INTERNATIONAL RECOMMENDATION

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Automatic gravimetric filling instruments

Part 1: Metrological and technical requirements - Tests

Doseuses pondérales à fonctionnement automatique

Partie 1: Exigences métrologiques et techniques - Essais

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ORGANISATION INTERNATIONALE
DE MÉTROLOGIE LÉGALE

INTERNATIONAL ORGANIZATION
OF LEGAL METROLOGY

Contents

Foreword

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Terminology

The Terminology used in this Recommendation conforms to *the International Vocabulary of Basic and General Terms in Metrology* (VIM, 1993 edition) and to *the International Vocabulary of Legal Metrology* (VIML, 2000 edition). In addition, for the purposes of this Recommendation, the following definitions apply.

T.1 General definitions

T.1.1 Mass

Quantity of matter in any solid object or in any volume of liquid or gas.

T.1.2 Load

Amount of material (or object) that can be carried at any one time by specified means.

T.1.3 Fill

One load, or more loads combined, that make up the predetermined mass.

T.1.4 Weight

Quantity representing the force resulting from the effect of gravity on a load.

T.1.5 Weighing

Process of determining the mass of a load from the effect of gravity on that load.

T.1.6 Weighing instrument

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

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

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

T.1.7 Automatic weighing instrument

Instrument which weighs without the intervention of an operator and/or follows a predetermined program of automatic process characteristic of the instrument.

T.1.8 Automatic gravimetric filling instrument

Instrument which fills containers with predetermined and virtually constant mass of product from bulk by automatic weighing, and which comprises essentially automatic feeding device(s) associated with weighing unit(s) and the appropriate control and discharge devices.

T.1.8.1 Associative (selective combination) weigher

Automatic gravimetric filling instrument comprising one or more weighing units and which computes an appropriate combination of the loads and combines them to a fill.

T.1.8.2 Cumulative weigher

Automatic gravimetric filling instrument with one weighing unit with the facility to effect the fill by more than one weighing cycle.

T.1.8.3 Subtractive weigher

Automatic gravimetric filling instrument for which the fill is determined by controlling the output feed from the weigh hopper.

T.1.9 Control instrument

Weighing instrument used to determine the mass of the test fill(s) delivered by the filling instrument.

The control instrument used during testing may be:

- Separate from the instrument being tested; or
- Integral, when the instrument being tested is used as the control instrument.

T.2 Construction

Note: In this Recommendation, the term "device" is applied to any part of a filling instrument which uses any means to perform one or more specific functions 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 a filling instrument.

T.2.1 Principal parts

T.2.1.1 Weighing unit

Device which provides information on the mass of the load to be measured. This device may consist of all or part of a nonautomatic weighing instrument.

T.2.1.2 Load receptor

Part of the instrument intended to receive the load.

T.2.1.3 Feeding device

Device which provides a supply of product from bulk to the weighing unit. It may operate in one or more stages.

T.2.1.4 Control device

Device that controls the operation of the feeding process. The device may incorporate software functions.

T.2.1.4.1 Feed control device

Device which regulates the rate of feed of the feeding device.

T.2.1.4.2 Fill setting device

Device which allows the setting of the preset value of the fill.

T.2.1.4.3 Final feed cut-off device

Device which controls the cut-off of the final feed so that the average mass of the fills corresponds to the preset value. This device may include an adjustable compensation for the material in flight.

T.2.1.4.4 Correction device

Device which automatically corrects the setting of the filling instrument.

T.2.2 Electronic parts

T.2.2.1 Electronic instrument

Instrument equipped with electronic devices.

T.2.2.2 Electronic device

Device comprising electronic sub-assemblies and performing a specific function. Electronic devices are usually manufactured as separate units and are capable of being independently tested.

T.2.2.3 Electronic sub-assembly

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

T.2.2.4 Electronic component

Smallest physical entity that uses electron or hole conduction in semi-conductors, gases or in a vacuum.

T.2.3 Indicating device (of a weighing instrument)

Part of the load measuring device that displays the value of a weighing result in units of mass and which may additionally display:

The difference between the mass of a load and a reference value; and/or

The value of the fill(s) and/or related quantities or parameters of a number of consecutive weighings.

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 Nonautomatic zero-setting device

Device for setting the indication to zero by an operator.

T.2.4.2 Semi-automatic zero-setting device

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

T.2.4.3 Automatic zero-setting device

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

T.2.4.4 Initial zero-setting device

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

T.2.4.5 Zero-tracking device

Device for automatically maintaining the zero indication within certain limits.

T.2.5 Tare device

Device for taring:

- Without altering the weighing range for net loads (additive tare device); or
- Reducing the weighing range for net loads (subtractive tare device).

The tare device may function as:

- A nonautomatic device (load balanced by the operator or tare preset by the operator);
- A semi-automatic device (load balanced automatically following a single manual command); or
- An automatic device (load balanced automatically without the intervention of an operator).

T.3 Metrological characteristics

T.3.1 Scale interval (*d*)

Value, expressed in units of mass, of the difference between:

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

T.3.2 Reference particle mass of a product

Mass equal to the mean of ten of the largest particles or pieces of the product taken from one or more fills.

T.3.3 Preset value

Value, expressed in units of mass, preset by the operator by means of the fill setting device, in order to define the nominal value of the fills.

T.3.4 Static set point

Value of the test weights or masses which, in static tests, balance the value selected on the indication of the fill setting device.

T.3.5 Weighing cycle

Combination of operations including:

- Delivery of material to the load receptor;
- A weighing operation; and
- The discharge of a single discrete load,

after the completion of which the weighing instrument returns to its initial state.

T.3.6 Final feed time

Time taken to complete the last stage of delivery of the product to a load receptor.

T.3.7 Minimum capacity (Min)

Smallest discrete load that can be weighed automatically on the load receptor of the filling instrument.

Note: For filling instruments which effect the fill by one weighing cycle, Min is equal to the rated minimum fill (Minfill).

T.3.8 Maximum capacity (Max)

Largest discrete load that can be weighed automatically on the load receptor of the filling instrument.

T.3.9 Rated minimum fill (Minfill)

Rated value of the fill below which the weighing results may be subject to errors outside the limits specified in this Recommendation.

Note: For filling instruments which effect the fill by more than one weighing cycle, Minfill is larger than the minimum capacity (Min).

T.3.10 Average number of loads per fill

Half the sum of the maximum and minimum number of loads per fill that can be set by the operator or, in cases where the number of loads per fill is not directly determined by the operator, either the mean of the actual number of loads per fill (if known) in a period of normal operation, or the optimum number of loads per fill, as may be specified by the manufacturer for the type of product which is to be weighed.

T.3.11 Static test load

Load that is used in static tests only.

T.3.12 Minimum discharge

Smallest load that can be discharged from a subtractive weigher.

T.3.13 Warm-up time

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

T.4 Indications and errors

T.4.1 Methods of indication

T.4.1.1 Analog indication

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

T.4.1.2 Digital indication

Indication in which the scale marks comprise a sequence of aligned figures that do not permit interpolation to fractions of a scale interval.

T.4.2 Errors

T.4.2.1 Error of indication (E)

Indication of a weighing instrument minus the (conventional) true value of the mass. *[based on VIM 5.20]*

T.4.2.2 Intrinsic error

Error of a weighing instrument, determined under reference conditions. *[based on VIM 5.24]*

T.4.2.3 Initial intrinsic error

Intrinsic error of a weighing instrument as determined prior to performance and span stability tests.

T.4.2.4 Maximum permissible error (MPE)

Extreme value of an error permitted by specifications or regulations between the indication of a weighing instrument and the corresponding true value, as determined by reference standard masses, at zero or no load, in the reference position. *[based on VIM 5.21]*

T.4.2.4.1 Maximum permissible deviation of each fill (MPD)

Maximum permissible deviation of each fill from the average value of all the fills of a test sequence.

T.4.2.4.2 Maximum permissible preset value error (MPSE)

Maximum permissible setting error for each preset value of the fill.

T.4.2.4.3 Maximum permissible error for influence factor tests

Maximum permissible error for influence quantity values.

T.4.2.5 Fault

Difference between the error of indication and the intrinsic error of a measuring instrument.

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

T.4.2.6 Significant fault

Fault greater than 0.25 of the maximum permissible deviation of each fill for in-service inspection as specified in 2.2.2, for a fill equal to the minimum capacity or rated minimum fill respectively of the filling instrument.

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

- Faults arising from simultaneous and mutually independent causes in the instrument;
- Faults that imply it is impossible to perform a measurement;
- Faults that are so serious that they will inevitably be noticed by those interested in the measurement; and
- Transitory faults that are momentary variations in the indications or operation that can not be interpreted, memorized or transmitted as a measurement result.

Note: For filling instruments where the fill may be greater than one load, the value of the significant fault applicable for a test on one static load shall be calculated in accordance with the test procedures in A.6.1.3.

T.4.2.7 Span stability

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

T.4.3 Reference value for accuracy class (Ref(x))

Value for accuracy class determined by static testing of the weighing unit during influence quantity testing at type approval stage. Ref(x) is equal to the best accuracy class for which the instrument may be verified for operational use.

T.5 Influences and reference conditions

T.5.1 Influence quantity

Quantity that is not the subject of the measurement but which influences the value of the measurand or the indication of the filling instrument. *[based on VIM 2.7]*

T.5.1.1 Influence factor

Influence quantity having a value within the specified rated operating conditions of the filling instrument.

T.5.1.2 Disturbance

Influence quantity having a value within the limits specified in this Recommendation but outside the rated operating conditions of the filling instrument.

T.5.2 Rated operating conditions

Conditions of use, giving the ranges of the measurand and of the influence quantities for which the metrological characteristics are intended to lie within the maximum permissible deviations specified in this Recommendation. *[based on VIM 5.5]*

T.5.3 Reference conditions

Set of specified values of influence factors fixed to ensure valid intercomparison of the results of measurements. *[based on VIM 5.7]*

T.6 Tests

T.6.1 Material test

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

T.6.2 Simulation test

Test carried out on a complete filling instrument or part of a filling 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 able to accomplish its intended functions.

T.6.4 Span stability test

Test to verify that the EUT is capable of maintaining its span stability.

Automatic gravimetric filling instruments

1 General

1.1 Scope

This International Recommendation specifies the metrological and technical requirements for automatic gravimetric filling instruments which produce predetermined mass of individual fills of products from one or more loads by automatic weighing.

Note 1: This Recommendation places no constraint on the maximum or minimum capacities of the filling instruments for which this Recommendation is applicable.

Note 2: Filling instruments may also be required to comply with certain requirements of other OIML Recommendations, e.g. automatic filling instruments which, in normal use, could be operated in nonautomatic mode will need to comply with OIML R 76 *Nonautomatic weighing instruments*, and fills less than or equal to 25 kg will need to comply with OIML R 87 *Quantity of product in prepackages*.

1.2 Terminology

The terminology on pages 5 to 10 shall be considered as a part of this Recommendation.

2 Metrological requirements

2.1 Accuracy classes

The accuracy class, X(x) and reference value for accuracy class, Ref(x) shall be specified in accordance with the limits of error given in 2.2 and marked on the filling instrument in accordance with the descriptive markings given in 3.10.

Accuracy classes for filling instruments shall be specified for intended usage, i.e. nature of the product(s) to be weighed, type of installation and operating environment, value of the fill, and operating rate in accordance with 5.2 and 5.3.

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

2.2 Limits of error

2.2.1 Maximum permissible error (MPE) for static tests

The filling instrument shall have a reference value for accuracy class, Ref(x), applicable for static testing at type approval stage, for which the MPE for influence factor tests shall be as specified in 2.5.

2.2.2 Maximum permissible deviation (MPD) of each fill

The filling instrument shall have a specified accuracy class X(x), determined at initial verification, for which the MPD of each fill from the average of all fills in a test shall be equal to the limits specified in Table 1, multiplied by the class designation factor (x).

The value of (x) shall be 1×10^k, 2×10^k or 5×10^k, k being a positive or negative whole number or zero.

Table 1 Maximum permissible deviation (MPD) of each fill

Value of the mass of the fills, *F* (g)					MPD of each fill from the average of the fills for class X(1) (as percentage of *F* or in grams)	
					Initial verification	In-service inspection
		F	≤	50	7.2 %	9 %
50	<	*F*	≤	100	3.6 g	4.5 g
100	<	*F*	≤	200	3.6 %	4.5 %
200	<	*F*	≤	300	7.2 g	9 g
300	<	*F*	≤	500	2.4 %	3 %
500	<	*F*	≤	1 000	12 g	15 g
1 000	<	*F*	≤	10 000	1.2 %	1.5 %
10 000	<	*F*	≤	15 000	120 g	150 g
15 000	<	*F*			0.8 %	1 %

(See 6.3 for the number of fills required to find the average value).

2.3 Particle mass correction (see T.3.2)

For material tests, when the reference particle mass exceeds 0.1 of the maximum permissible in-service deviation, the values derived from Table 1 shall be increased by 1.5 times the value of the reference particle mass. However, the maximum value of the MPD shall not exceed the value from the multiplication of the class designation factor (x) by 9 %.

Note 1: Particle mass correction is not applicable to limits which are derived from Table 1, e.g. influence quantity tests, zero-setting, etc.

Note 2: Instruments which are verified with particle mass correction are not suitable for fills which need to comply with OIML R 87 *Quantity of product in prepackages*. In the case of high particle mass of the product, associative (selective combination) weighers (see T.1.8.1) should be used.

2.4 Maximum permissible preset value error (MPSE)

For filling instruments where it is possible to preset a fill value, the maximum difference between the preset value (as defined in T.3.3 and 6.6) and the average mass of all the fills in a test sequence (as defined in 6.7) shall not exceed 0.25 of the MPD of each fill from the average of the fills, as specified for in-service inspection in 2.2.2. These limits will apply for initial verification and in-service inspection tests.

2.5 Maximum permissible error (MPE) for influence factor tests

The MPE for any static test load during influence factor tests shall be 0.25 of the MPD for in-service inspection as specified in 2.2.2 for a fill equal to the static test load.

Note: For filling instruments where the fill may not be equal to one load, the MPE applicable for a test on one static load shall be calculated in accordance with the test procedures in A.6.1.3.

2.6 Minimum capacity (Min)

The Min is the smallest load value specified by the manufacturer which can be automatically weighed on a load receptor within the error limits and requirements for filling instruments given in this Recommendation.

The Min shall be marked on the instrument in accordance with the descriptive markings in 3.10.

Note: For filling instruments which effect the fill by one weighing cycle, Min is equal to the Minfill.

2.7 Rated minimum fill (Minfill)

The Minfill is the rated minimum fill from automatic weighing below which the weighing results may be subject to errors outside the limits and requirements specified in this Recommendation.

Note: For filling instruments which effect the fill by more than one weighing cycle Minfill is larger than the Min.

The Minfill shall be subjected to the following requirements:

a) 3.8.2 Capability of zero-setting related to Minfill(*);

b) A.5.2 Warm-up error related to Minfill;

c) A.6.2.2 Temperature effect on no-load indication related to Minfill;

d) A.6.3 Significant fault for disturbance tests related to Minfill.

The Minfill value shall be marked on the instrument in accordance with the descriptive markings in 3.10.

2.8 Influence factors

The permissible effects of influence factors on instruments under simulated conditions are specified for each case below.

Refer to Annex A for test conditions.

2.8.1 Temperature

2.8.1.1 Prescribed temperature limits

If no particular working temperature is stated in the descriptive markings of the filling instrument, then the instrument shall comply with the appropriate metrological and technical requirements at temperatures from:

– 10 °C to + 40 °C.

The temperature limits shall be marked on the instrument in accordance with the descriptive markings in 3.10.

(*) With a resolution in scale interval (*d*) and the equilibrium device the filling instrument is able to meet the requirement of 3.8.2 with an error (*E*) = 0.25 *d*. Since 3.8.2 requires that 0.25 *d* ≤ 0.25 MPD in-service × Minfill, then the condition below is true:

Minfill ≥ *d* / MPD in-service (with MPD as a relative value)

For class X(x) instruments the minimum permissible values of Minfill for *d* values are tabled below:

d	Minimum permissible value of Minfill (g)			
(g)	X(0.2)	X(0.5)	X(1)	X(2)
0.5	28	11	6	3
1	111	22	11	6
2	334	44	22	12
5	1 665	335	110	30
10	3 330	1 330	330	110
20	6 660	2 660	1 340	340
50	25 000	6 650	3 350	1 650
100	50 000	20 000	6 700	3 300
200	100 000	40 000	20 000	6 600
≥ 500	500 *d*	200 *d*	100 *d*	50 *d*

(The gram values are rounded to the *d* values which can be indicated)

For calculating the Minfill value for class X(x) instruments the MPD and *F* values in Table 1 (on page 12) are used.

For example: Class X(0.2) instrument with *d* = 20 g and estimated MPD of 3 % * 0.2 = 0.6 %.

Calculated Minfill: 20 g / 0.006 = 3330 g. This value belongs to the *F* range with MPD of 1.5 % × 0.2 = 0.3 % therefore further calculation is necessary as follows:

Calculated Minfill: 20 g / 0.003 = 6660 g. This is the correct value because the *F* range and MPD are coherent.

Minfill cannot be obtained for any constant MPD value. Only the relative MPD values can be used for the calculation of the Minfill and the calculated Minfill shall be in the same *F* range as the MPD in the calculation.

For example: Class X(1) instrument with *d* = 10 g and constant MPD of 9 g = 3.6 % for an estimated Minfill of 250 g.

Calculated Minfill: 10 g / 0.036 = 280 g. For 280 g the MPD = 3.2 % therefore further calculation is necessary;

Calculated Minfill: 10 g / 0.032 = 310 g. For 310 g the MPD = 3.0 % therefore further calculation is necessary;

Calculated Minfill: 10 g / 0.03 = 330 g. This value is correct because the *F* range and MPD are coherent.

2.8.1.2 *Special temperature limits*

For special applications, the limits of the temperature range may differ from those given above, but such a range shall not be less than 30 °C and shall be specified in the descriptive markings.

2.8.1.3 *Temperature effect on no-load indication*

At specified temperatures, the indication at zero shall not vary by more than the MPE for influence factor tests specified in 2.5 for a load equal to the Minfill, for a difference in ambient temperature of 5 °C.

2.8.2 *Power supply (AC)*

An instrument which is powered by an AC electricity supply shall comply with the appropriate metrological and technical requirements when operated at voltages from – 15 % to + 10 % of the reference voltage values, marked on the instrument.

2.8.3 *Power supply (DC)*

A filling instrument which is powered by a DC supply shall comply with the appropriate metrological and technical requirements in accordance with 4.2.6 and shall be tested for compliance with the DC powered instruments tests according to A.6.4.

2.8.4 *Tilting*

A filling instrument which is not intended for installation in a fixed position and which does not have a level indicator shall comply with the appropriate metrological and technical requirements when tilted (longitudinally and transversely) by up to 5 %.

Where a level indicator is present it shall enable the filling instrument to be set to a tilt of 1 % or less.

2.9 Units of measurement

The units of mass are the:

- Metric carat (ct);
- Milligram (mg);
- Gram (g);
- Kilogram (kg); and
- Tonne (t).

3 Technical requirements

3.1 Suitability for use

A filling instrument shall be designed to suit the method of operation and the products for which it is intended. It shall be of adequately robust construction so that it maintains its metrological characteristics when properly installed and used in an environment for which it is intended.

3.2 Security of operation

3.2.1 *Fraudulent use*

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

3.2.2 *Accidental breakdown or maladjustment*

A filling instrument shall be so constructed that an accidental breakdown or maladjustment of control elements likely to disturb the instrument's correct operation cannot take place without its effect being evident.

3.2.3 *Security*

Means shall be provided for securing components, interfaces, software devices and preset controls of a filling instrument, to which unauthorized access is prohibited or is detected and made evident by an audit trail or similar.

National prescription may specify the security or sealing that is required.

3.2.4 *Modifications and identification*

Any modifications to the filling instrument or device(s) or software part(s) shall be such that they do not affect its correct operation and metrological characteristics. Modifications shall be identifiable and capable of being confirmed at verification.

3.3 Indication of weighing results

3.3.1 *Quality of reading*

Reading of the results shall be reliable, bright and easy under conditions of normal use.

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

3.3.2 Form of the indication

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

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

All indicating, printing and tare weighing devices of a filling instrument shall, within any one weighing range, have the same scale interval for any given load.

Digital indication shall display at least one figure beginning at the extreme right.

3.3.3 Use of a printer

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

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

Any printout is for information purposes only and not for use in any commercial transaction, except preset values and number of weighings.

3.3.4 Scale interval (d)

Scale intervals of all indicating devices associated with a weighing unit shall be the same.

3.4 Fill setting device

If fill setting is by means of a scale, it shall be graduated in units of mass.

If fill setting is by means of weights, they shall be either weights in accordance with OIML requirements or purpose-designed of any nominal value, distinguishable by shape and identified with the filling instrument.

3.5 Final feed cut-off device

The final feed cut-off device shall be clearly differentiated from any other device. The direction of movement corresponding to the sense of the desired result shall be shown, where applicable.

For automatic mechanical scales, the final feed cut-off device may include an adjustable compensation beam for the material in flight.

3.6 Feeding device

The feeding device shall be designed to provide sufficient and regular flowrate(s).

An adjustable feeding device shall be fitted with an indication of the direction of movement corresponding to the sense of the adjustment of the feed where applicable.

3.7 Load receptor

The load receptor, and feed and discharge devices as appropriate, shall be designed to ensure that residual material retained after each discharge is negligible.

A filling instrument using the subtractive weighing principle shall be designed to ensure that residual material retained at feed from the discharge gate is negligible.

The load receptor shall provide access and facilities so that where necessary test weights or masses up to the maximum capacity can be placed in position, in a safe and secure manner. If these facilities are not a permanent fixture of the instrument, they must be kept in the vicinity of the filling instrument.

Manual discharge of the load receptor shall not be possible during automatic operation.

3.8 Zero-setting and tare devices

A filling instrument shall be provided with zero-setting and/or tare devices and may be provided with additional zero-tracking devices. Tare devices (except preset tare devices) may also be used for zeroing. The devices may be:

- Nonautomatic (tare balancing and/or preset tare); or
- Semi-automatic; or
- Automatic.

3.8.1 Range of adjustment

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

The range of adjustment of zero-setting devices shall not exceed 4 % of the Max of the filling instrument. The range of adjustment of the initial zero-setting device shall not exceed 20 % of the Max of the filling instrument.

3.8.2 Accuracy of zero-setting and tare devices

Zero-setting and tare devices (except the preset tare function) shall be capable of setting to less than or equal to 0.25 of the MPD for in-service inspection as specified in 2.2.2 for a fill equal to the Min or Minfill respectively of the filling instrument.

3.8.3 Control of the zero-setting and tare devices

3.8.3.1 Nonautomatic and semi-automatic devices

Nonautomatic or semi-automatic zero-setting and tare devices must be locked during automatic operation.

The weighing unit shall be in stable equilibrium when the zero-setting and tare devices are operating.

3.8.3.2 Automatic devices

An automatic zero-setting device may operate at the start of automatic operation, as part of every automatic weighing cycle, or after a programmable time interval. A description of the operation of the automatic zero-setting device (e.g. the maximum programmable time interval) should be included in the type approval certificate.

The automatic zero-setting device shall operate sufficiently often to ensure that zero is maintained within twice the given MPE in 3.8.2.

Where the automatic zero-setting device operates as part of every automatic weighing cycle, it shall not be possible to disable this device or to set it to operate at time intervals.

Where the automatic zero-setting device operates after a programmable time interval, the manufacturer shall specify the maximum programmable time interval. The maximum programmable time interval shall not be greater than the value calculated according to the method in A.5.3.5, or shall be reduced depending on prevailing operating conditions.

The maximum programmable time interval for automatic zero-setting required above and specified in A.5.3.5 may start again after taring or zero-tracking has taken place.

The automatic zero-setting device shall generate suitable information to draw attention to overdue zero-setting.

3.8.4 Zero-tracking device

A zero-tracking device shall operate only when:

- The indication is at zero, or at a negative net value equivalent to gross zero; and
- The corrections are not more than 0.25 MPD in-service inspection for a fill equal to the Min or Minfill respectively of the filling instrument.

When zero is indicated after a tare operation, the zero-tracking device may operate within a range of 4 % of Max of the filling instrument around the actual zero value.

Note: Zero-tracking is functionally similar to automatic zero-setting. The differences are important in applying the requirements of 3.8. Automatic zero-setting and zero-tracking are defined in T.2.4.3 and T.2.4.5. Specifically:

- Automatic zero-setting is activated by an event, such as part of every automatic weighing cycle or after a programmed interval;
- Zero-tracking may operate continuously when the above conditions are fulfilled and must therefore be subject to a maximum rate of correction of 0.5 MPD in-service inspection to prevent interaction with the normal weighing process.

3.8.5 Tare device

3.8.5.1 Accuracy and control of tare devices

Accuracy and operation of the tare device shall be as specified in 3.8.2 and 3.8.3.

3.8.5.2 Subtractive tare device

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

3.8.5.3 Combined zero-setting and tare devices

If the same key operates the semi-automatic zero-setting device and the semi-automatic tare device, the accuracy requirements specified in 3.8.2 and in 3.8.4 apply at any load.

3.8.6 *Preset tare device*

3.8.6.1 *Scale interval*

The scale interval of a preset tare device shall be equal to or automatically rounded to the scale interval of the instrument.

3.8.6.2 *Modes of operation*

A preset tare device may be operated together with one or more tare devices provided that a preset tare operation cannot be modified or cancelled as long as any tare device operated after the preset tare operation is still in use.

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

3.9 Equilibrium mechanism

The equilibrium mechanism may be provided with detachable masses which shall be either weights in accordance with OIML requirements or purpose-designed masses of any nominal value, distinguishable by shape and identified with the filling instrument.

3.10 Descriptive markings

Filling instruments shall bear the following markings.

3.10.1 *Markings shown in full*

- Name or identification mark of the manufacturer
- Name or identification mark of the importer (if applicable)
- Date of manufacture of the instrument
- Serial number and type designation of the instrument
- Product(s) designation (i.e. materials that may be weighed)
- Temperature range (if applicable, see 2.8.1) in the form: .... °C / .... °C
- Electrical supply voltage in the form: V
- Electrical supply frequency in the form: .... Hz
- Pneumatic/hydraulic pressure (if applicable) in the form: .... kPa or bar
- Average number of loads/fill (if applicable) ....
- Maximum fill (if applicable) in the form: Maxfill ....
- Rated minimum fill (if applicable) in the form: Minfill ....
- Maximum rate of operation (if applicable) in the form: .... loads per minute

3.10.2 *Markings shown in code*

- Type approval sign
- Indication of the accuracy class in the form: X(x) = ...
- Reference value for the accuracy class in the form: Ref(x) = ...
- Scale interval (if applicable) in the form: *d* = ...
- Maximum capacity in the form: Max ....
- Minimum capacity (or minimum discharge where applicable) in the form: Min ....
- Maximum additive tare in the form: T = + ...
- Maximum subtractive tare in the form: T = – ....

3.10.3 *Supplementary markings*

Depending upon the particular use of the filling instrument, supplementary markings may be required on type approval by the metrological authority issuing the type approval certificate, for example: a filling instrument may be verified for different materials for which different classes apply or which require different operating parameters to maintain limits of error.

Marking shall be such that the materials and alternative class or operating parameters are clearly associated with the appropriate material designation.

In the case of subtractive weighers, the minimum load to be discharged shall be specified.

3.10.4 *Presentation of descriptive markings*

The descriptive markings shall be indelible and of a size, shape and clarity to enable legibility under normal conditions of use of the filling instrument.

They shall be grouped together in a clearly visible place on the filling instrument, either on a descriptive plate or on the filling instrument itself.

Where the markings are placed on a descriptive plate, it shall be possible to seal the plate bearing the markings. Where they are marked on the filling instrument itself, it shall not be possible to remove them without destroying them.

The descriptive markings may be shown on a programmable display which is controlled by software. In this case, means shall be provided for any access to reprogramming of the markings to be automatically and non-erasably recorded and made evident by an audit trail, e.g. by traceable access software such as an event logger providing an information record of the changes, or an event counter providing a non-resettable counter of changes.

When a programmable display is used, the descriptive plate on the instrument shall bear at least the following markings:

- Type and designation of the instrument;
- Name or identification mark of the manufacturer;
- Type approval number;
- Electrical supply voltage;
- Electrical supply frequency; and
- Pneumatic/hydraulic pressure.

3.11 Verification marks

3.11.1 Position

The filling instrument shall have a place for the application of verification marks. This place shall:

- Be such that the part on which it is located cannot be removed from the filling instrument without damaging the marks;
- Allow easy application of the mark without changing the metrological qualities of the filling instrument; and
- Be visible without the filling instrument or its protective covers having to be removed.

3.11.2 Mounting

A filling instrument 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.

3.12 Control instruments

Control instruments may be separate from, or an integral part of, the filling instrument.

Control instruments may incorporate other devices including software which allows them to determine the mass of the fill(s). Where other devices and software are incorporated into control instruments, they shall continue to function correctly and their metrological functions shall not be influenced.

4 Requirements for electronic instruments

The type of an electronic instrument is presumed to comply with the following general requirements if it passes the examination and tests specified in Annex A, in addition to the applicable requirements of all other clauses of this Recommendation.

4.1 General requirements

4.1.1 Rated operating conditions

Electronic 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 exposed to disturbances, either:

a) Significant faults do not occur, i.e. the difference between the weight indication due to the disturbance and the indication without the disturbance (intrinsic error) shall not exceed the value of the significant fault specified in T.4.2.6; or

b) Significant faults are detected and acted upon.

Note: A fault equal to or less than the value specified in T.4.2.6 is allowed irrespective of the value of the error of indication.

4.1.3 Durability

The requirements in 4.1.1, 4.1.2 and 4.2.1 shall be met durably in accordance with the intended use of the instrument.

4.1.4 Application

The requirements in 4.1.2 may be applied separately to:

- Each individual cause of significant fault; and/or
- Each part of the electronic instrument.

The choice of whether:

- Electronic instruments designed to withstand disturbances (4.1.2 a) above); or
- Electronic instruments designed to detect and act on significant faults (4.1.2 b) above)

is applied is left to the manufacturer of the filling instrument.

4.2 Functional requirements

4.2.1 Influence factors

An electronic instrument shall comply with the influence factors requirements in 2.8 and shall also comply with appropriate metrological and technical requirements at a relative humidity of 85 % at the upper limit of the temperature range of the instrument.

4.2.2 Indicator display test

If the failure of an indicator display element can cause a false weight indication then the instrument may have a display test facility which is automatically initiated at switch-on of indication, e.g. indication of all the relevant signs of the indicator in their active and non-active states for a period of time sufficient to be easily observed by the operator.

4.2.3 Acting upon a significant fault

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

4.2.4 Warm-up time

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

4.2.5 Interfaces

A filling instrument may be equipped with interfaces which allow it to be coupled to external equipment and software devices.

An interface comprises all mechanical, electrical and software devices at the communication point between instruments, peripheral and software devices.

When an interface is used, the filling instrument shall continue to function correctly and its metrological functions shall not be influenced by the attached external equipment or software devices or by disturbances acting on the interface.

Functions that are performed or initiated via an interface shall meet the relevant requirements and conditions of clause 3.

It shall not be possible to introduce into a filling instrument, through an interface, functions, program modules or data structures intended or suitable to:

- Display unclear data;
- Falsify displayed, processed or stored weighing results; or
- Unauthorized adjustment of the instrument.

Other interfaces shall be secured in accordance with 3.2.3.

4.2.6 Battery power supply (DC)

An instrument that operates from a battery power supply shall, whenever the voltage drops below the manufacturer's specified minimum value, either continue to function correctly or automatically be put out of service.

4.3 Examination and tests

Examination and testing of electronic instruments is intended to verify compliance with the applicable requirements of this Recommendation, particularly those of clause 4.

4.3.1 Examinations

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

4.3.2 Performance tests

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

Tests are to be carried out 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 electronic devices shall be tested, where possible as a simulated instrument including all electronic elements of a system which can affect the weighing result. In addition, an examination shall be carried out on the fully operational instrument.

Susceptibility to other equipment that would result from the use of electronic interfaces shall be simulated in the tests.

4.3.3 Span stability

When an electronic instrument is subjected to the span stability test specified in A.7, the absolute value of the difference between the errors obtained for any two measurements shall not exceed half the MPE for influence factor tests for a near maximum capacity load.

5 Metrological controls

5.1 General

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

- Type approval;
- Initial verification;
- Subsequent verification; and
- In-service inspection.

Tests should be applied uniformly by the metrological authority and should form a uniform program. Guidance for the conduct of pattern approval and initial verification is provided in OIML International Documents D 19 *Pattern evaluation and pattern approval* and D 20 *Initial and subsequent verification of measuring instruments and processes* respectively.

For the purposes of testing, the metrological authority may require the applicant to provide the product (i.e. the material to be weighed), the handling equipment, the control instrument (as defined in 3.12 and A.3.6) and the personnel to perform the tests.

5.2 Type approval

5.2.1 Documentation

The application for type approval shall include documentation comprising:

- The metrological characteristics of the instrument;
- A set of specifications for the instrument;
- A functional description of the components and devices;
- Drawings, diagrams and general software information (if applicable), explaining the construction and operation, including interlocks; and
- Any document or other evidence that the design and construction of the instrument complies with the requirements of the present 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 specified in 4.2.5, and for password protected access to prevent unauthorized access in accordance with 3.2.3).

5.2.2 General requirements

Type evaluation shall be carried out on one or more (and normally not more than three) instruments that represent the definitive type. At least one of the instruments shall be submitted in a form suitable for simulation testing in a laboratory and shall include the whole of the electronics which affect the weighing result except in the case of an associative weigher, where only one representative weighing unit may be included.

The evaluation shall consist of the tests specified in 5.2.3.

The MPE for static tests shall be apportioned in accordance with 5.2.3.3 to parts of the filling instrument that are tested separately.

5.2.3 Type evaluation

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

- The requirements for static tests specified in clause 2;
- The technical requirements in clause 3; and
- The requirements in clause 4 for electronic instruments, where applicable.

The metrological authority shall:

- Conduct the tests in a manner which prevents an unnecessary commitment of resources; and
- Permit the results of these tests to be assessed for initial verification.

Note: The metrological authority is advised to accept, with the consent of the applicant, equivalent test data obtained from other metrological authorities without repeating the tests.

5.2.3.1 *Operational tests for type evaluation*

Tests for type evaluation shall be conducted:

- In accordance with the appropriate parts of clause 3;
- Under the normal conditions of use for which the instrument is intended; and
- In accordance with the material test methods given in clause 6, using material that is representative of a product for which the filling instrument is designed to assess compliance with the technical requirements of clause 3.

5.2.3.2 *Influence factor tests*

Influence factors shall be applied to the instrument or simulator during simulation tests in a manner that will reveal a corruption of the weighing result of any weighing process to which the instrument could be applied, in accordance with:

- Subclause 2.8 for all instruments; and
- Clause 4 for electronic instruments.

5.2.3.3 *Apportioning of errors*

Where parts of a filling instrument are examined separately in the process of type approval, the following requirements apply:

The error limits applicable to a part 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 part have to be taken for the same accuracy class as for the complete instrument incorporating the part.

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 part, and shall be verified by an appropriate test. However, the fraction shall not exceed 0.8 and shall not be less than 0.3, when more than one part contributes to the effect in question.

If the metrological characteristics of the load cell or other major component have been evaluated in accordance with the requirements of any OIML International Recommendation (e.g. R 60 for load cells), then that evaluation shall be used to aid in the type evaluation if so requested by the applicant.

Note: As the requirements of this subclause only apply to the instrument submitted for type evaluation and not to those subsequently submitted for verification, the means by which it will be possible to determine whether the appropriate MPE or maximum allowable variation has been exceeded will be decided mutually between the metrological authority and the applicant. The means may be for example:

- The provision or adaptation of the indicating device to give the required resolution or appropriate increment or scale interval;
- The use of change point weights; or
- Any other means mutually agreed upon.

5.2.4 *Place of testing for type approval*

Instruments submitted for type approval may be tested either:

- On the premises of the metrological authority to which the application has been submitted; or
- In any other suitable place agreed between the metrological authority concerned and the applicant.

5.2.5 *Type approval certificate and determination of classes (2.2.1 and A.5)*

The type approval certificate shall state the reference value for the accuracy class Ref(x) as determined by the static tests in A.5, and shall state that the actual class (equal to or higher than the reference value) shall be determined by compliance with the metrological requirements on initial verification.

5.3 Initial verification

5.3.1 *General requirements*

Filling instruments shall be examined for conformity with the approved type (where applicable) and shall be tested for compliance with clause 2 (excluding 2.2.1 and 2.5) for the intended products and corresponding accuracy classes and when operated under normal conditions of use.

Tests shall be carried out by the metrological authority, in-situ, with the filling instrument fully assembled and fixed in the position in which it is intended to be used.

The installation of a filling instrument shall be so designed that an automatic weighing operation will be the same, whether for the purposes of testing or for use in a transaction.

5.3.2 *Material tests for initial verification*

In-situ material tests shall be done:

- In accordance with the descriptive markings given in 3.10;
- Under the normal conditions and with the products for which the filling instrument is intended; and
- In accordance with the test method in clause 6 and the material tests procedure given in A.8.2.

Accuracy requirements shall be applied in accordance with the appropriate parts of clause 2.

5.3.3 *Conduct of the tests*

The metrological authority:

- Shall conduct the tests in a manner which prevents an unnecessary commitment of resources; and
- May, where appropriate and to avoid duplicating tests previously performed on the instrument for type evaluation under 5.2, use the test results from type evaluation for initial verification.

5.3.4 *Determination of accuracy class X(x)*

For class X(x) filling instruments the metrological authority shall:

- Determine the accuracy class for the materials used in the tests in accordance with 5.2.5 by reference to the material test results from A.8 and the limits of error specified in 2.2.2 and 2.4 for initial verification; and
- Verify that accuracy classes marked in accordance with descriptive markings in 3.10 are equal to or greater than the accuracy classes determined as above.

5.4 Subsequent verification

Subsequent verification shall be carried out in accordance with the same provisions as in 5.3 for initial verification.

5.5 In-service inspection

In-service inspection shall be as specified in:

- 5.3.1 general requirements for initial verification; and
- 5.3.2 materials tests for initial verification.

The MPEs shall be as specified in 2.2.2 for in-service inspection.

6 Test methods

6.1 Determination of the mass of individual fills

The mass of individual fills is determined using either the separate verification method given in 6.5.1 or the integral verification method given in 6.5.2.

6.2 Conduct of material tests

6.2.1 *Values of the mass of the fills*

a) The tests shall be carried out on fills using loads at, or near to, the Max and also at, or near to, the Minfill of the filling instrument.

b) Cumulative weighers shall be tested as in a) with the maximum practical number of loads per fill and also with the minimum number of loads per fill, and associative weighers as in a) with the average (or optimum) number of loads per fill (see T.3.10).

c) If the Minfill is less than one third of the Maxfill then tests shall also be carried out near the center of the load weighing range preferably at a value close to, but not above, 100 g, 300 g, 1 000 g or 15 000 g, as appropriate.

6.2.2 *Types of test loads*

For type evaluation, the materials used for test loads shall be as specified in 5.2.3.1 and for initial verification and in-service inspection, they shall be as specified in 5.3.2.

6.2.3 *Condition of tests*

All tests shall be conducted with any adjustable parameter critical to metrological integrity, e.g. final feed time or rate, set to the most onerous condition allowed by the manufacturer's printed instructions and incorporated in the descriptive markings.

Prior to the start of a new test, the filling instrument shall be operated for a time period under normal operating conditions to enable stability, i.e. until all the principal parts, devices and parameters such as warm-up, temperature, indications, etc., critical to metrological integrity have stabilized according to the manufacturer's printed instructions. During this stabilization period the fills shall not be included in the test.

Any correction device, e.g. in flight correction and/or automatic zero-setting fitted to an instrument shall be operated during the tests according to the manufacturer's printed instructions.

The initial fills after the change between Max and Min shall be included in the test unless the instrument bears a clear warning to discard a stated number of fills after a change to the instrument settings.

6.3 Number of fills

The minimum number of individual test fills depends upon the preset value, F_P, as specified in Table 2.

Table 2 Number of test fills

Preset value of the fills, F_P (kg)	Minimum number of test fills, n
$F_P \leq 1$ kg	60 fills
1 kg $< F_P \leq 10$ kg	30 fills
10 kg $< F_P \leq 25$ kg	20 fills
25 kg $< F_P$	10 fills

6.4 Accuracy of standards

The control instrument and standard weights used in testing shall ensure the checking of the test fills to an error not greater than either:

a) One third of the MPD and MPSE (as appropriate) for automatic weighing (details as given in 2.2 and 2.4 respectively) if the control instrument or the device used for control purposes is verified immediately prior to the material test; or

b) One third of the MPD and MPSE (as appropriate) for automatic weighing (details as given in 2.2 and 2.4 respectively) in all other cases.

6.5 Material test methods

6.5.1 Separate verification method

The separate verification method requires the use of a (separate) control instrument (details as given in 3.12 and A.3.6) to find the conventional true value of the mass of the test fill.

6.5.2 Integral verification method

With this method the filling instrument being tested is used to determine the conventional true value of the mass of the test fill. The integral verification method shall be conducted using either:

a) An appropriately designed indicating device; or

b) An indicating device with standard weights to assess the rounding error.

The total uncertainty of the test method (separate or integral verification) shall be not greater than one third of the MPE for the filling instrument.

Note 1: The integral verification method depends on determining the masses of the loads. Limits of error as specified in 2.2 are for the mass of the fill. If it is not possible to ensure that in normal operation all of the load is discharged at each cycle of operation, i.e. that the sum of the loads is equal to the fill, then the separate verification method (details as given in 6.5.1) must be used.

Note 2: When using the integral verification method for a cumulative weighing instrument, a subdivision of the test fill is unavoidable. When calculating the conventional true value of the mass of the test fill, it is necessary to consider the increased uncertainty due to the division of the test fill.

6.5.2.1 Interruption of automatic operation

An automatic filling operation of a test fill shall be initiated as for normal operation. However, the automatic operation shall be interrupted twice during each filling cycle in the following conditions:

(a) On a filling instrument where the fill is weighed in the load receptor:
- After filling the load receptor (a)
- After discharge of the load receptor (b)

(b) On a filling instrument where the load is weighed in a container on the load receptor:
- After tare balancing the empty container (b)
- After filling the container (a)

(c) On a subtractive weigher:
- After tare balancing the filled load receptor (a)
- After discharge of the fill from the load receptor (b)

An automatic operation shall not be interrupted during consecutive weighing cycles if the interruption would significantly affect the mass of the fill. In this case, one or two fills shall be discharged in automatic operation without being checked, between the fills that are checked.

a) Pre-discharge (full) interrupt

The automatic operation shall be interrupted immediately after the feed of material has ceased and the load receptor(s), or the container on the load receptor has been filled, or on a subtractive weigher the filled load receptor has been tare balanced.

When the load receptor(s) has (have) stabilized, the net weight of the fill indicated or determined by balancing with standard weights shall be recorded and the instrument switched back to automatic operation.

b) Post-discharge (empty) interrupt

The automatic operation shall be interrupted after the load(s) has (have) been discharged, or a new container has been placed on the load receptor and its weight has been tare balanced, and the load receptor(s) is (are) ready to receive a further load. When the load receptor(s) has (have) stabilized, the empty load receptor weight indicated or determined by balancing with standard weights shall be recorded and the instrument switched back to automatic operation.

6.6 Preset value

The indicated preset value of the fill shall be noted, where applicable.

6.7 Mass and average value of the test fills

The test fill shall be weighed on a control instrument and the result shall be considered as being the conventional true value of the test fill. The average value of all the fills in the test shall be calculated and noted.

6.8 Deviation for automatic weighing

The deviation for automatic weighing used to determine compliance of each fill with the maximum permissible deviation for automatic weighing (specified in 2.2.2) shall be the difference between the conventional true value of the mass of the test fill (as defined in 6.7) and the average value of all the fills in the test.

6.9 Preset value error for automatic weighing

The preset value error for automatic weighing used to determine compliance with 2.4 shall be the difference between the average value of the conventional true value of the mass of the test fills (as defined in 6.7) and the preset value of the fills.

Annex A
Testing procedures for automatic gravimetric filling instruments (Mandatory)

Meaning of symbols:

I	=	Indication
I_n	=	n^{th} 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
MPE	=	Maximum permissible error
MPD	=	Maximum permissible deviation of each fill from the average value of all the fills
EUT	=	Equipment under test
se	=	Preset value error (setting error)
MPSE	=	Maximum permissible setting error
F	=	Conventional true value of the mass of the fill
F_P	=	Preset value of fill
md_{max}	=	Maximum of the absolute values of the actual deviations of the fill from the average value of all the fills

A.1 Examination for type approval

A.1.1 Documentation

Review the documentation that is submitted to determine if it is adequate and correct. For type approval the documentation shall be as specified in 5.2.1.

A.1.2 Compare construction with documentation

Examine the various devices of the instrument to ensure compliance with the documentation in accordance with 4.3.

A.1.3 Metrological requirements

Note the metrological characteristics using the checklist in the Test Report Format in R 61-2.

A.1.4 Technical requirements

Examine the instrument for conformity with the technical requirements of clause 3, using the checklist given in the Test Report Format in R 61-2.

A.1.5 Functional requirements

Examine the instrument for conformity with functional requirements according to details given in 4.2 and 4.3 respectively, using the checklist given in the Test Report Format in R 61-2.

A.2 Examination for initial verification

A.2.1 Compare construction with documentation

Examine the instrument for conformity with the approved type in accordance with the requirements in 5.3.1.

A.2.2 Descriptive markings

Check the descriptive markings in accordance with 3.10 and use the checklist given in R 61-2.

A.3 General test requirements

A.3.1 Power supply (in accordance with 2.8.2)

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 each test.

A.3.2 Zero-setting (in accordance with 3.8)

Using the manual or semi-automatic zero-setting facility, adjust the EUT as closely as practicable to zero prior to each test, and do not readjust it at any time during the test, except to reset if a significant fault has been indicated.

Status of automatic zero facilities shall be as specified for each test.

A.3.3 Temperature (in accordance with 2.8.1)

The tests shall be performed at a steady ambient temperature, usually normal ambient temperature unless otherwise specified. The temperature is deemed to be steady when the difference between the extreme temperatures noted during the test does not exceed one-fifth of the temperature range of the instrument without being greater than 5 °C, and the rate of change does not exceed 5 °C per hour.

The handling of the instrument shall not result in condensation of water on the instrument.

A.3.4 Recovery

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

A.3.5 Pre-loading

Before each weighing test the filling instrument shall be pre-loaded to Max, except for the tests in A.5.2 and A.6.2.2.

A.3.6 Control instruments (T.1.9 and 3.12)

A.3.6.1 Accuracy of test system (in accordance with 6.4)

The control instrument and standard weights used in testing shall ensure the determination of the weight of test loads and fills to an error not greater than one third of the MPE of the filling instrument in accordance with 6.4 a) or b) for material tests.

Note: Accuracy requirements for the test system depend on the limits of error, which depend on the accuracy class. However, the class is determined from the results of the tests. It is therefore necessary that the metrological authority responsible for testing should be informed of the best accuracy class that may be achieved, prior to commencement of testing.

A.3.6.2 Use of standard weights to assess rounding error of indication

A.3.6.2.1 General method to assess error of indication 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 prior to rounding is:

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

Example: A weighing instrument with a scale interval, d, of 5 g is loaded with 1 kg and thereby indicates 1 000 g. After adding successive weights of 0.5 g, the indication changes from 1 000 g to 1 005 g at an additional load of 1.5 g. Inserted in the above formula these observations give:

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

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

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

A.3.6.2.2 Correction for error at zero

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

Evaluate 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 = + 0.5 g, the corrected error is:

$$E_c = +\,1 - (+\,0.5) = +\,0.5$$

A.4 Test program

A.4.1 Type evaluation (in accordance with 5.2.2 and 5.2.3)

The following tests shall normally be applied for type evaluation:

- Examination for type approval in A.1;
- Static tests in A.5;
- Influence factor and disturbance tests given in A.6;
- Span stability test in A.7; and
- Material tests in A.8.1.

A.4.2 Nonautomatic weighing instruments (in accordance with 1.1)

For instruments in which the weighing function is provided by a nonautomatic weighing instrument that has been approved in respect of conformity with R 76, the tests specified in A.4.1 may be omitted where equivalent test results specified in R 76 prove conformity with the relevant parts of R 61. Use of R 76 test results shall be recorded in the test report checklist and summary in R 61-2.

A.4.3 Initial verification (in accordance with 5.3)

The following tests shall normally be applied for initial verification:

- Examination for initial verification in A.2; and
- Material tests at initial verification in A.8.2.

The static weighing test method (as detailed in A.5.4) may also be used if necessary to verify the indicator for the integral verification method of material tests.

A.5 Static tests (type approval stage)

A.5.1 General (in accordance with 5.2.2 and 5.2.3.2)

Electronic instruments or instrument simulators are required to have a load indicator, or an interface allowing access to a quantity that can be calibrated to provide an indication of load so that the effect of influence quantities may be tested and the reference accuracy class determined. This facility also enables testing of warm-up time and zero-setting and tare devices where applicable. The static weighing tests are normally done as part of influence quantity testing.

Limits for warm-up time tests and for accuracy of zero- and tare-setting tests are derived from 2.2, and are therefore dependent on the reference accuracy class Ref(x). Therefore the results of these tests must be evaluated after Ref(x) has been determined as specified in 5.2.5.

A.5.2 Warm-up time (in accordance with 4.2.4)

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 the zero variation and the errors at Max comply with the specified requirements during the first 30 minutes of operation. If the zero is set as part of the normal automatic weighing cycle then this function shall be enabled or simulated as part of the test.

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

1) Disconnect the instrument from the power 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) 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 A.3.4.2.1, 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) From 5) verify that E_{0I} is not greater than the MPE specified in 3.8.2.
7) Apply a static load close to Max. Determine the error by the method of A.3.4.2.1 and A.3.4.2.2.
8) Repeat steps 5) and 6) after 5, 15 and 30 minutes.
9) From 7) and 8) verify that:
    - The error (corrected for zero error) for a static load close to Max is not greater than the MPE specified in 2.5;
    - After each time interval the zero-variation error ($E_0 - E_{0I}$) is not greater than the MPE specified in 3.8.2.

A.5.3 Zero-setting and tare devices (in accordance with 3.8)

A.5.3.1 General

Unless it is clear that zero and tare functions are performed by the same process, then both functions shall be tested separately.

Zero-setting and taring may be by more than one mode, for example:

- Nonautomatic or semi-automatic;
- Automatic at switch-on;

- Automatic at start of automatic operation;
- Automatic at programmable time intervals; or
- Automatic as part of weighing cycle.

It is normally only necessary to test the accuracy of zero-setting and taring in one mode if it is clear that the same process is used for each mode. If zero-setting or taring is set as part of the automatic weighing cycle then this mode shall be tested. To test automatic zero-setting or taring it is necessary to allow the filling instrument to operate through the appropriate part of the automatic cycle and then to halt the instrument before testing.

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

A.5.3.2 Range of zero-setting

A.5.3.2.1 Initial zero-setting

a) Positive range

With the load receptor empty, set the instrument to zero. Place a test load on the load receptor and set the instrument to zero again. Continue this process until 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 load from the load receptor and set the instrument to zero. Then, if possible, remove any non-essential components of the load receptor. If, at this point, the instrument can be reset to zero with the zero-setting device, the mass of the non-essential components is used as the negative portion of the initial zero-setting range.
2) If the instrument cannot be reset to zero with the non-essential components removed, add loads to any live part of the scale until the instrument indicates zero again.
3) Then remove the loads and, after each load is removed, use the zero-setting device. The maximum load that can be removed while the instrument can still be reset to zero by the zero-setting device is the negative portion of the initial zero-setting range.
4) The initial zero-setting range is the sum of the positive and negative portions.
5) Alternatively, if it is not possible to test the negative range of initial zero-setting by removing parts of the instrument, the instrument may be temporarily re-calibrated with a test load applied before step 3) above. (The test load applied for the temporary re-calibration should be greater than the permissible negative portion of the initial zero-setting range which can be calculated from the result of the positive range test).
6) 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 zero-setting range need to be considered.
7) Reassemble or recalibrate the instrument for normal use after the above tests.

A.5.3.2.2 Automatic zero-setting range

Remove the non-essential parts of the load receptor or re-calibrate the instrument as described in A.5.3.2.1 and place weights on the live part of the scale until it indicates zero.

Remove weights in small amounts and after each weight is removed allow the instrument to operate through the appropriate part of the automatic cycle so as to see if the instrument is reset to zero automatically.

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

A.5.3.3 Accuracy of zero-setting

1) When the load receptor is empty, zero the filling instrument in a mode as determined by A.5.3.1.
2) Add load(s) to the load receptor to determine the additional load at which the indication changes from zero to one scale interval above zero.
3) Calculate the error at zero according to the method described in A.3.6.2.1.
4) Verify that the zero-setting error is within the limit specified in 3.8.2.

A.5.3.4 Accuracy of taring

The accuracy of the tare device shall be tested at the maximum tare as specified by the manufacturer.

1) Place the maximum tare load on the load receptor, then operate the tare function key immediately in a mode as determined by A.5.3.1 to enable the equilibrium device to release the tare function.
2) Add load(s) to the load receptor to determine the additional load at which the indication changes from zero to one scale interval above zero.
3) Calculate the error according to the method described in A.3.6.2.1.
4) Verify that the zero-setting error is within the limit specified in 3.8.2.

A.5.3.5 Frequency of automatic zero-setting and taring

This test does not need to be performed for filling instruments that have automatic zero-setting as part of every automatic weighing cycle.

If the zero-setting device is not part of the automatic weighing cycle but operates with a programmable time interval, the value for maximum permissible time interval for automatic zero-setting shall be determined as follows:

a) The maximum allowable rate of change of a steady ambient temperature is 5 °C per hour as specified in A.3.3.

b) Subclause 3.8.2 requires that maximum zero-setting error:

$(Ezse_{max}) \leq 0.25$ MPD in-service × Minfill × Ref(x) (1)

c) For the maximum zero-checking error, 3.8.3.2 requires that:

$(Ezc_{max}) \leq 0.5$ MPD in-service × Minfill × Ref(x) (2)

so the maximum zero-variation (Δz_{max}) is:

$(Ezc_{max} - Ezse_{max}) = 0.25$ MPD in-service × Minfill × Ref(x) (3)

d) A.6.2.2 requires that the maximum zero-variation (Δz_{max}) per 5 °C is less than or equal to 0.25 MPD in-service:

Δz_{max} per 5 °C ≤ 0.25 MPD in-service × Minfill × Ref(x) (4)

e) Substituting the 5 °C per hour steady ambient temperature from a) above for Δz_{max} per 5 °C in equation (4) gives:

Δz_{max} per hour ≤ 0.25 MPD in-service × Minfill × Ref(x) (5)

Since equations (4) and (5) are identical, a filling instrument which needs the maximum allowable variation given in A.6.2.2 has a maximum programmable time interval of automatic zero-setting or taring of 1 hour. If the filling instrument needs less or more of the maximum zero-variation given in A.6.2.2, the maximum programmable time interval of automatic zero-setting or taring may be increased or decreased proportionally.

In exceptional situations the effects of external factors such as operating temperatures, environmental conditions, stickiness of the product being handled, etc, may determine the maximum programmable time interval of automatic zero-setting or taring, which shall be no greater than 2 hours.

A.5.4 Static weighing test method for type evaluation (in accordance with 5.2.3)

Apply test loads from zero up to and including Max, and similarly remove the test loads back to zero. The test loads selected shall include values close to Max and Min and other critical loads as specified in 6.2.1 c), subject to the requirements of this Annex.

Determine the error at each test load, using the standard weights assessment procedure of A.3.6.2, if necessary, to obtain the accuracy of the test system as specified in A.3.6.1.

It should be noted that when loading or unloading, the load shall be progressively increased or progressively decreased.

A.5.5 Determination of reference accuracy class, Ref(x) (in accordance with 5.2.5)

The static weighing tests during application of influence factors (as appropriate) shall be used at type approval stage to establish the reference value for accuracy class, i.e. Ref(x), as follows:

1) Perform static weighing tests for influence factors and loads as specified in this Annex.

2) Determine the MPE for influence factor tests for class X(1), $MPE_{(1)}$ for each load as follows:

   $MPE_{(1)} = 0.25\ MPD_{(1)} \times (P_i$, if applicable) in-service inspection for the fill value equal to the load.

   For example, with a load of 10 kg, the MPE for influence factor tests as specified in 2.5 will be calculated thus:

   $MPE_{(1)} = P_i \times (0.25 \times 1.5\ \% \times 10\ 000\ g)$

   where: P_i (as specified in 5.2.3.3) is a fraction of the MPE applied to a part of the filling instrument which is examined separately;

   $MPE_{(1)}$ is the error limit specified in 2.2 and given in Table 1 for mass of fill.

3) Calculate [|Error| / $MPE_{(1)}$] for each load

   where: Error is the corrected error calculated at zero load, in units of mass, as specified in A.3.6.2.2.

4) From 3) determine the maximum value of [|Error| / $MPE_{(1)}$] for all the influence factor tests,

i.e. [|Error| / MPE(1)]Max for all influence factor tests

5) Determine Ref(x) from [|Error| / $MPE_{(1)}]_{Max}$ such that:

   Ref(x) ≥ [|Error| / MPE(1)]Max and

   Ref(x) = 1×10^k, 2×10^k, or 5×10^k, the index k being a positive or negative whole number or zero. Values for significant fault shall then be calculated from the MPD for the reference class.

A.6 Influence factor and disturbance tests

A.6.1 Test conditions

A.6.1.1 General requirements

Prior to a test, the error at zero shall be assessed and corrected by the methods given in A.3.6.2 and in A.3.6.2.2.

Influence factor and disturbance tests specified in 4.1.2 and 4.2.1 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.

It is generally not possible to apply the influence factors or disturbances to a filling instrument which are processing material automatically. The instrument shall therefore be subjected to the influence factors or disturbances under static conditions or simulated operation as defined herein. 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 filling instrument shall be allowed to recover sufficiently before the following test.

Where parts of the filling instrument are examined separately, errors shall be apportioned in accordance with details given in 5.2.3.3.

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

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

A.6.1.2 Simulator requirements

A.6.1.2.1 General

The simulator for influence factor and disturbance tests should include all electronic devices of the weighing system.

A.6.1.2.2 Load cell

The simulator should 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 should 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.6.1.2.3 Interfaces (details as given in 4.2.5)

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.6.1.2.4 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.

This information shall be attached to, or be traceable from the test report.

A.6.1.3 Test limits for multi-load instruments

For a filling instrument where the fill may consist of more than one load, the value of a significant fault and the limit of error for influence factor tests must be determined by the metrological authority or manufacturer after considering the design of the instrument and the method of test, such that the effect on the fill is not greater than the significant fault value specified in T.4.2.6 and the MPE specified in 2.5.

A.6.1.3.1 Significant fault for multi-load instruments

The following examples show how to determine the value of a significant fault on selective combination weighers and cumulative weighers when testing.

- Significant fault for selective combination weighers:

A fault greater than 0.25 MPD of each fill (as given in Table 1) for in-service inspection divided by the square root of the average (or optimum) number of loads in a fill, for a fill equal to the Min multiplied by the average (or optimum) number of loads in a fill.

Example: For a class X(1) filling instrument with Min = 200 g designed for an average of 8 loads per fill, fill = 1 600 g, the MPD of each fill from the average fill (as specified in Table 1) for in-service inspection is 1.5 % = 24 g. Hence the value of significant fault is:

$$0.25 \times (24 / \sqrt{8}) = 2.12 \text{ g}$$

- Significant fault for cumulative weighers:

A fault greater than 0.25 MPD of each fill (as given in Table 1) for in-service inspection, for a fill equal to the Minfill, divided by the square root of the minimum number of loads per fill.

Example: For a class X(1) filling instrument with Max = 1 200 g and Minfill of 8 kg: 8 kg/1.2 kg = 6.67; therefore the minimum number of loads per fill is 7. The MPD (as given in Table 1) for the Minfill of 8 kg is 1.5 % or 120 g. Hence the value of significant fault is:

$$0.25 \times (120 / \sqrt{7}) = 11.34 \text{ g}$$

Note: This definition of significant fault for cumulative weighers does not include Min. A cumulative weigher would normally be used at or near to Max.

A.6.1.3.2 Limits of error for influence factor tests for multi-load instruments

The following examples show how to determine the limit of error for influence factor testing for selective combination weighers and cumulative weighers when testing. This method determines the MPE for influence factor testing for a fill consisting of more than one static test load.

- For selective combination weighers the MPE for any static test load during influence factor tests shall be 0.25 MPD for in-service inspection for the appropriate mass of the fill divided by the square root of the average (or optimum) number of loads per fill.

Example: Class X(1) selective combination weigher, where the average number of loads per fill is equal to 4. For a static test load = 100 g, the appropriate mass of the fill will be 400 g for which the MPD for in-service inspection is 3 %, i.e. 12 g. Hence the MPE for influence factor tests is:

$$0.25 \times (12 \text{ g} / \sqrt{4}) = 1.5 \text{ g}$$

- For cumulative weighers the MPE for any static test load during influence factor tests shall be 0.25 MPD for in-service inspection for the Minfill divided by the square root of the minimum number of loads per fill.

Example: For a class X(1) filling instrument with Max = 1 200 g and Minfill of 8 kg: 8 kg / 1.2 kg = 6.67; therefore the minimum number of loads per fill = 7. The MPD (as specified in Table 1) for the Minfill of 8 kg is 1.5 %, i.e. 120 g. Hence the MPE for influence factor tests is:

$$0.25 \times (120 / \sqrt{7}) = 11.34 \text{ g}$$

Note: For cumulative weighers the average number of loads per fill is not known. Therefore it is not possible to define the limit of error for influence factors in terms of average loads per fill and appropriate mass of the fill. The above definition is based on Max load and Minfill.

A.6.2 Influence factor tests

Summary of tests

§	Test	Characteristic under test	Conditions applied
A.6.2.1	Prescribed (static) temperatures	Influence factor	MPE
A.6.2.2	Temperature effect on no-load indication	Influence factor	MPE
A.6.2.3	Damp heat, steady state	Influence factor	MPE
A.6.2.4	Power voltage variation	Influence factor	MPE
A.6.2.5	Tilting	Influence factor	MPE

A.6.2.1 Prescribed (static) temperatures (in accordance with 2.8.1.1)

Prescribed temperatures for static tests are carried out in accordance with basic standard IEC Publication 60068-2-1 (1994)(**) and IEC Publication 60068-2-2 (1994)(**) as detailed in Bibliography [1] and according to Table 3.

(**) Or the most recent issue of the publication valid at the time of testing the instrument.

Table 3 Static temperature tests

Environmental phenomena	Test specification	Test setup
Temperature	Reference of 20 °C	
	Specified high for 2 hours	IEC 60068-2-2
	Specified low for 2 hours	IEC 60068-2-1
	5 °C	IEC 60068-2-1
	Reference of 20 °C	
Use IEC 60068-3-1 (1974) for background information and refer to Bibliography [1] for specific parts of the IEC test.		

Supplementary information to the IEC test procedures:

Object of the test: To verify compliance with the provisions given in 2.8.1.1 under conditions of dry heat (non condensing) and cold. The test A.6.2.2 may be conducted during this test.

Test procedures in brief

Precondition: 16 hours.

Condition of the EUT: Normal power supplied and "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. The automatic zero-setting should be disabled.

Stabilization: Minimum of 2 hours at each temperature under "free air" conditions.

Temperature: As specified in 2.8.1.1.

Temperature sequence: Reference temperature of 20 °C;
Specified high temperature;
Specified low temperature;
Temperature of 5 °C;
Reference temperature of 20 °C.

Number of test cycles: At least one cycle.

Weighing test: After stabilization at the reference temperature and again at each specified temperature conduct the following:

Adjust the EUT as close to zero indication as practicable. It is important to ensure that the test result is unaffected by the automatic zero-setting function which should therefore be disabled. The EUT shall be tested with at least five different static test loads (or simulated loads) including Max and Min capacities. When loading or unloading weights the load must be respectively increased or decreased monotonically. Record the following data:

a) Date and time;
b) Temperature;
c) Relative humidity;
d) Test load;
e) Indications;
f) Errors;
g) Functional performance.

Maximum allowable variations: All functions shall operate as designed. All errors shall be within the MPEs specified in 2.5.

A.6.2.2 Temperature effect on no-load indication (in accordance with 2.8.1.3)

Note: This test should not be performed for instruments that have automatic zero-setting as part of the automatic weighing cycle.

The instrument is set to zero, then the temperature is changed to the prescribed highest and lowest temperatures as well as at 5 °C. After stabilization, the error of the zero indication is determined. The change in zero indication per 5 °C is calculated. The changes of these errors per 5 °C are calculated for any two consecutive temperatures of this test.

This test may be performed during the temperature test procedure given in A.6.2.1.

Maximum allowable variations: The change in zero indication shall not vary by more than the MPE for influence factor tests as specified in 2.5 for the Minfill of the filling instrument, for a temperature difference of 5 °C.

Condition of the EUT: Normal power supplied and "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.

A.6.2.3 Damp heat, steady state (in accordance with 4.1.2)

The damp heat, steady state test is carried out in accordance with basic standard IEC Publication 60068-2-78 (2001)(**) and IEC Publication 60068-3-4 (2001)(**) as detailed in Bibliography [2] and according to Table4.

Table 4 Damp heat, steady state

Environmental phenomena	Test specification	Test setup
Damp heat, Steady state	Upper limit temperature and relative humidity of 85 % for 2 days	IEC 60068-2-56
Use IEC 60068-3-4 (2001) for guidance for damp heat tests and refer to Bibliography [2] for specific parts of the IEC test.		

Supplementary information to the IEC test procedures:

Object of the test: To verify compliance with the provisions given in 4.1.2 under conditions of high humidity and constant temperature.

Precondition: None required.

Test load: A complete weighing test in accordance with A.5.4 and 6.2.1.

Condition of the EUT: Normal power supplied and "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.

The zero-setting and zero-tracking facilities shall be enabled as for normal operation.

Adjust the EUT as close to zero indication as is practicable, prior to the test.

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 2.8.1.1.

Temperature: Reference temperature of 20 °C and at the upper limit as specified in 2.8.1.1.

Relative humidity: 50 % at reference temperature;

85 % at upper limit temperature.

(**) **Or the most recent issue of the publication valid at the time of testing the instrument.**

Temperature/ humidity sequence:	The reference temperature at 50 % relative humidity; The upper limit temperature at 85 % humidity; The reference temperature at 50 % relative humidity.
Number of test cycles:	At least one cycle.
Weighing test and test sequence:	After stabilization of the EUT at reference temperature and 50 % humidity apply the test load. Record the following data: a) Date and time; b) Temperature; c) Relative humidity; d) Test load; e) Indications; f) Errors. 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 2 days. Following the 2 days, apply the static test load and record the data as indicated above. Allow full recovery of the EUT before any other tests are performed.
Maximum allowable variations:	All errors shall be within the MPEs specified in 2.5.

A.6.2.4 Power voltage variation (in accordance with 2.8.2)

Power voltage variation tests are carried out in accordance with basic standard IEC Publication 61000-4-11 (2004)(**) as detailed in Bibliography [6] and according to Table 5.

Table 5 Power voltage variation tests

Environmental phenomena	Test specification	Test setup
Voltage variation	Reference voltage	IEC 61000-4-11
	Reference voltage + 10 %	
	Reference voltage – 15 %	
	Reference voltage	
The reference voltage (rated voltage) shall be as defined in IEC 61000-4-11 section 5. Refer to Bibliography [6] for specific parts of the IEC test.		

Supplementary information to the IEC test procedures:

Object of the test:	To verify compliance with the provisions given in 2.8.2 under conditions of voltage variations.
Test procedures in brief	
Precondition:	None required.
Condition of the EUT:	Normal power supplied 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. If it has an automatic zero-setting function then the instrument should be set to zero after applying each level of voltage.
Number of test cycles:	At least one cycle.

(**) Or the most recent issue of the publication valid at the time of testing the instrument.

Weighing test:	The EUT shall be tested with a test load approximately equal to the minimum capacity, and one load between $^{1}/_{2}$ Max and Max. Zero-setting function shall be in operation.
Test sequence:	Stabilize the power supply at the reference voltage within the defined limits and apply the test load. Record the following data: a) Date and time; b) Temperature; c) Power supply voltage; d) Test load; e) Indications (as applicable); f) Errors; g) Functional performance. Repeat the test weighing for each of the voltages defined in IEC 61000-4-11 in section 5 (noting the need in certain cases to repeat the test weighing at both ends of the voltage range) and record the indications.
Maximum allowable variations:	All functions shall operate as designed. All errors shall be within the MPEs specified in 2.5.

A.6.2.5 Tilting

Note: This test only applies to instruments that will not be permanently installed. This test is not required for mobile instruments with a level indicator if it can be established that the tilt can be adjusted to 1 % or less as specified in 2.8.4.

Test method:	Static tests whilst the EUT is tilted.
Object of the test:	To verify compliance with the provisions given in 2.8.4.
Test procedure in brief:	The test consist of tilting the EUT both forwards and backwards, longitudinally and from side to side (transversely), while observing the weight indications for a static test load.
Test severity:	Two test loads at Min and Max at a tilt of 5 %.
Maximum allowable variations:	All indications shall be within MPEs specified in 2.5.
Condition of the EUT:	Normal power supplied and “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. Adjust the EUT in its reference position (not tilted) as close to zero indication as practicable. If the instrument is provided with automatic zero-setting it shall not be in operation.
Test sequence:	Record the zero indication. Apply the test load approximately equal to the Max and record the indication. Remove the test load. Tilt the EUT longitudinally to the appropriate extent and record the zero indication. Apply the test load approximately equal to the Max and record the indication. Remove the test load. Without further adjustment to any control affecting metrological performance tilt the EUT to the appropriate extent in the opposite direction and repeat the static weighing tests as above. Tilt the EUT in the transverse direction to the appropriate extent and repeat the above tests. Tilt the EUT in the opposite direction and repeat the above tests.

Record the following data:

a) Date and time;

b) Test load;

c) Indications at each tilt;

d) Errors;

e) Functional performance.

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

A.6.3 Disturbance tests (in accordance with 4.1.2)

Summary of disturbance tests

§	Test	Condition applied
A.6.3.1	Short time power reduction	Significant fault
A.6.3.2	Electrical bursts (fast transient tests)	Significant fault
A.6.3.3	Electrostatic discharge	Significant fault
A.6.3.4	Electromagnetic susceptibility	Significant fault

A.6.3.1 Short time power reduction

Short time power reduction (voltage dips and short interruptions) tests are carried out in accordance with basic standard IEC Publication 61000-4-11 (2004)(**) as detailed in Bibliography [7] and according to Table 6.

Table 6 Short time power reduction tests

Environmental phenomena	Test specification	Test setup
Voltage dips and short interruptions	Interruption from reference voltage to zero voltage for one half cycle. Interruption from reference voltage to 50 % of reference voltage for two half cycles. These mains voltage interruptions shall be repeated ten times with a time interval of at least 10 seconds.	IEC 61000-4-11
The reference voltage (rated voltage) shall be as defined in section 5. Refer to Bibliography [7] for specific parts of the IEC test.		

Supplementary information to the IEC test procedures:

Object of the test: To verify compliance with the provisions given in 4.1.2 under conditions of short mains voltage interruptions and reductions while observing the weight indication for a small static load.

Test procedures in brief

Precondition: None required.

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

(**) **Or the most recent issue of the publication valid at the time of testing the instrument.**

	Adjust the EUT as close to zero indication as practicable, prior to the test. Zero-setting functions shall not be in operation. Not to be adjusted or readjusted at any time during the test except the reset if a significant fault has been indicated.
Number of test cycles:	At least one cycle.
Weighing test and test sequence:	The EUT shall be tested with one small static test load. Stabilize all factors at nominal reference conditions. Apply the test load and record the following data: a) Date and time; b) Temperature; c) Power supply voltage; d) Test load; e) Indications; f) Errors; g) Functional performance. Interrupt the power supply to zero voltage for a period equal to one half cycle 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. Reduce the power supply to 50 % of nominal voltage for a period equal to two half cycles and conduct the test as detailed in IEC 61000-4-11 section 8.2.1 during reductions observe the effect on the EUT and record, as appropriate.
Maximum allowable variations:	The difference between the weight indication due to the disturbance and the indication without the disturbance either shall not exceed the significant fault value specified in T.4.2.6, or the EUT shall detect and act upon a significant fault.

A.6.3.2 Electrical bursts (fast transient tests)

Electrical bursts tests (fast transient tests) are carried out in accordance with basic standard IEC 61000-4-4 (2004)(**), for 2 minutes with a positive polarity and for 2 minutes with a negative polarity as detailed in Bibliography [5] and according to Tables 7.1, 7.2 and 7.3.

Table 7.1 Ports for signal lines and control lines

Environmental phenomena	Test specification	Test setup
Fast transient common mode	0.5 kV (peak) 5/50 ns T_1 / T_h 5 kHz repetition frequency	IEC 61000-4-4
Note: Applicable only to ports or interfacing with cables whose total length may exceed 3 m according to the manufacturer's functional specification.		

Table 7.2 Input and output DC power ports

Environmental phenomena	Test specification	Test setup
Fast transient common mode	1 kV (peak) 5/50 ns T_1 / T_h 5 kHz repetition frequency	IEC 61000-4-4
Note: Not applicable to battery operated appliances that cannot be connected to the mains while in use.		

(**) **Or the most recent issue of the publication valid at the time of testing the instrument.**

Table 7.3 Input and output AC power ports

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

A coupling/decoupling network shall be applied for testing AC power ports.

Supplementary information to the IEC test procedures:

Object of the test: To verify compliance with the provisions given in 4.1.2 under conditions where electrical bursts (fast transients) are superimposed on the mains voltage while observing the weight indication for one small static test load.

Test procedures in brief

Precondition: None required.

Condition of the EUT: Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Reset the EUT if a significant fault has been indicated.

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

Weighing test: With the single static load in place record the following with and without the transients:

a) Date and time;

b) Temperature;

c) Test load;

d) Indications (as applicable).

Maximum allowable variations: The difference between the weight indication due to the disturbance and the indication without the disturbance either shall not exceed the significant fault value specified in T.4.2.6, or the instrument shall detect and act upon a significant fault.

A.6.3.3 Electrostatic discharge

Electrostatic discharge tests are carried out in accordance with basic standard IEC 61000-4-2 Ed.1.2 (2001)(**), with test signals and conditions as given in Table 8 and detailed in Bibliography [3].

Table 8 Electrostatic discharge tests

Environmental phenomena	Test specification	Test setup
Electrostatic discharge	8 kV air discharge 6 kV contact discharge	IEC 61000-4-2
Note: 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 s. 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 (2001). Air discharges shall be used where contact discharges cannot be applied. Tests with other (lower) voltages than those given in Table 8 are not required.

(**) **Or the most recent issue of the publication valid at the time of testing the instrument.**

Supplementary information to the IEC test procedures:

Object of the test:	To verify compliance with the provisions given in 4.1.2 under conditions where electrostatic discharges are applied while observing the weight indication for one small static test load.
Test procedures in brief	
Precondition:	None required.
Condition of the EUT:	Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Reset the EUT if a significant fault has been indicated.
Stabilization:	Before any test, stabilize the EUT under constant environmental conditions.
Weighing test:	With the single static load in place, record the following with and without electrostatic discharge: a) Date and time; b) Temperature; c) Test load; d) Indications (as applicable).
Maximum allowable variations:	The difference between the weight indication due to the disturbance and the indication without the disturbance either shall not exceed the significant fault value specified in T.4.2.6, or the instrument shall detect and act upon a significant fault.

A.6.3.4 Electromagnetic susceptibility

A.6.3.4.1 Radiated

Radiated, radio frequency electromagnetic susceptibility tests are carried out in accordance with IEC 61000-4-3 Ed.2.1 (2002)(**) as detailed in Bibliography [4] and according to Table 9.

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 9 Enclosure port

Environmental phenomena	Test specification	Test setup
Radio-frequency electromagnetic field, 1 kHz, 80 % AM	80 MHz to 2 GHz 6 V/m (RMS) on one face, or 3 V/m (RMS) on all faces if fails	IEC 61000-4-3

Supplementary information to the IEC test procedures:

Object of the test:	To verify compliance with the provisions given in 4.1.2 under conditions of specified electromagnetic fields applied while observing the weight indication for one small static test load.
Test procedures in brief	
Precondition:	None required.
Condition of the EUT:	Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Reset the EUT if a significant fault has been indicated.

(**) **Or the most recent issue of the publication valid at the time of testing the instrument.**

Stabilization:	Before any test, stabilize the EUT under constant environmental conditions.
Weighing test:	With the single static load in place record the following with and without electromagnetic fields: a) Date and time; b) Temperature; c) Test load; d) Indications (as applicable).
Maximum allowable variations:	The difference between the weight indication due to the disturbance and the indication without the disturbance either shall not exceed the significant fault value in T.4.2.6, or the instrument shall detect and act upon a significant fault.

A.6.3.4.2 Conducted

Conducted, radio frequency, electromagnetic field immunity tests are carried out in accordance with IEC 61000-4-6 (2003)(**) as detailed in Bibliography [8] 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 10 Enclosure port

Environmental phenomena	Test specification	Test setup
Radio-frequency electromagnetic field, 1 kHz, 80 % AM	150 kHz to 80 MHz 3 V (RMS)	IEC 61000-4-6

Coupling and decoupling devices shall be used for appropriate coupling of the disturbing signal (over the entire frequency range, with 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 given in 4.1.2 under conditions of specified conducted electromagnetic fields while observing the weight indication for one static test load.
Test procedures in brief	
Precondition:	None required.
Condition of the EUT:	Normal power supplied and “on” for a time period equal to or greater than the warm-up time specified by the manufacturer. Reset the EUT if a significant fault has been indicated.
Stabilization:	Before any test, stabilize the EUT under constant environmental conditions.
Weighing test:	With the single static load in place record the following with and without electromagnetic fields: a) Date and time; b) Temperature; c) Test load; d) Indications (as applicable).
Maximum allowable variations:	The difference between the weight indication due to the disturbance and the indication without the disturbance either shall not exceed the significant fault value in T.4.2.6, or the instrument shall detect and act upon a significant fault.

(**) Or the most recent issue of the publication valid at the time of testing the instrument.

A.6.4 Disturbances on DC voltage powered instruments (2.8.3)

Electronic measuring systems supplied with DC voltage shall fulfill the:

a) Influence factor tests in A.6.2; and

b) Disturbance tests in A.6.3,

with the exception of:

a) Power voltage variation tests in A.6.2.4;

b) Short time power reduction in A.6.3.1; and

c) Electrical bursts in A.6.3.2,

which are to be replaced by the following provisions.

A.6.4.1 General provision

For under-voltages and over-voltages all errors shall be within the MPEs specified in 2.5 when the instrument is still operating.

The under-voltage or over-voltage is applied for a complete measurement or part of a measurement.

A.7 Span stability test (in accordance with 4.3.3)

Test method:	Span stability.
Object of the test:	To verify compliance with the provisions given in 4.3.3 after the EUT has been subjected to the performance tests.
References to standards:	No references to international standards are given.
Test procedure in brief:	The test consists of observing the variations of error of the EUT under sufficiently constant ambient conditions (reasonably constant conditions in a normal 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. Other performance tests listed in this Annex may be performed. The EUT shall be disconnected from the mains power supply, or battery supply where fitted, two times for at least 8 hours during the period of the test. The number of disconnections may be increased if the manufacturer of the instrument specifies so or at the discretion of the approved authority in the absence of any such 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 5 hours, and at least 16 hours after the temperature and damp heat tests have been performed.
Test severities:	Test duration: 28 days or over the period necessary for the conduct of the performance tests, whichever is less.
Time t (days) between tests:	$0.5 \le t \le 10$
Test load:	A static test load near Max; the same test weights shall be used throughout the test.
Maximum allowable variations:	The variation in the indication of the test load shall not exceed half of the absolute value of the MPE for influence factor tests (2.5) for the test load applied on any of the (n) tests conducted.

Number of tests (n):	$n \geq 8$. If the test results indicate a trend more than half the permissible variation specified above, conduct additional tests until the trend comes to rest or reverses itself, or until the error exceeds the maximum permissible variation.
Precondition:	None required.
Test equipment:	Verified mass standards.
Condition of the EUT:	Adjust the EUT as close to zero indication as practicable before each test.
Test sequence:	Stabilize all factors at nominal reference conditions. If the instrument is provided with automatic zero-setting it shall not be in operation. Apply the test load (or simulated load) and record the following data: a) Date and time; b) Temperature; c) Barometric pressure; d) Relative humidity; e) Test load; f) Indication; g) Errors; h) Changes in test location. Apply all necessary corrections resulting from variations of temperature, pressure, etc. between the various measurements. At the first measurement immediately repeat zeroing and loading four times to determine the average value of error. For the next measurements perform only one, unless either the result is outside the specified tolerance or the range of the five readings of the initial measurement was more than 1/10 of the maximum permissible variation. Repeat this test at periodic intervals during and after the conduct of the various performance tests. Allow full recovery of the EUT before any other tests are performed.

A.8 Procedure for material tests

A.8.1 Material tests at type evaluation (in accordance with 5.2.3.1)

Operational tests with material shall be done on a complete instrument to assess compliance with the requirements of clause 3 with material for the test load as specified in 5.2.3.1.

A.8.1.1 Feeding device (details as given in 3.6)

Check that the feeding device provides a sufficient and regular flow rate.

Check that any adjustable feed device has an indication of the direction of movement corresponding to the sense of the adjustment of the feed (where applicable).

For instruments using the subtractive weighing principle check that residual material retained at the feeding device after each load is delivered, is negligible relative to limits of error.

A.8.1.2 Load receptor (details as given in 3.7)

For instruments that weigh material in a separate load receptor prior to discharge to a container:

- Check that the residual material retained at the load receptor after each discharge is negligible relative to limits of error;
- Check that manual discharge of the load receptor is not possible during automatic operation.

A.8.2 Material tests at initial verification (in accordance with 5.3.2)

Metrological tests with material shall be done on a complete filling instrument, fully assembled and fixed in the position in which it is intended to be used and as specified in 5.3.2.

The accuracy class X(x) (or classes) shall be determined from the results.

A.8.2.1 Requirements for metrological material tests

- Types of loads shall be as specified in 6.2.2;
- Mass of test loads and fills shall be as specified in 6.2.1 a, b and c;
- Condition of material tests shall be as specified in 6.2.3;
- Number of fills shall be as specified in 6.3.

A.8.2.2 Methods for metrological material tests (as given in 6.5)

One of the following verifications methods shall be used:

- Separate verification method: the separate verification method is as defined in 6.5.1;
- Integral verification method: the integral verification method is as defined in 6.5.2.

A.8.2.3 Procedure for metrological material tests

1) Set up the instrument in accordance with the conditions of test given in 6.2.3.
2) Select a preset value for the fill and set the load value if different from the fill, in accordance with values of the mass of the fills as specified in 6.2.1. Record the indicated preset value.
3) Run the instrument to produce a number of fills as specified in 6.3 using types of test loads specified in 6.2.2.
4) Weigh all the fills by either:
   - Separate verification method specified in 6.5.1; or
   - The integral verification method specified in 6.5.2

   to determine the mass of fill in accordance with 6.7 so that the result of weighing the test fill on the control instrument shall be considered as the conventional true value of the test fill.
5) In accordance with 6.7 calculate the average value of all the fills in the test as follows:

   $$\sum F / n$$

   where: F is the mass of the fill (conventional true value), in units of mass; and
   n is the number of fills in the test.
6) In accordance with 6.8 calculate the deviation of each fill from the average of all the fills in the test as follows:

   $$|md| = F - (\sum F / n)$$

   where: md is the deviation from average, in units of mass.
7) Repeat steps 2) to 6) for other loads as specified for values of the mass of the fills in 6.2.1.

A.8.2.4 Determination of accuracy class, X(x) (in accordance with 5.2.5)

1) For each preset value of the test fill, F_P:
   - Calculate the preset value error specified in 2.4 in accordance with 6.9 as follows:

     $$|se| = (\sum F / n) - F_P$$

   where: se is the preset value error.
   - Determine the maximum permissible preset value error for class X(1), $MPSE_{(1)}$ as follows:

     $MPSE_{(1)} = 0.25\ MPD_{(1)}$ for in-service inspection, corresponding to the value of a fill equal to F_P
   - Then calculate: $|se| / MPSE_{(1)}$.

2) For each preset value of the test fill, F_P:
   - Determine the maximum (largest) of the absolute values of the actual deviation from the average i.e. md_{max}.
   - Determine the maximum permissible deviation from the average for class X(1), $MPD_{(1)}$.
   - Then calculate: md_{max} / $MPD_{(1)}$.
3) From 1) determine the maximum (largest) value of $|se|/ MPSE_{(1)}$,

   $$\text{i.e. } [|se| / MPSE_{(1)}]_{max} \text{ from all the preset test fills.}$$
4) From 2) determine the maximum (largest) value of md_{max} / $MPD_{(1)}$,

   $$\text{i.e. } [md_{max} / MPD_{(1)}]_{max} \text{ from all the preset test fills.}$$
5) Determine the accuracy class (x) such that

   $$(x) \geq [|se| / MPSE_{(1)}]_{max}$$
   $$\text{and } (x) \geq [md_{max}/ MPD_{(1)}]_{max}$$
   $$\text{and } (x) = 1 \times 10^k,\ 2 \times 10^k, \text{ or } 5 \times 10^k,$$

   the index k being a positive or negative whole number or zero.

Bibliography

Below are references to Publications of the International Electrotechnical Commission (IEC), where mention is made in some of the tests in Annex A. Use these or the most recent issue of the publication valid at the time of testing the instrument.

[1] IEC Publication 60068-2-1 (1994) with amendment 2: Basic environmental testing procedures. Part 2: Tests, Test Ad: Cold, for heat dissipating equipment under test (EUT), with gradual change of temperature.

IEC Publication 60068-2-2 (1994) with amendment 2: Basic environmental testing procedures, Part 2: Tests, Test Bd: Dry heat, for heat dissipating equipment under test (EUT) with gradual change of temperature.

IEC Publication 60068-3-1 (1974): Background information, Section 1: Cold and dry heat tests.

[2] IEC Publication 60068-2-78 (2001): Environmental testing, Part 2: Tests, Test Cb: Damp heat, steady state. Primarily for equipment.

IEC Publication 60068-3-4 (2001): Environmental testing, Part 3-4: Supporting documentation and guidance for damp heat tests.

[3] IEC Publication 61000-4-2 Ed.1.2 (2001) Consolidated Edition: Electromagnetic Compatibility (EMC), Part 4: Testing and measurement techniques - Section 2: Electrostatic discharge immunity test.

[4] IEC Publication 61000-4-3 (2002): with amendment 1: Electromagnetic Compatibility (EMC), Part 4: Testing and measurement techniques - Section 3: Radiated, radio-frequency, electromagnetic field immunity test.

[5] IEC Publication 61000-4-4 (2004): Electromagnetic Compatibility (EMC), Part 4: Testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test.

[6] IEC Publication 61000-4-11 (2004): Electromagnetic compatibility (EMC), Part 4: Testing and measurement techniques - Section 11: Voltage dips, short interruptions and voltage variations immunity tests. Section 5.2 (Test levels - Voltage variation). Section 8.2.2 (Execution of the test-voltage variation).

[7] IEC Publication 61000-4-11 (2004): Electromagnetic compatibility (EMC), Part 4: Testing and measurement techniques - Section 11: Voltage dips, short interruptions and voltage variations immunity tests. Section 5.1 (Test levels - Voltage dips and short interruptions). Section 8.2.1 (Execution of the test-voltage dips and short interruptions).

[8] IEC Publication 61000-4-6 (2003): Electromagnetic Compatibility (EMC) Part 4: Testing and measurement techniques - Section 6: Immunity to conducted disturbances, induced by radio-frequency field.

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