg}$$

A.4 Test program

A.4.1 Type evaluation (5.1)

All tests in A.5 to A.8 shall be applied for type evaluation, using the test methods in Clause 6.

Tests in A.5.1.2 may be omitted if the instrument under test is not an integral control instrument.

A.4.2 Initial verification (5.2)

The tests in A.2 and A.5 except for A.5.3 (warm-up test) shall be applied for initial verification. The types of test loads used shall comply with 6.1, e).

A.5 Metrological tests

A.5.1 Material test requirements

Material tests shall be conducted with the material, test load, requirements and methods in:

a) 5.1.4 for type approval;

b) 5.2.2 for initial verification;

c) A.5.1.1 or A.5.1.2 (using the materials test procedure in A.5.2).

A.5.1.1 Separate verification method (6.2 and A.9.2.3)

The separate control instrument is used to weigh the material either before or after it is weighed on the discontinuous totalizing automatic weighing instrument.

A.5.1.1.1 Calculation of error (6.6)

When calculating the error, it is necessary to consider the scale interval of the control indicating device and the number of subdivisions of the test load.

The values on the separate control instrument are observed and recorded. The error for automatic weighing shall be the difference between the conventional true value of the mass of the test load determined on the separate control instrument (6.4, a)) and the values obtained from the principal totalization indication (6.5, a)).

This is the value that shall be used for comparison with the appropriate maximum permissible error for automatic weighing in 2.2.1.

A.5.1.2 Integral verification method (6.2.2 and A.9.2.1)

The integral control instrument is used for static weighing of material test loads by use of a test-stop program as part of the automatic weighing program to interrupt automatic weighing operation for test purposes during the automatic process.

A.5.1.2.1 Determination of weighing test performance

The tests are performed on the control instrument in-situ at the time of type approval or verification.

The integral verification weighing performance may be determined as follows, prior to the material tests, for determining the errors in material testing.

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 shall be selected, and for other weighing tests at least 5 shall be selected. The test loads selected shall include Max and Min so that the errors may be determined for the nominal hopper loads that will be used in the material tests.

Determine the error at each test load using the procedure in A.3.6.2 if necessary to obtain the accuracy requirements of A.3.6.1.

When loading or unloading weights the load shall be progressively increased or decreased.

Errors of indication shall be recorded and taken into account when determining the errors in material testing.

A.5.1.2.2 Weighing test using substitution material (6.2.3)

The test shall be carried out only during verification and at the place of use taking A.5.1.2.1 into account.

Determine the allowed number of substitutions according to 6.2.3.

Check the repeatability error at a load of about the value where the substitution is made, by placing it three times on the load receptor.

Apply test loads from zero up to and including the maximum portion of standard weights.

Determine the error (A.3.6.2) and then remove the weights so that the no-load indication is reached.

Substitute the previous weights with substitution material until the same changeover point as used for the determination of the error is reached. Repeat the above procedure until Max of the instrument is reached.

Unload in reverse order to zero, i.e. unload the weights and determine the changeover point. Load the weights back on and remove the substitution material until the same changeover point is reached. Repeat this procedure until no-load indication is reached.

Similar equivalent procedures may be applied.

A.5.1.2.3 Interruption of automatic weighing during operational tests

a) Interruption before emptying (automatic gross weighing). After the load receptor has been loaded and the instrument has automatically processed a gross value, the automatic operation shall be interrupted by a test-stop program (6.3).

b) The static control weighing indication of the loaded receptor is observed and recorded after complete stabilization of the instrument and auxiliary equipment following stage a) above. If necessary, standard weights may be used to interpolate between scale intervals. The static control indication shall be corrected for the errors determined in A.5.1.2.1 (for increasing loads).

c) Interruption after emptying (automatic tare weighing). After the load has been discharged and the instrument has automatically processed a tare load, the automatic operation shall be interrupted by a test-stop program (6.3).

d) The static control weighing indication of the empty receptor is observed and recorded after complete stabilization of the instrument following a). The static indication shall be corrected for the errors determined in A.5.1.2.1 (for decreasing loads).

A.5.1.2.4 Calculation of error (6.6)

When calculating the error, it is necessary to consider the scale interval of the control indicating device and the number of subdivisions of the test load.

The error for automatic weighing shall be the difference between the conventional true value of the mass of the test load in A.5.1.2.5 and the values obtained from the totalization indication in A.5.1.2.6.

This is the value that shall be used for comparison with the appropriate maximum permissible error for automatic weighing in 2.2.1.

A.5.1.2.5 Conventional true value of the mass of the test load (6.4, b))

The values obtained under static conditions on the control indicating device or those values obtained by balancing with standard weights are noted and totalized. For each weighing cycle, the net value is the difference between the values obtained in A.5.1.2.3, b) and d). The conventional true value of the mass of the total test load is determined by summation of the net values obtained at each cycle.

A.5.1.2.6 Indicated totalized mass (6.5, b))

The values obtained automatically on the principal totalization indicating device are noted and totalized. Normally the totalization indicating devices automatically calculate the net value. Otherwise for each weighing cycle, the net value is the difference between the values obtained in A.5.1.2.3, a) and c).

A.5.1.2.7 Air-enclosed integrated instruments (6.3, A.9.2.2)

If the instrument is installed in an air-enclosed system (T.2.6), the moving mass of material causes air turbulence that can affect the weighing results. To ensure that such an instrument is tested in normal conditions of use, the automatic operation shall not be interrupted during consecutive weighing cycles so that at least one receptor shall be discharged in automatic mode. In this case it is necessary to observe and record the indications according to A.5.1.2.3, a) or c) or the net value indicated by the instrument during automatic weighings shall be used to determine the discharged mass which corresponds to the value of the test load.

A.5.2 Materials test procedure (6.1, A.9)

The test procedure shall be as follows:

1) Start up the automatic weighing system, including the surrounding equipment which is normally in use when the instrument is itself in use.

2) Run the system for five weigh cycles (or more if necessary) to ensure normal working conditions.

3) Halt the automatic weighing system and record the indication of totalized mass.

4) Run the weighing system for a number of weighing cycles as specified for each test in 6.1, ensuring that the processed material can be weighed on the control instrument (integral or separate) in accordance with one of the alternative verification methods of A.5.1.1 or A.5.1.2.

5) Halt the weighing system, and record the final indication of totalized mass.

6) Determine the indicated totalized mass for the test from the difference between the indications at start (step 3)) and finish (step 5)).

7) Repeat the above procedure for further tests as specified in 6.1.

8) Determine the material test error from the difference between the indicated totalized mass as determined in step 6) and the total mass of material determined using the control instrument as in 4).

A.5.3 Warm-up (4.2.5)

This test is to verify that metrological performance is maintained in the period immediately after switch on. The method is to check that automatic operation is inhibited until a stable indication is obtained and to verify that zero and span errors comply with the requirements during the first 30 minutes of operation. Zero-tracking and automatic zero-setting (if available) shall be disabled, unless if the zero-setting operates as part of every automatic weighing cycle in which case this function shall be enabled or simulated as part of the test.

Note: For instruments that do not tare weigh after each discharge it is not necessary to calculate the zero variation error.

Other test methods which verify that metrological performance is maintained during the first 30 minutes of operation may be used.

The warm-up test shall be performed in non-automatic (static) operation. A single static test load near maximum capacity shall be used.

1) Disconnect the instrument from the supply for a period of at least 8 hours prior to the test.

2) Reconnect the instrument and switch on while observing the load indicator.

3) Check that it is not possible to initiate automatic weighing until the indicator has stabilized (4.2.2).

4) As soon as the indication has stabilized, set the instrument to zero if this is not done automatically.

5) Determine the error at zero by the method of Annex A.3.6.2.1, and specify this error as E_{0I} (error of initial zero-setting) at first and as E_0 (zero-setting error) when repeating this step.

6) Apply a static load close to Max. Determine the error by the method of A.3.6.2.1 and A.3.6.2.2.

7) Verify that:

   - zero indication error, E_{0I}, is not greater than 0.25 d_t (3.8.1),
   - span error is not greater than the maximum permissible error specified in 2.2.2 Table 2 for initial verification.

8) Repeat steps 5) and 6) after 5, 15 and 30 minutes.

9) After each time interval verify that:

   - zero variation error, $E_0 - E_{0I}$, is not greater than 0.25 $d_t \times p_i$,
   - span error is not greater than the maximum permissible error specified in 2.2.2 Table 2 for initial verification.

A.5.4 Zero-setting (3.8)

A.5.4.1 Modes of zero-setting

It is normally only necessary to test the range and accuracy of zero-setting in one mode. If zero is set as part of the automatic weighing cycle then this mode shall be tested. To test automatic zero it is necessary to allow the instrument to operate through the appropriate part of the automatic cycle and then to halt it before testing.

The range and accuracy of zero-setting shall be tested by applying loads as specified below in non-automatic (static) operation to the load receptor after the instrument is halted.

A.5.4.2 Range of zero-setting

A.5.4.2.1 Initial zero-setting

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

a) Positive range

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 off and on, it does not reset to zero. The maximum load that can be re-zeroed is the positive portion of the initial zero-setting range.

b) Negative range

1) Remove any weights from the load receptor and set the instrument to zero. Then remove the load receptor (or the platform for test weights) 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 initial zero-setting range.

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

3) 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 initial zero-setting range.

4) The zero-setting range is the sum of the positive and negative portions. If the load receptor cannot readily be removed, then before proceeding to step 3) above, apply a test load greater than the permissible negative portion of the initial zero setting range which can be calculated from the result of the positive range test.

If it is not possible to test the negative portion of the initial zero-setting range by these methods then only the positive part of the initial zero-setting range need be considered.

A.5.4.2.2 Non-automatic and semi-automatic zero-setting

This test is conducted in the same manner as described in A.5.4.2.1, except that the zero-setting device is used rather than switching the instrument on and off.

A.5.4.3 Accuracy of zero-setting

1) Set the instrument to zero.

2) Add weights to the load receptor to determine the additional load at which the indication changes from zero to one totalization scale interval above zero.

3) Calculate the error at zero according to the description in A.3.6.2.1.

A.5.4.4 Control of the zero-setting (3.8.3)

This test is applicable for instruments with programmable automatic zero-setting only and does not need to be performed for instruments that have automatic zero-setting as part of every automatic weighing cycle or instruments that do tare weigh after each discharge.

To verify that an automatic zero-setting facility will operate sufficiently often to ensure that zero error is not greater than 0.5 d_t, apply the following method:

1) Determine the maximum permissible time interval as specified by the manufacturer in accordance with 3.8.3.
2) Allow the instrument to be reset to zero automatically.
3) After an interval close to the maximum permissible zero-setting interval established in 1) but before a further automatic zero-setting, carry out the test of A.5.4.3, but without zero-setting.
4) Steps 2) and 3) shall also be carried out as soon the instrument is operable after switch-on, i.e. immediately after the normal warm-up time.

A.6 Additional functionality

A.6.1 Test for the stability of equilibrium (3.2.10)

Check the documentation of the manufacturer; whether the following stable equilibrium functions are described in detail and sufficiently:

- The basic principle, the function and the criteria for stable equilibrium;
- All adjustable and non-adjustable parameters of the stable equilibrium function (time interval, number of measuring cycles, etc.);
- Securing of these parameters;
- Definition of the most critical adjustment of the stable equilibrium.

Test the stable equilibrium by manually disturbing the equilibrium by one single action (e.g. by operation of a test switch) and initiate the command for printing, zero-setting or other function, as soon as possible. In the case of printing, read the indicated value 5 seconds after printing. Stable equilibrium is considered to be achieved when no more than two adjacent values are indicated, one of which is the printed value. In the case of zero-setting check the accuracy as in A.5.4.3. Perform the test five times, but this condition is only valid for each separate weighing test and not for the group of five tests.

Check whether under continuous disturbance of the equilibrium no functions can be performed that require stable equilibrium, e.g. printing or zero operations.

A.6.2 Agreement between multiple indicating devices (2.4)

During the tests verify that for the same load, the difference between any two indicating devices having the same scale interval is as follows:

- zero for digital indicating devices;
- not greater than the maximum permissible error for analog devices.

A.6.3 Adjustments in automatic operating mode (3.2.7)

Verify that it is not possible to make operating adjustments nor to reset the indicating devices during an automatic weighing operation.

A.6.4 Securing of components and pre-set controls (3.3)

Verify that it is not possible to make unauthorized adjustments or resetting of components, interfaces, software devices and pre-set controls without any access becoming automatically evident.

A.6.5 Indication of weighing results (3.4)

For indication of weighing results, verify that:

- in automatic operation the totalization devices cannot be reset to zero;
- when automatic operation is finished the partial totalization device cannot be reset to zero unless the total is automatically recorded. Test by disabling the indicating device and attempting to reset the partial totalization device;
- an automatic indication of the total is generated if the automatic operation is interrupted;
- printing of the indicated values is inhibited if the stability criteria (3.2.10) are not fulfilled.

A.6.6 Retention of total load value after mains power failure (4.2.7)

Switch off mains power to the instrument while the principal totalization device is indicating a total load value of not less than Σ_{min}. Verify that this total value is retained for at least 24 hours.

A.6.7 DC mains voltage or battery voltage variations (4.2.8)

Reduce voltage until the instrument ceases to operate or ceases to give a weight value indication. Verify that no malfunction or significant fault occurs before the instrument is thus put out of service. Measure and record the voltage value when the instrument ceases to operate or ceases to give a weight value indication and compare this measured value with the manufacturer's specified value.

A.6.8 Zero offset interlock (3.8.3)

A.6.8.1 Positive offset

Set the instrument to zero by the method used for the tests in A.5.4.2. Add a load to the load receptor of greater than d_t for instruments with an automatic zero-setting device, or greater than 0.5 d_t for instruments without an automatic zero-setting device. Confirm that automatic operation is no longer possible.

A.6.8.2 Negative offset

Add a load to the load receptor of greater than d_t for instruments with an automatic zero-setting device, or greater than 0.5 d_t for instruments without an automatic zero-setting device.

Set the instrument to zero by the method used for the tests in A.5.4.2. Remove the test weights and confirm that automatic operation is no longer possible.

Check if the instrument is zeroed automatically following an automatic weighing cycle.

A.7 Influence factor and disturbance tests

A.7.1 General

Influence factor and disturbance tests are intended to verify that electronic instruments can perform and function as intended in the environment and under the conditions specified. Each test indicates, where appropriate, the reference condition under which the intrinsic error is determined.

The influence factors or disturbance tests shall be applied to a complete instrument under normal operation. Where it is not possible to apply the influence factors or disturbances to an instrument under normal operation, the instrument shall be subjected to the influence factors or disturbances under static conditions or simulated operation as defined herein. The minimum requirements for simulators are listed under the test equipment heading for each test. The permissible effects of the influence factors or disturbances, under these conditions, are specified for each case.

When the effect of one influence factor is being evaluated, all other factors are to be held relatively constant, at a value close to normal. After each test the instrument shall be allowed to recover sufficiently before the following test.

Where modules of the instrument are examined separately, errors shall be apportioned in accordance with 5.1.4.1.

After each test the instrument shall be allowed to recover sufficiently before the following test.

The operational status of the instrument or simulator shall be recorded for each test.

When an instrument is connected in other than a normal configuration, the procedure shall be mutually agreed on by the metrological authority and the applicant.

For disturbance testing the instrument shall be tested in non-automatic (static) operation. Each test shall be performed with one small static test load.

A.7.2 Simulator requirements

A.7.2.1 General

Simulators shall be designed to enable verification of the accuracy of the weighing function and the integrity of the totalization storage and indicating function. The automatic process control and data processing functions shall be verified where possible.

Where possible the simulator shall include all electronic devices of the weighing processing system. It shall also include the load cell and a means to apply standard test loads. Where this is not possible, e.g. for high capacity instruments, then a load cell simulator may be used or alternatively the load cell interface may be modified to incorporate a scaling factor to give the design output for a small test load.

Repeatability and stability of a load cell simulator shall make it possible to determine the performance of the instrument with at least the same accuracy as when the instrument is tested with weights.

A.7.2.2 Interfaces (4.2.6)

Susceptibility that would result from the use of electronic interfaces to other equipment shall be simulated in the tests. For this purpose it is sufficient to connect 3 m of interface cable terminated to simulate the interface impedance of the other equipment.

A.7.2.3 Documentation

Simulators shall be defined in terms of hardware and functionality by reference to the instrument under test, and by any other documentation necessary to ensure reproducible test conditions and this information shall be attached to or traceable from the test report.

A.7.2.4 Weighing function

The weighing function may be verified by observation of the control indicating device, if available, during application of the influence factors or disturbances.

Alternatively the totalization indicator may be observed while the total is being incremented by continually adding the result of weighing a static load during application of the influence factors or disturbances. This may be achieved by special test software or by manual intervention, or by combinations thereof. Other methods which enable the weighing function to be verified may be used as appropriate. The maximum permissible errors, in terms of mass, will be the same regardless of the method used.

A.7.2.5 Totalization storage and indication function

The following requirement is applicable to instruments of which the totalization device is a separate sub-assembly inside or even outside the instrument (i.e. not a part of the generally used memory).

The simulator must display a recorded total of not less than the minimum totalized load, Σ_{min}. It must be verified that the recorded total is retained during and after application of influence factors or disturbances. Transient errors that it is not possible to record and temporary failure of indication when disturbances are applied are acceptable.

In case of purely digital totalization device(s), the totalization device(s) need not be tested during influence factor and disturbance testing. The operation of the totalization device(s) shall be checked at least once during normal operating conditions.

A.7.3 Influence factor tests

Summary of tests:

Test	Criteria	§
Static temperatures	mpe*	A.7.3.1
Temperature effect on no load indication	mpe	A.7.3.2
Damp heat test steady-state	mpe	A.7.3.3
AC mains voltage variations	mpe	A.7.3.4
DC mains voltage variations	mpe	A.7.3.5
Battery DC voltage variations	mpe	A.7.3.6
Voltage variations of 12 V or 24 V road vehicle battery power	mpe	A.7.3.7

* maximum permissible error as specified in 2.2.2

A.7.3.1 Static temperature tests (2.7.1.1)

Static temperature tests are carried out according to basic standard IEC Publications 60068-2-1 [11], 60068-2-2 [12] and 60068-3-1 [13], and according to Table 4.

Table 4

Environmental phenomena	Test specification	Test setup
Temperature	Reference temperature of 20 °C	
	Specified high temperature for 2 hours	IEC 60068-2-2
	Specified low temperature for 2 hours	IEC 60068-2-1
	Temperature of 5 °C, if the specified low temperature is ≤ 0 °C	IEC 60068-3-1
	Reference temperature of 20 °C	

Note: Use IEC 60068-3-1 for background information.

Supplementary information to the IEC test procedures:

Object of the test:	To verify compliance with the provisions in 2.7.1.1 under conditions of dry heat (non-condensing) and cold. The test in A.7.2.2 may be conducted during this test.
Preconditioning:	16 hours
Condition of the EUT:	EUT is connected to the mains power and on for a time period equal to or greater than the warm-up time specified by the manufacturer. Mains power is to be on for the duration of the test. The zero-setting and zero-tracking facilities shall be enabled as for normal operation.
Stabilization:	2 hours at each temperature under "free air" conditions. "Free air" conditions mean a minimum air circulation to keep the temperature at a stable level.
Temperature:	As specified in 2.7.1.1
Temperature sequence:	a) at the reference temperature of 20 °C; b) at the specified high temperature; c) at the specified low temperature; d) at a temperature of 5 °C, if the specified low temperature is below 0 °C; and e) at the reference temperature.
Number of test cycles:	At least one cycle.
Test information:	Adjust the EUT as close to zero indication as practicable prior to the test (if an automatic zero-tracking device is connected, adjust it to a value near zero). The EUT shall not be readjusted at any time during the test. Changes in barometric pressure shall be taken into account. After stabilization at the reference temperature and again at each specified temperature, apply at least five different test loads or simulated loads and record: a) date and time; b) temperature; c) relative humidity; d) test load; e) indications (as applicable); f) errors; g) functional performance; h) barometric pressure. The EUT shall display a recorded total not less than the minimum totalized load, Σ_{min}, but observe A.7.2.5.
Maximum allowable variations:	All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 2.2.2 Table 2.

A.7.3.2 Temperature effect on the no-load indication (2.7.1.2)

No reference to international standards can be given at the present time. This test should therefore be conducted as described below.

This test does not need to be performed for instruments that have automatic zero-setting as part of every automatic weighing cycle or that do tare weigh after each discharge.

The instrument is set to zero, the temperature is then changed from 20 °C to the prescribed highest and lowest temperature, to 5 °C (if the specified low temperature is below 0 °C), and to reference 20 °C. After stabilization the error of the zero indication is determined at each temperature level. The change in zero indication per 5 °C is calculated. The changes of these errors are calculated for any two consecutive temperatures of this test.

This test shall be performed together with the temperature test (A.7.3.1). The errors at zero shall then be additionally determined immediately before changing to the next temperature and after the 2-hour period after the instrument has reached stability at this temperature.

Note: Pre-loading is not allowed before these measurements.

Automatic zero-setting or zero-tracking if available shall not be in operation.

Condition of the EUT: Normal power on for a time period equal to or greater than the warm up time specified by the manufacturer. Power is to be on for the duration of the test.

Maximum allowable variations: The change in zero indication shall not vary by more than one totalization scale interval for a temperature difference of 5 °C.

A.7.3.3 Damp heat, steady-state (4.2.3)

Damp heat, steady state tests are carried out according to Basic Standard IEC Publications 60068-2-78 [14] and 60068-3-4 [15], and according to Table 5.

Table 5

Environmental phenomena	Test specification	Test setup
Damp heat, steady state	Upper limit temperature and relative humidity of 85 % for 48 hours.	IEC 60068-2-78 IEC 60068-3-4

Note: Use IEC 60068-3-4 for guidance for damp heat tests.

Supplementary information to the IEC test procedures:

Object of the test: To verify compliance with the provisions in 4.1.1 under conditions of constant temperature (see A.3.3) and a constant relative humidity.

Preconditioning: None required.

Condition of the EUT: EUT is connected to the mains power and on for a time period equal to or greater than the warm-up time specified by the manufacturer. The zero-setting and zero-tracking facilities shall be enabled as for normal operation.

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

Stabilization:	3 hours at reference temperature and 50 % humidity. 2 days at the upper limit temperature as specified in 2.7.1.1.
Temperature:	Reference temperature (20 °C or the mean value of the temperature range whenever 20 °C is outside this range) and at the upper limit as specified in 2.7.1.1.
Temperature-humidity 48 hour sequence:	a) Reference temperature of 20 °C at 50 % humidity; b) Upper limit temperature at 85 % humidity; c) Reference temperature of 20 °C at 50 % humidity.
Number of test cycles:	At least one cycle.
Test information:	After stabilization of the EUT at reference temperature and 50 % humidity, apply at least five different test loads or simulated loads and record: a) date and time; b) temperature; c) relative humidity; d) test load; e) indications (as applicable); f) errors; g) functional performance. Increase the temperature in the chamber to the upper limit and increase the relative humidity to 85 %. Maintain the EUT at no load for a period of 48 hours. Following the 48 hours, apply the same test loads or simulated loads and record the data as indicated above. Decrease the relative humidity to 50 % and decrease the temperature in the chamber to the reference temperature. After stabilization of the EUT, apply the same test loads or simulated loads and record the data as indicated above. The EUT shall display a recorded total not less than the minimum totalized load, Σ_{min}, but observe A.7.2.5. Allow full recovery of the EUT before any other tests are performed.
Maximum allowable variations:	All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 2.2.2 Table 2.

A.7.3.4 AC mains voltage variations (2.7.2, 4.2.7)

AC mains voltage variations tests are carried out according to Basic Standard IEC Publications 61000-2-1 [16] and 61000-4-1 [17], and according to Table 6.

Table 6

Environmental phenomena	Test specification	Test setup
AC mains voltage variations	U_{nom}	IEC 61000-2-1 IEC 61000-4-1 IEC 61000-4-11
	Upper limit: $1.10 \times U_{nom}$ or $1.10 \times U_{max}$	
	Lower limit: $0.85 \times U_{nom}$ or $0.85 \times U_{min}$	
	U_{nom}	

Note. Where an instrument is powered by a three-phase supply, the voltage variations shall apply for each phase successively

Supplementary information to the IEC test procedures:

Object of the test: To verify compliance with the provisions in 2.7.2 under conditions of voltage variations in AC mains supply.

Preconditioning: None required.

Condition of the EUT: EUT is connected to the AC mains power and on for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable prior to the test and do not readjust at anytime during the test except to reset if a significant fault has occurred.

Number of test cycles: At least one cycle.

Test information: The EUT shall be tested with a test or simulated load at or near Min and with one test load or simulated load between 50 % and the maximum capacity of the EUT. Changes in barometric pressure shall be taken into account.

Stabilize the EUT at the reference voltage and record:

a) date and time;
b) temperature;
c) relative humidity;
d) AC voltage;
e) test load;
f) indications (as applicable);
g) errors;
h) functional performance;
i) barometric pressure.

Repeat the test for each of the voltages defined in IEC 61000-4-1, section 5 (noting the need in certain cases to repeat the weighing test at both ends of the voltage range) and record the indications.

The EUT shall display a recorded total not less than the minimum totalized load, Σ_{min}, but observe A.7.2.5.

Maximum allowable variations: All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 2.2.2 Table 2.

A.7.3.5 DC mains voltage variations (2.7.2, 4.2.8)

Tests of instruments with external or plug-in mains voltage (AC or DC), including on-line rechargeable battery voltage shall be conducted in accordance with A.7.3, with the exception of A.7.3.4, which is to be replaced by the test according to basic standard IEC Publication 60654-2 [18] and according to Table 7.

Table 7

Environmental phenomena	Test specification	Test setup
Voltage variations of DC mains supply	U_{nom}	IEC 60654-2
	Upper limit: $1.20 \times U_{nom}$ or $1.20 \times U_{max}$	
	Lower limit: minimum operating voltage (see 2.7.2)	
	U_{nom}	

Note: If a voltage-range is marked, use the average value as nominal U_{nom}

Supplementary information to the IEC test procedures:

Object of the test: To verify compliance with the provisions in 2.7.2 under conditions of voltage variations in the DC mains supply.

Preconditioning: None

Condition of the EUT: EUT is connected to the DC mains power and on for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test.

Number of test cycles: At least one cycle.

Test information: Changes in barometric pressure shall be taken into account.

Stabilize the EUT at the reference voltage within the defined limits and record the following data at no load and with one test load or simulated load:

date and time;

a) temperature;
b) relative humidity;
c) supply voltage;
d) test load;
e) indications (as applicable);
f) errors;
g) functional performance;
h) barometric pressure.

Reduce the voltage until the instrument ceases to function properly according to the specifications and metrological requirements, and record the indications.

The EUT shall display a recorded total not less than the minimum totalized load, Σ_{min}, but observe A.7.2.5.

Maximum allowable variations: All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 2.2.2 Table 2.

A.7.3.6 Battery power supply (DC), not mains connected (2.7.2, 4.2.8)

Battery-powered instruments shall fulfill the tests in A.7.3, with the exception of A.7.3.4, A.7.3.5 and A.7.3.7 which are to be replaced by the test in Table 8.

Table 8

Environmental phenomena	Test specification	Test setup
Low voltage variations of fully charged battery supply voltage (DC)	U_{nom}	No reference to standards for this test
	Upper limit: U_{nom} or U_{max}	
	Lower limit: minimum operating voltage (see 2.7.2)	
	U_{nom}	

Note: If a voltage range is marked, use the average value as nominal U_{nom}

Supplementary test information:

Object of the test: To verify compliance with the provisions in 2.7.2 under conditions of variations of battery voltage.

Pre-condition: None

Condition of the EUT: EUT is connected to the DC supply and on for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test.

Number of test cycles: At least one cycle.

Test information: Changes in barometric pressure shall be taken into account.

Stabilize the EUT at the reference voltage within the defined limits and record the following data at no load and with one test load or simulated load:

a) date and time;
b) temperature;
c) relative humidity;
d) supply voltage;
e) test load;
f) indications (as applicable);
g) errors;
h) functional performance;
i) barometric pressure.

Reduce the voltage until the instrument ceases to function properly according to the specifications and metrological requirements, and record the indications.

The EUT shall display a recorded total not less than the minimum totalized load, Σ_{min}, but observe A.7.2.5.

Maximum allowable variations: All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 2.2.2 Table 2.

A.7.3.7 Voltage variations of 12 V or 24 V DC road vehicle batteries (2.7.2)

Instruments operated from 12 V or 24 V DC road vehicle battery power shall fulfill the tests in A.7.3, with the exception of A.7.3.4 and A.7.3.5 which are to be replaced by the following test according to ISO 16750-2 [19] and according to Table 9.

Table 9

Environmental phenomena	Test specification			Test setup
	U_{nom}	Upper limit	Lower limit	
Voltage variations of 12 V and 24 V DC road vehicle batteries	12 V	16 V	9 V	ISO 16750-2
	24 V	32 V	16 V	

Note: The nominal voltage, U_{nom}, of the electrical system in road vehicles is usually 12 V or 24 V. But the practical voltage at the battery-terminal points can vary considerably.

Supplementary information to the ISO test procedures:

Object of the test: To verify compliance with the provisions in 2.7.2 under conditions of voltage variations in 12 V or 24 V DC road vehicle batteries.

Preconditioning: None

Condition of the EUT: EUT is connected to the DC mains power and on for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test.

Number of test cycles: At least one cycle.

Test information: The test consists of exposure to the specified condition of the battery when the former is operating under normal atmospheric conditions with one test load (or simulated load).

Changes in barometric pressure shall be taken into account.

Stabilize the EUT at reference voltage and record the following data at no load and with one load or simulated load:

a) date and time;
b) temperature;
c) relative humidity;
d) supply voltage;
e) test load;
f) indications (as applicable);
g) errors;
h) functional performance;
i) barometric pressure.

Reduce the voltage until the instrument ceases to function properly according to the specifications and metrological requirements, and record the indications.

The EUT shall display a recorded total not less than the minimum totalized load, Σ_{min}, but observe A.7.2.5.

Maximum allowable variations: All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 2.2.2 Table 2.

A.7.4 Disturbance tests (4.1.2)

Summary of tests:

Test	Criteria	§
AC mains short-time power reduction	sf*	A.7.4.1
Electrical bursts (fast transients) on mains voltage and on I/O signal and communication lines	sf	A.7.4.2
Electrical surges on mains voltage and on signal and communication lines	sf	A.7.4.3
Electrostatic discharge	sf	A.7.4.4
Immunity to electromagnetic fields	sf	A.7.4.5
Electrical transient conduction for 12 V or 24 V batteries	sf	A.7.4.6

* value of the significant fault (see T.4.5.6)

Prior to any test, the rounding error shall be set as close as possible to zero.

If there are interfaces on the instrument (or simulator), the use of these interfaces to other equipment shall be simulated in the tests. For this purpose, either an appropriate peripheral device or 3 m of interface cable to simulate the interface impedance of the other equipment, shall be connected to each different type of interface.

A.7.4.1 AC mains short time power reductions

Short time power reduction (voltage dips and short interruptions) tests are carried out according to Basic Standard IEC Publication 61000-4-11 [20] and according to Table 10.

Table 10

Environmental phenomena	Test specification			Test setup
	Test	Reduction of amplitude to	Duration / number of cycles	
Voltage dips and short interruptions	Test a	0 %	0.5	IEC 61000-4-11
	Test b	0 %	1	
	Test c	40 %	10	
	Test d	70 %	25/30 [2)]	
	Test e	80 %	250/300 [2)]	
	Short interruption	0 %	250/300 [2)]	

Note 1: A test generator suitable to reduce for a defined period of time the amplitude of one or more half cycles (at zero crossings) of the AC mains voltage shall be 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.

Note 2: These values are for 50 Hz/60 Hz, respectively.

Supplementary information to the IEC test procedures

Object of the test:	To verify compliance with the provisions in 4.1.2 under conditions of short-time mains voltage interruptions and reductions while observing the indication of a single static load.
Preconditioning:	None required.
Condition of the EUT:	EUT is connected to the AC mains power and on for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test. Zero-setting functions shall not be in operation and are not to be adjusted at any time during the test except to re-set if a significant fault has occurred.
Number of test cycles:	At least one cycle.
Test information:	The EUT shall be tested with one small static test load. Stabilize all factors at nominal reference conditions. Apply one load or simulated load and record: a) date and time; b) temperature; c) relative humidity; d) supply voltage; e) test load; f) indications (as applicable); g) errors; h) functional performance. In accordance with the test specification in Table 10, interrupt the voltages to the corresponding durations / number of cycles and conduct the test as detailed in IEC 61000-4-11 section 8.2.1. During interruption observe the effect on the EUT and record as appropriate.
Maximum allowable variations:	The difference between the error of indication when the disturbance is present and the intrinsic error either shall not exceed 1 d_t, or the EUT shall detect and react to a significant fault. In the case of voltage interruptions (0 % for 250/300 cycles), the requirement is for the instrument to recover fully.

A.7.4.2 Electrical bursts (fast transient tests) on mains power lines and on I/O signal and communication lines

Electrical bursts tests (fast transients) are carried out at the positive and the negative polarity for at least 1 minute at each polarity in accordance with the Basic Standard Publication IEC 61000-4-4 [21] and according to Tables 11 and 12.

Table 11

Environmental phenomena	Test specification	Test setup
Fast transient common mode	0.5 kV (peak) 5/50 ns T_1 /T_h 5 kHz rep. frequency	IEC 61000-4-4

Note: Applicable only to lines or interfacing with cables whose total length exceed 3 m according to the manufacturer's functional specification.

Table 12

Environmental phenomena	Test specification	Test setup
Fast transient common mode	1 kV (peak) 5/50 ns T_1 /T_h 5 kHz rep. frequency	IEC 61000-4-4

Note: DC power lines, not applicable to battery-operated appliance that cannot be connected to the mains while in use.

Supplementary information to the IEC test procedures

Object of the test:	To verify compliance with the provisions in 4.1.2 under conditions where fast transients are superimposed separately on the mains voltage, and on the I/O signal and communication lines, while observing the indications for one static test load.
Preconditioning:	None required.
Condition of the EUT:	The performance of the test generator shall be verified before connecting the EUT. The EUT is connected to the mains power and on for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test. Zero-setting functions shall not be in operation and are not to be adjusted at any time during the test except to reset if a significant fault has occurred.
Number of test cycles:	At least one cycle.
Test information:	Both positive and negative polarity of the bursts shall be applied. The duration of the test shall not be less than one minute for each amplitude and polarity. The injection network on the mains shall contain blocking filters to prevent the burst energy being dissipated in the mains. For the coupling of the bursts into the input/output and communication lines, a capacitive coupling clamp as defined in the reference standard shall be used. The EUT shall be tested with one small static test load. Before any test stabilize the EUT under constant environmental conditions. Changes in barometric pressure shall be taken into account. Apply one small static

test load or simulated load and record:

a) date and time;
b) temperature;
c) relative humidity;
d) supply voltage;
e) test load;
f) indications (as applicable);
g) errors;
h) functional performance;
i) barometric pressure.

Maximum allowable variations: The difference between the indication due to the disturbance and the indication without the disturbance (intrinsic error) either shall not exceed 1 d_t, or the EUT shall detect and react to a significant fault.

A.7.4.3 Electrical surges on mains power lines and on signal and communication lines

Electrical surge tests are carried out according to IEC 61000-4-5 [22] and according to Table 13.

Table 13

Environmental phenomena	Test specification	Test setup
Surges on mains power lines and on signal and communication lines	0.5 kV line to line	IEC 61000-4-5
	1.0 kV line to earth	
	Three positive and three negative surges applied synchronously with AC supply voltage in angles 0°, 90° and 270°	
	Three positive and three negative surges applied on DC voltage lines and on signal and communication lines	

Note: This test is only applicable in those cases where, based on typical situations of installation, the risk of a significant influence of surges can be expected. This is especially relevant in cases of outdoor installations and/or indoor installations connected to long signal lines (lines longer than 30 m or those lines partially or fully installed outside the buildings regardless of their length). The test is applicable to the power lines and other lines for signal and communication. It is also applicable to DC powered instruments if the voltage comes from a DC network.

Supplementary information to the IEC test procedures

Object of the test: To verify compliance with the provisions in 4.1.2 under conditions where electrical surges are applied separately to the mains power lines and to the signal and communication lines (if any), while observing the indications for one static test load.

Preconditioning: None required.

Condition of the EUT:	The characteristics of the test generator shall be verified before connecting the EUT. EUT connected to the mains power and on for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test. Zero-setting functions shall not be in operation and are not to be adjusted at any time during the test except to reset if a significant fault has occurred.
Number of test cycles:	At least one cycle.
Test information:	The test consists of exposure to surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impendence load and minimum time interval between two successive pulses are defined in IEC 61000-4-5. The injection network depends on the lines the surge is coupled to and is defined in IEC 61000-4-5. The EUT shall be tested with one small static test load. Before any test stabilize the EUT under constant environmental conditions. Changes in barometric pressure shall be taken into account. Apply one small static load or simulated load and record: a) date and time; b) temperature; c) relative humidity; d) supply voltage; e) test load; f) indications (as applicable); g) errors; h) functional performance; i) barometric pressure.
Maximum allowable variations:	The difference between the error of indication when the disturbance is present and the intrinsic error either shall not exceed 1 d_t, or the EUT shall detect and react to a significant fault.

A.7.4.4 Electrostatic discharge test

Electrostatic discharge tests are carried out according to Basic Standard Publication IEC 61000-4-2 [23], with test signals and conditions as given in Table 14.

Table 14

Environmental phenomena	Test specification		Test set-up
	Test voltage	Levels [1)]	
Electrostatic discharge	contact discharge	6 kV	IEC 61000-4-2
	air discharge	8 kV	

Note 1: Tests shall be performed at the specified lower levels, starting with 2 kV and proceeding with 2 kV steps up to and including the level specified above in accordance with IEC 61000-4-2.

Note 2: The 6 kV contact discharge shall be applied to conductive accessible parts. Metallic contacts, e.g. in battery compartments or in socket outlets are excluded from this requirement.

Contact discharge is the preferred test method. 20 discharges (10 with positive and 10 with negative polarity) shall be applied on each accessible metal part of the enclosure. The time interval between successive discharges shall be at least 10 seconds. In the case of a non-conductive enclosure, discharges shall be applied on the horizontal or vertical coupling planes as specified in IEC 61000-4-2. Air discharges shall be used where contact discharges cannot be applied.

Supplementary information to the IEC test procedures

Object of the test:	To verify compliance with the provisions in 4.1.2 under conditions where electrostatic discharges are applied while observing the indication for one small static test load.
Preconditioning:	None required.
Condition of the EUT:	EUT is connected to the mains power and on for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test. Zero-setting functions shall not be in operation and are not to be adjusted at any time during the test except to re-set if a significant fault has occurred.
Number of test cycles:	At least one cycle.
Test information:	The EUT shall be tested with one small static test load. Before any test stabilize the EUT under constant environmental conditions. Changes in barometric pressure shall be taken into account. Apply one load or simulated load and record the following with and without electrostatic discharge: a) date and time; b) temperature; c) relative humidity; d) supply voltage; e) test load; f) indications (as applicable); g) errors; h) functional performance; i) barometric pressure.
Maximum allowable variations:	The difference between the error of indication when the disturbance is present and the intrinsic error either shall not exceed 1 d_t, or the EUT shall detect and react to a significant fault.

A.7.4.5 Immunity to electromagnetic fields

A.7.4.5.1 Immunity to radiated electromagnetic fields

Radiated, radio frequency, electromagnetic field immunity tests are carried out in accordance to Basic Standard Publication IEC 61000-4-3 [24] and according to Table 15.

The unmodulated carrier of the test signal is adjusted to the indicated test value. To perform the test the carrier is in addition modulated as specified.

Table 15

Environmental phenomena	Test specification		Test setup
	Frequency ranges (MHz)	Field strength (V/m)	
Immunity to radiated electromagnetic fields	80 to 2000 [1]	10	IEC 61000-4-3
	26 to 80 [2]		
Modulation 80 % AM, 1 kHz sine wave			

Note 1: IEC 61000-4-3 only specifies test levels above 80 MHz. For frequencies in the lower range, the test methods for conducted radio frequency disturbances are recommended (A.6.3.5.2).

Note 2: For EUTs having no mains or other I/O ports available so that the test according to A.6.3.5.2 cannot be applied, the lower limit of the radiation test is 26 MHz.

Supplementary information to the IEC test procedures

Object of the test: To verify compliance with the provisions in 4.1.2 under conditions of specified radiated electromagnetic fields applied while observing the indication for one small static test load.

Preconditioning: None required.

Condition of the EUT: EUT is connected to the mains power and on for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test. Zero-setting functions shall not be in operation and are not to be adjusted at any time during the test except to reset if a significant fault has occurred.

Number of test cycles: At least one cycle.

Test information: The EUT shall be tested with one small static test load. Before any test stabilize the EUT under constant environmental conditions. Changes in barometric pressure shall be taken into account. Apply one load or simulated load and record the following:

a) date and time;
b) temperature;
c) relative humidity;
d) supply voltage;
e) test load;
f) indications (as applicable);
g) errors;
h) functional performance;
i) barometric pressure.

Maximum allowable variations: The difference between the error of indication when the disturbance is present and the intrinsic error either shall not exceed 1 d_t, or the EUT shall detect and react to a significant fault.

A.7.4.5.2 Immunity to conducted electromagnetic fields

Conducted, radio-frequency, electromagnetic field immunity tests are carried out in accordance to basic Standard Publication IEC 61000-4-6 [25] and according to Table 16.

The unmodulated carrier of the test signal is adjusted to the indicated test value. To perform the test the carrier is in addition modulated as specified.

Table 16

Environmental phenomena	Test specification		Test setup
	Frequency range (MHz)	RF amplitude (50 ohms) (V emf)	
Immunity to conducted electromagnetic fields	0.15 to 80	10	IEC 61000-4-6
Modulation 80 % AM, 1 kHz sine wave			

Note 1: This test is not applicable when the EUT has no mains or other input port.

Note 2: Coupling and decoupling devices shall be used for appropriate coupling of the disturbing signal (over the entire frequency range, with a defined common-mode impedance at the EUT port) to the various conducting cables connected to the EUT.

Supplementary information to the IEC test procedures

Object of the test: To verify compliance with the provisions in 4.1.2 under conditions of specified conducted electromagnetic fields applied while observing the indication for one small static test load.

Preconditioning: None required.

Condition of the EUT: EUT is connected to the mains power and on for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test. Zero-setting functions shall not be in operation and are not to be adjusted at any time during the test except to reset if a significant fault has occurred.

Radio frequency electromagnetic current, simulating the influence of electromagnetic fields shall be coupled or injected into the power ports and I/O ports of the EUT using coupling/decoupling devices as defined in the referred standard.

Number of test cycles: At least one cycle.

Test information: The EUT shall be tested with one small static test load. Before any test stabilize the EUT under constant environmental conditions. Changes in barometric pressure shall be taken into account. Apply one load or simulated load and record the following:

a) date and time;
b) temperature;
c) relative humidity;
d) supply voltage;
e) test load;
f) indications (as applicable);
g) errors;
h) functional performance;
i) barometric pressure.

Maximum allowable variations: The difference between the error of indication when the disturbance is present and the intrinsic error either shall not exceed 1 d_t, or the EUT shall detect and react to a significant fault.

A.7.4.6 Electrical transient conduction for instruments powered from a road vehicle battery

A.7.4.6.1 Conduction along supply lines of 12 V or 24 V batteries

For this test refer to ISO 7637-2 [26] and according to Table 17.

Table 17

Environmental phenomena	Test specification			Test setup
	Test pulse	Pulse voltage, U_s		
		U_{nom} = 12 V	U_{nom} = 24 V	
Conduction along 12 V or 24 V supply lines	2a	+50 V	+50 V	ISO 7637-2
	2b [1)]	+10 V	+20 V	
	3a	−150 V	−200 V	
	3b	+100 V	+200 V	
	4	−7 V	−16 V	

Note 1: Test pulse 2b is only applicable if the instrument is connected to the battery via the main (ignition) switch of the car, i.e. if the manufacturer has not specified that the instrument is to be connected directly (or by its own main switch) to the battery.

Supplementary information to the ISO test procedures

Applicable standards: ISO 7637-2 § 5.6.2: Test pulse 2a + b,
§ 5.6.3: Test pulse 3a + 3b,
§ 5.6.4: Test pulse 4.

Object of the test: To verify compliance with the provisions in 4.1.2 under the following conditions while observing the indication for one small static test load:

- transients due to a sudden interruption of currents in a device connected in parallel with the device under test due to the inductance of the wiring harness (pulse 2a);
- transients from DC motors acting as generators after the ignition is switched off (pulse 2b);
- transients on the supply lines, which occur as a result of the switching processes (pulses 3a and 3b);
- voltage reductions caused by energizing the starter-motor circuits of internal combustion engines (pulse 4).

Preconditioning: None

Condition of the EUT: The EUT is connected to the mains power and on for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable prior to the test. Zero-setting functions shall not be in operation and are not to be adjusted at any time during the test except to reset if a significant fault has occurred.

Stabilization: Before any test, stabilize the EUT under constant environmental conditions.

Test information: The test consists of exposure of the EUT to conducted disturbances (on the power voltage by direct brief coupling on supply lines) of the strength and character as specified in Table 17. With the static load or simulated load in place record:

a) date and time;
b) temperature;
c) relative humidity;
d) supply voltage;
e) test load;
f) indications (as applicable);
g) errors;
h) functional performance.

Repeat the test weighing for the defined voltages and record the indications.

Maximum allowable variations: The difference between the error of indication when the disturbance is present and the intrinsic error either shall not exceed 1 d_t, or the EUT shall detect and react to a significant fault.

A.7.4.6.2 Electrical transient conduction via lines other than supply lines

For this test refer to ISO 7637-3 [27] and according to Table 18.

Table 18

Environmental phenomena	**Test specification**			**Test setup**
	Test pulse	**Pulse voltage, U_s**		
		U_{nom} = 12 V	**U_{nom} = 24 V**	
Electrical transient conduction via lines other than supply lines	a	−60 V	−80 V	ISO 7637-3
	b	+40 V	+80 V	

Supplementary information to the ISO test procedures:

Applicable standards: ISO 7637-3, § 4.5: Test pulses a and b

Object of the test: To verify compliance with the provisions in 4.1.2 under conditions of transients which occur on other lines as a result of the switching processes (pulses a and b).

The test shall be performed with one small test load only.

Preconditioning: None

Condition of the EUT:	EUT is connected to the mains power and on for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable prior to the test. Zero-setting functions shall not be in operation and are not to be adjusted at any time during the test except to reset if a significant fault has occurred.
Stabilization:	Before any test stabilize the EUT under constant environmental conditions.
Test information:	The test consists of exposure of the EUT to conducted disturbances (bursts of voltage spikes by capacitive and inductive coupling via lines other than supply lines) of the strength and character as specified in Table 18. Record: a) date and time; b) temperature; c) relative humidity; d) test load; e) indications (as applicable); f) errors; g) functional performance. Repeat the test weighing for the defined voltages and record the indications.
Maximum allowable variations:	The difference between the error of indication when the disturbance is present and the intrinsic error either shall not exceed 1 d_t or the instrument shall detect and react to a significant fault.

Note: An instrument must comply with the provisions in 4.1.3 in any type of vehicle.

A.8 Span stability test (4.3.3)

Table 19

Test	Characteristic under test	Condition applied
Span stability	Stability	$0.5 \times \lvert \text{mpe} \rvert$

Note 1: The maximum permissible error for the zero point shall also be taken into consideration.

Note 2: mpe: maximum permissible error on initial verification in 2.2.2 Table 2.

Object of the test:	To verify compliance with the provisions in 4.1.3 after the EUT has been subjected to the performance tests.
Test procedure in brief:	The test consists of observing the variations of the error of the EUT or simulator under sufficiently constant ambient conditions (reasonable constant conditions in a laboratory environment) at various intervals: before, during, and after the EUT has been subjected to performance tests. The performance tests shall include the temperature test and, if applicable, the damp heat test; an endurance test shall not be included. Other performance tests listed in this Annex may be performed.

The EUT shall be disconnected twice from the mains supply voltage (or battery voltage supply where fitted) for at least 8 hours during the period of the test. The number of disconnections may be increased if so specified by the manufacturer or at the discretion of the approval authority in the absence of any specification.

In the conduct of this test, the operating instructions for the instrument as supplied by the manufacturer shall be considered.

The EUT shall be stabilized at sufficiently constant ambient conditions after switch-on for at least five hours, and at least 16 hours after the temperature and damp heat tests have been performed.

Test severities:

Test duration: 28 days or the time period necessary to conduct the performance tests, whichever is less.

Time, t , between tests (days): $0.5 < t < 10$.

Test load: Near maximum capacity, Max; the same test weights shall be used throughout the test.

Maximum allowable variations: The variation in the errors of indication shall not exceed half the absolute value of the maximum permissible error in 2.2.2 Table 2 for the test load applied on any of the n measurements.

Number of tests, n: At least eight, except where the difference of the results indicates a trend more than half the allowable variation specified, the measurements shall be continued until the trend comes to rest or reverses itself, or until the error exceeds the maximum allowable variation.

Preconditioning: None.

Test equipment: Verified mass standards or simulated load.

Condition of the EUT: Power supplied and on for a time period equal to or greater than the warm-up time specified by the manufacturer.

Test sequence: Stabilize all factors at nominal reference conditions.

Adjust the EUT as close to zero as possible.

Automatic zero-tracking (if available) shall be made inoperative and automatic built-in span adjustment device shall be made operative.

- Initial measurement:

  Determine the span error using the following method:

  1) Determine the initial zero error, E_0

     If necessary disable any automatic zero-setting or zero-tracking devices by placing a “zero weight” of for example ten times the scale interval on the load receptor. Note the indication at zero, I_0.

     Either by use of an indicator with a suitable higher resolution scale interval or using the change point weight method in A.3.6.2 (noting the total addition change point weight ΔL_0), determine and record the initial zero error, E_0.

  2) Determine the error near Max, E_L

     Carefully remove the change point weights (if used) and apply the test load (or simulated load) and note the indication, I_L. Either by use of an indicator with a suitable higher resolution scale

interval or using the change point weight method in A.3.6.2 (noting the total addition change point weight, ΔL, determine and record the error near Max, E_L).

Record:

a) date and time;
b) temperature;
c) barometric pressure;
d) relative humidity;
e) value of 0.1 d_t;
f) test load;
g) total of added change point weights at zero load, ΔL_0;
h) total of added change point weights at test load, ΔL;
i) the following indications:
   - indication at zero, I_0;
   - indication of test load, I_L;
k) calculate:
   - initial zero error, E_0;
   - error at test load, E_L;
l) change in location;

and apply all necessary corrections resulting from variations of temperature, pressure, etc. between the various measurements.

Immediately repeat steps 1) and 2) four more times and determine and record the average value of the error for the five tests.

- Subsequent measurements:

  After observing the time between measurements requirement repeat the test sequence 1) to 2) once recording the data above unless either:

  - the result is outside the maximum allowable variation; or
  - the range of the five readings of the initial measurement is more than 0.1 d,

  in which case continue four more times repeating steps 1) and 2) recording the data above and determine and record the average value of the error of the five tests.

  The measurements shall continue until there are at least eight measurements except where the difference of the results indicates a trend more than half the allowable variation specified, the measurements shall be continued until the trend comes to rest or reverses itself, or until the error exceeds the maximum allowable variation.

A.9 Procedure for in-situ tests

Meaning of symbols:

A_{net} net test load in automatic mode

S_{net} net test load in non-automatic (static) mode

A_{gross} gross weight value in automatic operation or alternatively discharged mass in discharged mode

A_{tare} tare value in automatic operation, or in discharge mode the indication of the instrument after subtractive tare of the filled receptor

S_{gross} gross load in non-automatic (static) mode

S_{tare} tare value in non-automatic (static) mode

E error of measurement ($E = A_{net} - S_{net}$)

E_{inst} error of measurement of control instrument

A.9.1 General

For type approval, tests shall be carried out in accordance with the requirements of this Recommendation, and especially the requirements in 2.2 for limits of error, and in 5.1 for type approval.

For initial verification, tests shall be carried out corresponding to the normal operation of the instrument. In this case, limits of error in 2.2.1 for initial verification and the requirements in 5.2 for initial verification apply.

A.9.2 Control instrument

A.9.2.1 Integral control instrument (A.5.1.2)

Establish whether or not the instrument is to be used as an integral control instrument. If it is an integral control instrument then it shall comply with 6.2.2 and be tested in accordance with A.5.1.2.

A.9.2.1.1 The number of automatic weighing cycles for each test procedure is the rounded up value of minimum totalized load divided by the single load of each cycle, with each cycle conducted as follows:

a) Interruption of automatic weighing cycle before emptying the load receptor.

   Initiate automatic operation of the instrument and all essential auxiliary equipment. After the load receptor has been filled with material or test weights and completion of automatic gross weighing, the automatic operation shall be interrupted and:

   1) Before discharge of the load receptor, record the automatic gross weight indication, A_{gross}.

   2) When the filled load receptor has stabilized to conditions comparable to those for nonautomatic testing, the static gross weight indication, S_{gross}, shall be recorded. The static indication of the control instrument shall be corrected by the previously determined errors of the control instrument in A.5.1.2.1 (at increasing loading).

b) Interruption of automatic weighing cycle after emptying load receptor.

   Following step a) 2) above, initiate automatic operation of the instrument and all essential auxiliary equipment, and interrupt the automatic operation after discharge of the filled load receptor and completion of automatic tare weighing and:

   1) Before re-filling of the load receptor, the automatic tare indication, A_{tare}, shall be recorded.

2) When the empty load receptor has stabilized to conditions comparable to those for non-automatic testing, the static tare indication, S_{tare}, of the empty load receptor shall be recorded. The indication of the control instrument shall be corrected by the previously determined error of the control instrument A.5.1.2.1 (at decreasing loading).

Steps a) and b) shall be repeated for the specified number of weighing cycles and the required test mass.

A.9.2.1.2 Determination of the net value and calculation of the error for automatic weighing:

a) For automatic mode:

$$A_{net} = \sum_{i=1}^{n} \left(A_{gross_i} - A_{tare_i} \right)$$

b) For the non-automatic mode (test instrument):

$$S_{net} = \sum_{i=1}^{n} \left(\left(S_{gross_i} - E_{inst} \right) - \left(S_{tare_i} - E_{inst} \right) \right)$$

Taking into account the error of the control instrument at A_{net} or S_{net}, the error, E, of the weighing instrument at the corresponding test load accumulated over a specified number of weighing cycles is:

$$E = A_{net} - S_{net}$$

A.9.2.2 Air-enclosed integrated instruments (A.5.1.2.7)

Air-enclosed discontinuous automatic weighing instruments produce air turbulence that can affect the weighing results. To ensure that such an instrument is tested in normal conditions of use, at least one receptor shall be dispensed in automatic mode, i.e., the automatic operation shall not be interrupted in A.9.2.1, a) or b) during consecutive weighing cycles. In this case the uninterrupted automatic weighing results according to A.9.2.1, a) or b) or the net value registered by the instrument shall be displayed and recorded, in order to correctly calculate the discharged mass which corresponds to the value of the test load.

In the case of discharge weighing the test is to be performed as mentioned above, while the indications have a different sign, i.e. the indication is zero for a loaded receptor, and the indication is positive after discharging the receptor.

Example: Evaluation with the instrument using re-weighing (of the emptied receptor) and using discharge weighing, assuming:

- Error of control instrument, E_{inst}, is zero;
- A_{tare} = indication of the weighing results of the single load in automatic mode;
- S_{tare} = indication of the weighing results of the single load in non-automatic mode.

Weighing instrument (kg)		**Weighing instrument with discharge weighing (kg)**	
A_{gross}	400.0	A_{tare}	0
S_{gross}	400.05	S_{tare}	−0.05
A_{tare}	0.0	A_{gross}	400.0
S_{tare}	0.1	S_{gross}	400.1
A_{net}	400.0 – 0.0 = 400.0	A_{net}	400.0 – 0.0 = 400.0
S_{net}	400.05 − 0.1 = 399.95	S_{net}	400.1 − (−0.05) = 400.15
E	400.0 – 399.95 = 0.05	E	400.0 – 400.15 = −0.15

A.9.2.3 Separate verification method (A.5.1.1)

If the control instrument is separate from the instrument being verified then it shall comply with 6.2 and be tested in accordance with A.5.1.1, for the specified number of weighing cycles as follows:

a) Start of the test

   Initiate automatic operation of the instrument and all essential auxiliary equipment. After the load receptor has been filled with material and a minimum of five weighing cycles has been reached record the indicated weight value.

b) End of the test

   With the weighing instrument in automatic operation, conduct the necessary number of weighing cycles to obtain the required test load, making sure that the test load of products can be weighed using a separate control instrument.

c) Determination of the value of the test load and calculation of the error for automatic weighing

The weight value indication from the weighing instrument is:

- the difference between the indication at the start of the test in A.9.2.3, a) and the indication at the end of the test in A.9.2.3, b) using the principal totalization device; or
- the indication of the partial totalization device when reset to zero before b) is started.

The conventional true value of the mass of the test load is determined by weighing the test load on a separate control instrument.

The error for automatic weighing is the difference between indicated weight value from the instrument and the indicated weight value indication from the separate control instrument.

Bibliography

Below are references to Publications of the International Electrotechnical Commission (IEC), the International Organization for Standardization (ISO) and the OIML, where mention is made in this Recommendation.

Ref.	Standards and reference documents	Description
[1]	International Vocabulary of Basic and General Terms in Metrology (VIM) (1993)	Vocabulary, prepared by a joint working group consisting of experts appointed by BIPM, IEC, IFCC, ISO, IUPAC, IUPAP and OIML.
[2]	International Vocabulary of Terms in Legal Metrology, OIML, Paris (2000)	Vocabulary including only the concepts used in the field of legal metrology. These concepts concern the activities of the legal metrology service, the relevant documents as well as other problems linked with this activity. Also included in this Vocabulary are certain concepts of a general character which have been drawn from the VIM.
[3]	OIML B 3 (2003) OIML Certificate System for Measuring Instruments (formerly OIML P1)	Provides rules for issuing, registering and using OIML Certificates of Conformity.
[4]	OIML D 11 (2004) General requirements for electronic measuring instruments	Contains general requirements for electronic measuring instruments.
[5]	OIML R 111 (2004) Weights of classes E_1, E_2, F_1, F_2, M_1, M_{1-2}, M_2, M_{2-3} and M_3	Provides the principal physical characteristics and metrological requirements for weights used with and for the verification of weighing instruments and weights of a lower class.
[6]	OIML R 60 (2000) Metrological regulation for load cells	Provides the principal static characteristics and static evaluation procedures for load cells used in the evaluation of mass.
[7]	OIML R 76 -1 (2006) Non-automatic weighing instruments	Provides the principal physical characteristics and metrological requirements for the verification of non-automatic weighing instruments.
[8]	OIML D 19 (1988) Pattern evaluation and pattern approval.	Provides advice, procedures and influencing factors on type evaluation and type approval.
[9]	OIML D 20 (1988) Initial and subsequent verification of measuring instruments and processes	Provides advice, procedures and influencing factors on the choice between alternative approaches to verification and the procedures to be followed in the course of verification.
[10]	OIML D 28 (2004) Conventional value of the result of weighing in air	Presents the definition of the quantity “conventional mass” (conventional value of the result of weighing in air) as it is used for the characterization of weights and its relation to the physical quantities mass and density and the evaluation of its uncertainty.
[11]	IEC 60068-2-1 (1990-05) with Amendments 1 (1993-02) and 2 (1994-06)	Basic environmental testing procedures - Part 2: Tests, Test Ad: Cold, for heat dissipating equipment under test (EUT), with gradual change of temperature.

[12]	IEC 60068-2-2 (1974-01) with Amendments 1 (1993-02) and 2 (1994-05). Environmental testing Part 2: Tests, Test B: Dry heat	Contains test Ba: dry heat for non heat dissipating specimen with sudden change of temperature; test Bb dry heat for non heat dissipating specimen with gradual change of temperature; tests Bc: dry heat for heat dissipating specimen with sudden change of temperature; test Bd dry heat for heat dissipating specimen with gradual change of temperature. The 1987 reprint includes IEC No. 62-2-2A.
[13]	IEC 60068-3-1 (1974-01) + Supplement A (1978-01): Environmental testing Part 3 Background information, Section 1: Cold and dry heat tests	Gives background information for Tests A: Cold (IEC 68-2-1), and Tests B: Dry heat (IEC 68-2-2). Includes appendices on the effect of: chamber size on the surface temperature of a specimen when no forced air circulation is used; airflow on chamber conditions and on surface temperatures of test specimens; wire termination dimensions and material on surface temperature of a component; measurements of temperature, air velocity and emission coefficient. Supplement A - gives additional information for cases where temperature stability is not achieved during the test.
[14]	IEC 60068-2-78 (2001-08) Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state (IEC 60068-2-78 replaces the following withdrawn standards: IEC 60068-2-3, test Ca and IEC 60068-2-56, test Cb)	Provides a test method for determining the suitability of electro-technical products, components or equipment for transportation, storage and use under conditions of high humidity. The test is primarily intended to permit the observation of the effect of high humidity at constant temperature without condensation on the specimen over a prescribed period. This test provides a number of preferred severities of high temperature, high humidity and test duration. The test can be applied to both heat-dissipating and non-heat dissipating specimens. The test is applicable to small equipment or components as well as large equipment having complex interconnections with test equipment external to the chamber, requiring a set-up time which prevents the use of preheating and the maintenance of specified conditions during the installation period.
[15]	IEC 60068-3-4 (2001-08) Environmental testing - Part 3-4: Supporting documentation and guidance - Damp heat tests	Provides the necessary information to assist in preparing relevant specifications, such as standards for components or equipment, in order to select appropriate tests and test severities for specific products and, in some cases, specific types of application. The object of damp heat tests is to determine the ability of products to withstand the stresses occurring in a high relative humidity environment, with or without condensation, and with special regard to variations of electrical and mechanical characteristics. Damp heat tests may also be utilized to check the resistance of a specimen to some forms of corrosion attack.

[16]	IEC 61000-2-1 (1990-05) Electromagnetic compatibility (EMC) Part 2: Environment Section 1	Electromagnetic compatibility (EMC) Part 2: Environment Section 1: Description of the environment-Electromagnetic environment for low-frequency conducted disturbances and signaling in public power supply systems
[17]	IEC 61000-4-1 (2000-04) Basic EMC Publication Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques. Section 1: Overview of IEC 61000-4 series.	Gives applicability assistance to the users and manufacturers of electrical and electronic equipment on EMC standards within the IEC 61000-4 series on testing and measurement techniques. Provides general recommendations concerning the choice of relevant tests.
[18]	IEC 60654-2 (1979-01), with amendment 1 (1992-09). Operating conditions for industrial-process measurement and control equipment - Part 2: Power.	Gives the limiting values for power received by land-based and offshore industrial process measurement and control systems or parts of systems during operation.
[19]	ISO 16750-2 (2003)	Road vehicles - Environmental conditions and testing for electrical and electronic equipment – Part 2: Electrical loads.
[20]	IEC 61000-4-11 (2004-03) Electromagnetic compatibility (EMC) Part 4-11: Testing and measuring techniques - Voltage dips, short interruptions and voltage variations immunity tests	Defines the immunity test methods and range of preferred test levels for electrical and electronic equipment connected to low-voltage power supply networks for voltage dips, short interruptions, and voltage variations. This standard applies to electrical and electronic equipment having a rated input current not exceeding 16 A per phase, for connection to 50 Hz or 60 Hz AC networks. It does not apply to electrical and electronic equipment for connection to 400 Hz AC networks. Tests for these networks will be covered by future IEC standards. The object of this standard is to establish a common reference for evaluating the immunity of electrical and electronic equipment when subjected to voltage dips, short interruptions and voltage variations. It has the status of a Basic EMC Publication in accordance with IEC Guide 107.
[21]	IEC 61000-4-4 (2004-07) Electromagnetic compatibility (EMC) Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test.	Establishes a common and reproducible reference for evaluating the immunity of electrical and electronic equipment when subjected to electrical fast transient/burst on supply, signal, control and earth ports. The test method documented in this part of IEC 61000-4 describes a consistent method to assess the immunity of an equipment or system against a defined phenomenon. The standard defines: ▪ test voltage waveform; ▪ range of test levels; ▪ test equipment; ▪ verification procedures of test equipment; ▪ test set-up; and ▪ test procedure. The standard gives specifications for laboratory and post-installation tests.

[22]	IEC 61000-4-5 (2001-04) consolidated edition 1.1 (Including Amendment 1 and Correction 1) Electromagnetic compatibility (EMC)- Part 4-5: Testing and measurement techniques - Surge immunity test	Relates to the immunity requirements, test methods, and range of recommended test levels for equipment to unidirectional surges caused by over-voltages from switching and lightning transients. Several test levels are defined which relate to different environment and installation conditions. These requirements are developed for and are applicable to electrical and electronic equipment. Establishes a common reference for evaluating the performance of equipment when subjected to high-energy disturbances on the power and inter-connection lines.
[23]	IEC 61000-4-2 (1995-01) with amendment 1 (1998-01) and amendment 2 (2000-11) Consolidated Edition: IEC 61000-4-2 (2001-04) Ed. 1.2.	Basic EMC Publication. Electromagnetic Compatibility (EMC) - Part 4: Testing and measurement techniques - Section 2: Electrostatic discharge immunity test. Basic EMC Publication.
[24]	IEC 61000-4-3 Consolidated Edition 2.1 (including amendment 1) (2002-09)	Electromagnetic Compatibility (EMC) - Part 4: Testing and measurement techniques - Section 3: Radiated, radio-frequency, electromagnetic field immunity test.
[25]	IEC 61000-4-6 (2003-05) with amendment 1 (2004-10) Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques. Section 6: Immunity to conducted disturbances, induced by radio-frequency fields	Relates to the conducted immunity requirements of electrical and electronic equipment to electromagnetic disturbances coming from intended radio-frequency (RF) transmitters in the frequency range 9 kHz up to 80 MHz. Equipment not having at least one conducting cable (such as mains supply, signal line or earth connection), which can couple the equipment to the disturbing RF fields is excluded. This standard does not intend to specify the tests to be applied to particular apparatus or systems. Its main aim is to give a general basic reference to all concerned product committees of the IEC. The product committees (or users and manufacturers of equipment) remain responsible for the appropriate choice of the test and the severity level to be applied to their equipment.
[26]	ISO 7637-2 (2004)	Road vehicles - Electrical disturbance by conduction and coupling - Part 2: Electrical transient conduction along supply lines only.
[27]	ISO 7637-3 (1995) with correction 1 (1995)	Road vehicles - Electrical disturbance by conduction and coupling - Part 3: Passenger cars and light commercial vehicles with nominal 12 V supply voltage and commercial vehicles with 24 V supply voltage - electrical transient transmission by capacitive and inductive coupling via lines other than supply lines.