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EXPLANATORY NOTE

OIML TC 9/SC 2 *Automatic weighing instruments*

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~~0 TERMINOLOGY (terms and definitions)~~

~~The terminology used in this Recommendation conforms to the *International Vocabulary of Basic and General Terms in Metrology* (VIM) [1], the *International Vocabulary of Legal Metrology* (VIML) [2], the *OIML B 3 Basic Certificate System for OIML Type Evaluation of Measuring Instruments* [3], the *OIML D 11 General requirements for Electronic Measuring Instruments* [4], the OIML R 76 *Non automatic weighing instruments* [7], and to the *OIML D 31 General requirements for software controlled measuring instruments* [23]. In addition, for the purposes of this Recommendation, the following definitions apply.~~

~~0.1 general definitions~~

~~0.1.1 mass~~

~~physical quantity, which can be ascribed to any material object and which gives a measure of its quantity of matter OIML D 28 [25]~~

~~0.1.1.1 particle mass~~

~~particle mass is a small localized object to which can be ascribed physical or chemical properties such as volume or mass.~~

~~0.1.2 load (*L*)~~

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

~~0.1.3 fill *(F)*~~

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

~~0.1.4 weight~~

~~quantity representing the force resulting from the effect of gravity on a load.~~NOTE: In this Recommendation “mass” (or “weight value”) is preferably used in the sense of “conventional mass” or “conventional value of the result of weighing in air” according to OIML R 111 [5] and OIML D 28 [25], whereas “weight” is preferably used for an embodiment (= material measure) of mass that is regulated in regard to its physical and metrological characteristics.

~~0.1.5 weighing~~

~~process of determining the mass of a load using the effect of gravity on that load.~~

~~0.1.6 weighing instrument~~

~~measuring instrument used to determine the mass of a body by using the action of gravity on the body.~~

~~NOTE: In this Recommendation “mass” (or “weight value”) is preferably used in the sense of “conventional mass” or “conventional value of the result of weighing in air” according to OIML R 111 [5] and OIML D 28 [25], whereas “weight” is preferably used for an embodiment (= material measure) of mass that is regulated in regard to its physical and metrological characteristics.~~

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

~~0.1.7 measurement result~~
~~result of measurement~~

~~set of quantity values being attributed to a meas-urand together with any other available relevant information~~

~~0.1.8 metrologically relevant device~~

~~any device, module, part, component or function of a weighing instrument that may influence the weighing result or any other primary indication is considered as metrologically relevant.~~

~~0.1.9 audit trail~~

~~continuous data file containing a time stamped information record of events, e.g. changes in the values of the parameters of a device or software updates, or other activities that are legally relevant and which may influence the metrological characteristics. OIML D 31~~

~~0.2 categories of instruments~~

~~0.2.1 automatic weighing instrument~~

~~weighing instrument operating without the intervention of an operator and /or follows a predetermined program of automatic process characteristic of the instrument.~~

~~0.2.2 automatic gravimetric filling instrument (AGFI)~~

~~automatic weighing instrument intended to fill containers with a predetermined and virtually constant mass of product from bulk (including liquid material) by automatic weighing, and which comprises essentially automatic feeding device(s)associated with weighing module(s) and the appropriate control and discharge devices.~~

~~0.2.2.1 associative (selective combination) weigher~~

~~AGFI comprising one or more weighing modules and which computes an appropriate combination of the loads and combines them to a fill.~~

~~0.2.2.2 cumulative weigher~~

~~AGFI comprising one weighing module with the facility to apply more than one weighing cycle for the composition of the desired fill.~~

~~0.2.2.3 subtractive weigher~~

~~AGFI for which the fill is determined by controlling the output feed from the weigh hopper.~~

~~0.2.2.4 control instrument~~

~~weighing instrument used to determine the mass of the test fill(s) delivered by the AGFI.~~

~~The control instrument used during testing may be:~~

~~a) separate, from the instrument being tested~~

~~**b)** integral, the instrument being tested is used as the control instrument~~

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~~**0.3 construction**~~

~~NOTE: In this Recommendation the term "device" is applied to any part of the AGFI which uses any means to perform one or more specific functions irrespective of the physical realisation e.g. by a mechanism or a key initiating an operation; the device may be a small part or a major portion of theAGFI.~~

~~**0.3.1 principal parts**~~

~~**0.3.1.1 weighing module**~~

~~device which provides information on the mass of the load to be measured. This device may consist of all or part of a non-automatic weighing instrument.~~

~~**0.3.1.2 load receptor**~~

~~part of the instrument intended to receive the load.~~

~~**0.3.1.3 feeding device**~~

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

~~**0.3.1.4 control device**~~

~~device that control the operation of the feeding process. The devices may incorporate software functions.~~

~~**0.3.1.4.1 feed control device**~~

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

~~**0.3.1.4.2 fill setting device**~~

~~device which allows the setting of the preset value of the fill.~~

~~**0.3.1.4.3 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.~~

~~**0.3.1.4.4 correction device**~~

~~device which automatically corrects the setting of the AGFI.~~

~~**0.3.2 electronic parts**~~

~~0.3.2.1 **electronic instrument**~~

~~instrument equipped with electronic devices~~

~~0.3.2.2 **electronic device**~~

~~device employing electronic sub-assemblies and performing a specific function. Electronic devices are usually manufactured as separate units and are capable of being independently tested. OIML D 11, 3.2 [4]~~

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

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

~~0.3.3 **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 may additionally display:~~

1. ~~the difference between mass of a load and a reference value~~
2. ~~the value of the fill(s) and /or related quantities or parameters of a number of consecutive weighings.~~

~~0.3.4 **zero-setting device**~~

~~device for setting the indication to zero when there is no load on the load receptor. OIML R76, T.2.7.2 [7]~~

~~0.3.4.1 **non-automatic zero-setting device**~~

~~device for setting the indication to zero by an operator. OIML R76, T.2.7.2.1 [7]~~

~~0.3.4.2 **semi-automatic zero-setting device**~~

~~device for setting the indication to zero automatically following a manual command. OIML R76, T.2.7.2.2 [7]~~

~~0.3.4.3 **automatic zero-setting device**~~

~~device for setting the indication to zero automatically without the intervention of an operator.OIML R76, T.2.7.2.3 [7]~~

~~0.3.4.4 **initial zero-setting device**~~

~~device for setting the indication to zero automatically at the time the instrument is switched on and before it is ready for use. OIML R76, T.2.7.2.4 [7].~~

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~~**0.3.4.5 zero-tracking device**~~

~~device for maintaining the zero indication within certain limits automatically.~~
~~OIML R76, T.2.7.3 [7]~~

~~**0.3.5 tare device**~~

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

- ~~a) without altering the weighing range for net loads (additive tare device), or~~
- ~~b) reducing the weighing range for net loads (subtractive tare device).~~

~~The tare device may function as:~~

- ~~a) a non-automatic device (load balanced by operator),~~
- ~~b) a semi-automatic device (load balanced automatically following a single manual command),~~
- ~~c) an automatic device (load balanced automatically without the intervention of an operator).~~

~~OIML R76, T.2.7.4 [7]~~

~~**0.3.6 software**~~

~~**0.3.6.1 legally relevant software**~~

~~part of the applied software that is subject to legal control. VIML, 6.10 [2]~~

~~**0.3.6.2 legally relevant parameter**~~

~~parameter of a measuring instrument (electronic) device, sub-assembly, software or a module subject to legal control.~~

~~NOTE: The following types of legally relevant parameters can be distinguished: type-specific parameters and device-specific parameters. VIML, 4.10 [2]~~

~~**0.3.6.3 type-specific parameter**~~

~~legally relevant parameter with a value that depends on the type of instrument only. VIML 4.11, [2]~~

~~NOTE: Type-specific parameters are part of the legally relevant software. Examples of type-specific parameters are: parameters used for weight value calculation, stability analysis or price calculation and rounding, software identification.~~

~~**0.3.6.4 device-specific parameter**~~

~~legally relevant parameter with a value that depends on the individual instrument. VIML 4.12, [2]~~

~~**0.3.6.5 software identification**~~

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~~sequence of readable characters (e.g. version number, checksum) that is inextricably linked to the software or software module under consideration. It can be checked on an instrument while in use. VIML, 6.01 [2]~~

~~0.3.6.6 software separation~~

~~separation of the software in measuring instruments which can be divided into a legally relevant part and a legally non-relevant part. VIML, 6.02 [2]~~

~~0.3.7 data storage device~~

~~storage device used for keeping weighing data ready after completion of the measurement for subsequent indication, data transfer, totalizing, etc.~~

~~0.3.8 interface~~

~~shared boundary between two functional units, defined by various characteristics pertainingto the functions, physical interconnections, signal exchanges, and other characteristicsof the units, as appropriate. OIML D 31, 3.1.27 [23]~~

~~0.3.9 user interface~~

~~interface that enables information to be interchanged between the operator and the measuring instrument or its hardware or software components, e.g. switches, keyboard, mouse, display, monitor, printer, touch-screen, software window on a screen including the software that generates it. VIML 6.15 [2]~~

~~NOTE: Often also designated as "HMI" (human machine interface)~~

~~0.3.10 protective interface~~

~~interface (hardware and/or software) which will only allow the introduction into the instrument of data or instructions that cannot influence the metrological properties of the instrument.~~

~~0.3.11 module~~

~~identifiable part of an instrument or device that performs a specific function or functions, and that can be separately evaluated according to the metrological and technical performance requirements in this Recommendation. OIML B 3, 3.4 [3]~~

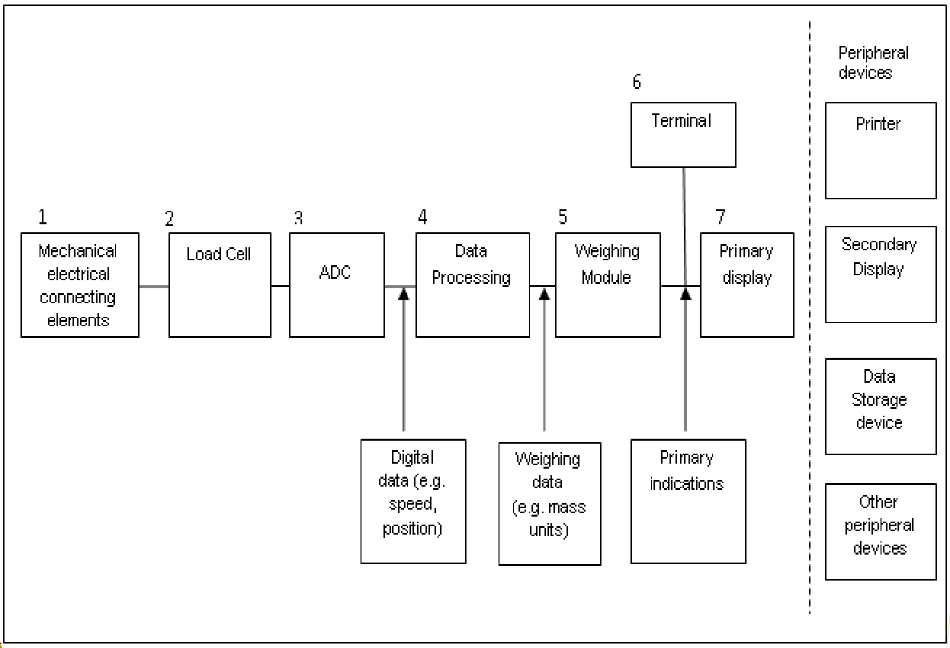
~~NOTE: The modules of the AGFI may be subject to specified partial error limits.~~

~~Typical modules of the AGFI are: load cell, indicator, analogue or digital processors, weighing module, remote display, software.~~

~~Figure 1~~

~~Definition of typical modules according to 0.2.11 and 5.1.6~~

~~(other combinations are possible)~~



~~load cell~~	~~(0.3.11.1)~~	~~2 + 3 + (4)*)~~
~~indicator~~	~~(0.3.11.2)~~	~~(3) + 4 + (5) + (6) + 7~~
~~analogue data processing device~~	~~(0.3.11.3)~~	~~3 + 4 + (5) + (6)~~
~~digital data processing device~~	~~(0.3.11.4)~~	~~(4) + 5 + (6)~~
~~primary display~~	~~(0.3.11.5)~~	~~7~~
~~weighing module~~	~~(0.3.11.6)~~	~~1 + 2 + 3 + 4 + (5) + (6)~~
~~Terminal~~	~~(0.3.11.7)~~	~~(5) + 6 + 7~~

~~*) Numbers in brackets indicate options~~

~~0.3.11.1 load cell~~

~~measuring transducer that, in response to an applied load will produce an output. This output may be converted by another device into measurement units such as mass.~~

~~0.3.11.1.1 load cell equipped with electronics~~

~~load cell employing an assembly of electronic components having a~~

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~~recognizable function of its own.~~

~~NOTE: Load cells equipped with electronics that produce an output in digital form are often referred to as “digital load cells” (see Figure 1).~~

~~0.3.11.2 indicator~~

~~electronic device that may perform the analogue-to-digital conversion of the output signal of the load cell, and further process the data, and display the weighing results.~~

~~0.3.11.3 analogue data processing device~~

~~electronic device that performs the analogue-to-digital conversion of the output signal of the load cell, and further processes the data, and supplies the weighing result in a digital format via a digital interface without displaying it.~~

~~0.3.11.4 digital data processing device~~

~~electronic device that processes digital data.~~

~~0.3.11.5 primary display~~

~~digital display, either incorporated in the indicator housing, or in the terminal housing or realized as a display in a separate housing (i.e. terminal without keys), e.g. for use in combination with a weighing module.~~

~~0.3.11.6 weighing module~~

~~part providing information on the mass of the load to be measured. It may optionally have devices for further processing (digital) data and operating the AGFI.~~

~~0.3.11.7 terminal~~

~~digital device equipped with operator interface(s) such as a keypad, mouse, touch-screen, etc. used to monitor the operations of the instrument. Also equipped with a display to provide feedback to the operator, such as: weighing results; belt speed; flow rate; etc. transmitted via the digital interface of a weighing module or an analogue data processing device.~~

~~0.4 metrological characteristics~~

~~0.4.1 scale interval (d)~~

~~value, expressed in units of the measured quantity of the difference between:~~

- ~~a) the values corresponding to two consecutive scale marks for analogue indication, or~~
- ~~b) two consecutive indicated values for digital indication.~~

~~VIML, 5.01 [2]~~

~~0.4.2 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.~~

~~0.4.3 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.~~

~~0.4.4 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.~~

~~0.4.5 weighing cycle~~

~~the combination of operations including:~~

~~a) delivery of material to the load receptor,~~
~~b) a weighing operation, and~~
~~c) the discharge of a single discrete load~~

~~after the completion of which the AGFI is in its initial state.~~

~~0.4.6 final feed time~~

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

~~0.4.7 minimum capacity (Min)~~

~~smallest discrete load that can be weighed automatically on a load receptor of the AGFI.~~

~~NOTE: For AGFIs which effect the fill by one weighing cycle minimum capacity (Min) is equal to the rated minimum fill (Minfill).~~

~~0.4.8 maximum capacity (Max)~~

~~largest discrete load that can be weighed automatically on a load receptor of the AGFI.~~

~~0.4.9 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 AGFIs which effect the fill by more than one weighing cycle Minfill is larger than the minimum capacity (Min).~~

~~0.4.10 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.~~

~~**0.4.11 static test load**~~

~~load that is used in static tests only.~~

~~**0.4.12 minimum discharge**~~

~~smallest load that can be discharged from a subtractive weigher.~~

~~**0.4.13 warm-up time**~~

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

~~**0.5 indications and errors**~~

~~**0.5.1 indication of a measuring instrument**~~

~~quantity value provided by a measuring instrument or measuring system VIM, 4.1 [1].~~

~~NOTE: "Indication", "indicate" or "indicating" includes both displaying, and/or printing.~~

~~**0.5.1.1 primary indications**~~

~~values of fills, signals and symbols that are subject to the requirements of this Recommendation.~~

~~**0.5.1.2 secondary indications**~~

~~indications, signals and symbols that are not primary indications.~~

~~**0.5.1.3 analogue indication**~~

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

~~**0.5.1.4 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.~~

~~**0.5.1.5 digital display**~~

~~digital display (device) is an output device visualizing actual information in volatile digital format.~~

~~NOTE:A digital display may concern a primary display or a secondary display.~~
~~The terms "primary display" and "secondary display" should not be confused with the terms "primary indication" and "secondary indication" (0.4.1.1 and 0.4.1.2).~~

~~**0.5.1.6 secondary display**~~

~~additional (optional) digital peripheral device, which repeats the weighing result and any other primary indication, or provides further, non-metrological information.~~

~~**0.5.2 error**~~

~~**0.5.2.1 measurement error**~~
~~error of measurement~~
~~error~~

~~measured quantity value minus a reference quantity value. VIM 2.16 [1]~~

~~NOTE 1: The concept of 'measurement error' can be used both:~~

~~a) when there is a single reference quantity value to refer to, which occurs if a calibration is made by means of a measurement standard with a measured quantity value having a negligible measurement uncertainty or if a conventional quantity value is given, in which case the measurement error is known, and~~

~~b) if a measurand is supposed to be represented by a unique true quantity value or a set of true quantity values of negligible range, in which case the measurement error is not known.~~

~~NOTE 2: Measurement error should not be confused with production error or mistake.~~

~~**0.5.2.2 intrinsic error**~~

~~error of a measuring instrument, determined under reference conditions. VIML, 0.06 [2]~~

~~**0.5.2.3 initial intrinsic error**~~

~~intrinsic error of a measuring instrument as determined prior to performance tests and durability evaluations VIML 5.10 [2]~~

~~**0.5.2.4 maximum permissible measurement error (MPME)**~~
~~**maximum permissible error (MPE)**~~

~~extreme value of measurement error, with respect to a known reference quantity value, permitted by specifications or regulations for a given measurement, measuring instrument, or measuring system~~

~~NOTE: usually, the term "maximum permissible errors" or "limits of error" is used where there are two extreme values.~~
~~the term "tolerance" should not be used to designate 'maximum permissible error'. VIM 4.26 [1]~~

~~**0.5.2.4.1 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.~~

~~**0.5.2.4.2 maximum permissible preset value error (MPSE)**~~

~~maximum permissible setting error for each preset value of the fill.~~

~~**0.5.2.4.3 maximum permissible error for influence factor tests**~~

~~maximum permissible error for weighing results during influence factor tests.~~

~~**0.5.2.5 fault**~~

~~difference between the error of indication and instrinsic error of a measuring instrument. OIML D11, 3.9 [4]~~

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

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

~~**0.5.2.6 significant fault**~~

~~fault greater than 0.25 MPD~~

~~NOTE: For each fill, the value of 0.25 MPD is that appropriate to each fill for in-service inspection (see4.2.1), equal to the minimum capacity or rated minimum fill.~~

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

~~a) faults arising from simultaneous and mutually independent causes in the AGFI,~~
~~b) faults that imply it is impossibile to perform a measurement~~
~~c) faults that are so serious that they will inevitably be noticed by those interested in the measurement,~~
~~d) 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 AGFIs where the fill may be greater than one load, the value of the significant fault applicable for a test on a static load shall be calculated in accordance with the test procedures in A.6.1.3. Adapted from OIML D11, 3.12 [4]~~

~~**0.5.2.7 span stability**~~

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

~~**0.5.3 reference value for accuracy class (Ref(x))**~~

~~value for accuracy class determined by static testing of the weighing module during influence quantity testing at type evaluation stage. Ref(x) is equal to the best accuracy class for which the AGFI may be verified for operational use.~~

~~**0.6 influences and reference conditions**~~

~~**0.6.1 influence quantity**~~

~~quantity that, in a direct measurement, does not affect the quantity that is actually measured, but affects the relation between the indication and the measurement result VIM 2.52 [1]~~

~~**0.6.1.1 influence factor**~~

~~influence quantity having a value within the rated operating conditions of a measuring instrument specified in this recommendation. VIML, 5.15 [2]~~

~~**0.6.1.2 disturbance**~~

~~influence quantity having a value within the limits specified in this Recommendation but outside the rated operating conditions of the measuring instrument. VIML, 5.16 [2]~~

~~**0.6.2 rated operating conditions**~~

~~operating condition that must be fulfilled during measurement in order that a measuring instrument or measuring system perform as designed. VIM, 4.9 [1]~~

~~NOTE: Rated operating conditions generally specify intervals of values for a quantity being measured and for any influence quantity.~~

~~**0.6.3 reference conditions**~~

~~operating condition prescribed for evaluating the performance of a measuring instrument or measuring system or for comparison of measurement results. VIM 4.11 [1]~~

~~NOTE 1: Reference operating conditions specify intervals of values of the measurand and of the influence quantities.~~
~~NOTE 2: In IEC 60050-300, item 311-06-02, the term "reference condition" refers to an operating condition under which the specified instrumental measurement uncertainty is the smallest possible.~~

~~**0.7 tests**~~

~~**0.7.1 material test**~~

~~test carried out on a complete AGFI using the type of material which it is intended to weigh.~~

~~**0.7.2 simulation test**~~

~~test carried out on a complete AGFI or part of the AGFI in which any part of the weighing operation is simulated.~~

~~**0.7.3 performance test**~~

~~test to verify whether the equipment under test (EUT) is able to accomplish its intended functions. VIML, 5.18 [2]~~

~~**0.7.4 span stability test**~~

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

~~**0.8 Abbreviations and Symbols**~~

~~*I* = Indication~~
~~*In* = *n*th indication~~
~~*L* = Load~~
~~*ΔL* = Additional load to next changeover point~~
~~*P* = *I* + ½ *d* – *ΔL* = Indication prior to rounding (digital indication)~~
~~*E* = *I* – *L* or *P* – *L* = Error~~
~~*F* = Mass of fill~~
~~F_p = Preset value of fill~~
~~*P*i = Fraction of the MPE (1) applicable to one part of the instrument which is examined separately~~
~~(x) = Class designation factor~~
~~MPE = Maximum permissible error (absolute value)~~
~~EUT = Equipment under test~~
~~MPE(1) = Maximum permissible error for influence factor tests for class X(1)~~
~~se = Preset value error (setting error)~~
~~MPSE(1) = Maximum permissible preset value error for class X(1)~~
~~*md*max = Maximum of the actual deviations of each fill from the average of all fills~~
~~MPD(1) = Maximum permissible deviation of each fill from the average for class X(1)~~
~~*mpΔz*(1) = Maximum permissible zero change per 5 °C for class X(1)~~
~~AGFI = Automatic gravimetric filling instrument~~

~~*P* = *I* + ½ *d* – *ΔL* = Indication prior to rounding (digital indication)~~
~~*E* = *I* – *L* or *P* – *L* = Error~~

PART 1 – METROLOGICAL AND TECHNICAL REQUIREMENTS

1 Introduction

This OIML Recommendation consists of 3 parts:

Part 1: Metrological and Technical Requirements;
Part 2: Metrological Controls and Performance Tests;
Part 3: Report Format for Type Evaluation.

Parts 1 and 2 are a combined publication and Part 3 is a separate publication

2 Scope

This International Recommendation specifies the metrological and technical requirements, metrological controls and tests for automatic gravimetric filling instruments (hereafter referred to as “AGFI(s)”) 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 AGFIs for which this Recommendation is applicable.
NOTE 2: AGFIs may also be required to comply with other OIML Recommendations.

~~For example, AGFIs which, in normal use, could be operated in non-automatic mode will need to comply with OIML R 76 [7], and fills less than or equal to 25 kg will need to comply with OIML R 87 [24].~~

3 Terms and Definitions

The terminology used in this Recommendation conforms to the *International Vocabulary of Basic and General Terms in Metrology* (VIM) [1], the *International Vocabulary of Legal Metrology* (VIML) [2], the *OIML D 11 General requirements for Electronic Measuring Instruments* [3], the OIML R 76 *Non-automatic weighing instruments* [6], and to the *OIML D 31 General requirements for software controlled measuring instruments* [29]. In addition, for the purposes of this Recommendation, the following definitions apply.

3.1 general definitions

3.1.1 mass

physical quantity, which can be ascribed to any material object and which gives a measure of its quantity of matter OIML D 28 [22]

3.1.1.1 **reference~~particle~~ mass**

~~Particle mass is a~~ small localized material object to which can be ascribed properties ~~physical or chemeical~~ properties such as volume or mass.

3.1.2 load (*L*)

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

3.1.3 fill *(F)*

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

3.1.4 weight

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

NOTE: In this Recommendation “mass” (or “weight value”) is preferably used in the sense of “conventional mass” or “conventional value of the result of weighing in air” according to OIML R 111 [4] and OIML D 28 [22], whereas “weight” is preferably used for an embodiment (= material measure) of mass that is regulated in regard to its physical and metrological characteristics.

3.1.5 weighing

process of determining the mass of a load using the effect of gravity on that load.

3.1.6 weighing instrument

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

According to its method of operation, a weighing instrument is classified as an automatic (3.2.1) or non-automatic instrument.

3.1.7 measurement result

result of measurement

set of quantity values being attributed to a measurand together with any other available relevant information

3.1.8 metrologically relevant device

any device, module, part, component or function of an instrument that may influence the weighing result or any other primary indication is considered as metrologically relevant.

3.1.9 audit trail

continuous data file containing a time stamped information record of events, e.g. changes in the values of the parameters of a device or software updates, or other activities that are legally relevant and which may influence the metrological characteristics. Refer to OIML D 31 [29], for further details.

3.2 categories of instruments

3.2.1 automatic weighing instrument

weighing instrument operating without the intervention of an operator and following a predetermined program of automatic processes characteristic for the instrument.

3.2.2 automatic gravimetric filling instrument (AGFI)

automatic weighing instrument intended to fill containers with a predetermined and virtually constant mass of product from bulk (including liquid material) by automatic weighing, and which comprises essentially automatic feeding device(s) associated with weighing module(s) and the appropriate control and discharge devices.

3.2.2.1 associative (selective combination) weigher

AGFI comprising one or more weighing modules and which computes an appropriate combination of the loads and combines them to a fill.

3.2.2.2 cumulative weigher

AGFI comprising one weighing module with the facility to apply more than one weighing cycle for the composition of the desired fill.

3.2.2.3 subtractive weigher

AGFI for which the fill is determined by controlling the output feed from the weigh hopper.

3.2.2.4 control instrument

weighing instrument used to determine the mass of the test fill(s) delivered by the AGFI.

The control instrument used during testing may be:

a) separate, from the instrument being tested

b) integral, the instrument being tested is used as the control instrument

3.3 construction

NOTE: In this Recommendation the term “device” is applied to any part of the AGFI which uses any means to perform one or more specific functions irrespective of the physical realisation e.g. by a mechanism or a key initiating an operation; the device may be a small part or a major portion of the AGFI.

3.3.1 principal parts

~~**weighing module**~~

~~device which provides information on the mass of the load to be measured that may consist of all or part of a non-automatic weighing instrument.~~

3.3.1.1 load receptor

part of the instrument intended to receive the load.

3.3.1.2 feeding device

device which provides a supply of product from bulk to the weighing module that may operate in one or more stages.

3.3.1.3 control device

device that control the operation of the feeding process and may incorporate software functions.

3.3.1.3.1 feed control device

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

3.3.1.3.2 fill setting device

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

3.3.1.3.3 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 and may include an adjustable compensation for the material in flight.

3.3.1.3.4 correction device

device which automatically corrects the setting of the AGFI.

3.3.2 electronic parts

3.3.2.1 electronic measuring instrument

instrument equipped with electronic devices

3.3.2.2 electronic device

identifiable part of an electronic measuring instrument that performs a specific function OIML D 11(2013).

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

NOTE 2: An electronic device can be a module in the sense that this term is used in OIML V1 International vocabulary of terms in legal metrology (VIML) (2013) 4.04 [2].

3.3.3 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 may additionally display:

- the difference between mass of a load and a reference value
- the value of the fill(s) and /or related quantities or parameters of a number of consecutive weighings.

3.3.4 zero-setting device

device for setting the indication to zero when there is no load on the load receptor. Refer to OIML R 76 [6], for further details.

3.3.4.1 non-automatic zero-setting device

device for setting the indication to zero by an operator. Refer to OIML R 76 [6], for further details.

3.3.4.2 semi-automatic zero-setting device

device for setting the indication to zero automatically following a manual command. Refer to OIML R 76 [6], for further details.

3.3.4.3 automatic zero-setting device

device for setting the indication to zero automatically without the intervention of an operator. Refer to OIML R 76 [6], for further details.

3.3.4.4 initial zero-setting device

device for setting the indication to zero automatically at the time the instrument is switched on and before it is ready for use. Refer to OIML R 76 [6], for further details.

3.3.4.5 zero-tracking device

device for maintaining the zero indication within certain limits automatically. Refer to OIML R 76 [6], for further details

3.3.5 tare

3.3.5.1 tare device

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

a) without altering the weighing range for net loads (additive tare device), or
b) reducing the weighing range for net loads (subtractive tare device).

The tare device may function as:

a) a non-automatic device (load balanced by operator),
b) a semi-automatic device (load balanced automatically following a single manual command),
c) an automatic device (load balanced automatically without the intervention of an operator).

3.3.5.2 preset tare device

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

3.3.5.2 preset tare value, PT

Numerical value, representing a weight, that is introduced into the instrument and is intended to be applied to other weighings without determining individual tares.
“Introduced” includes procedures such as: keying in, recalling from a data storage device, or inserting via an interface. Refer to OIML R 76 [6], for further details

3.3.6 software

3.3.6.1 legally relevant software

part of the applied software that is subject to legal control. VIML, 6.10 [2]

3.3.6.2 legally relevant parameter

parameter of a measuring instrument (electronic) device, sub-assembly, software or a module subject to legal control.

NOTE: The following types of legally relevant parameters can be distinguished: type-specific parameters and device-specific parameters. VIML, 4.10 [2]

3.3.6.3 type-specific parameter

legally relevant parameter with a value that depends on the type of instrument only. VIML 4.11 [2]

NOTE: Type-specific parameters are part of the legally relevant software. Examples of type-specific parameters are: parameters used for weight value calculation, stability analysis or price calculation and rounding, software identification.

3.3.6.4 device-specific parameter

legally relevant parameter with a value that depends on the individual instrument. VIML 4.12 [2]

3.3.6.5 software identification

sequence of readable characters (e.g. version number, checksum) that is inextricably linked to the software or software module under consideration. It can be checked on an instrument while in use. VIML, 6.01 [2]

3.3.6.6 software separation

separation of the software in measuring instruments which can be divided into a legally relevant part and a legally non-relevant part. VIML, 6.02 [2]

3.3.7 data storage device

storage device used for keeping weighing data ready after completion of the measurement for subsequent indication, data transfer, totalizing, etc.

3.3.8 interface

shared boundary between two functional units, defined by various characteristics pertainingto the functions, physical interconnections, signal exchanges, and other characteristicsof the units, as appropriate. Refer to OIML D 31 [29], for further details.

3.3.9 user interface

interface that enables information to be interchanged between the operator and the measuring instrument or its hardware or software components, e.g. switches, keyboard, mouse, display, monitor, printer, touch-screen, software window on a screen including the software that generates it. VIML 6.08 [2]

NOTE: Often referred to as “HMI” (human machine interface)

3.3.10 protective interface

interface (hardware and/or software) which will only allow the introduction into the instrument of data or instructions that cannot influence the metrological properties of the instrument.

3.3.11 module

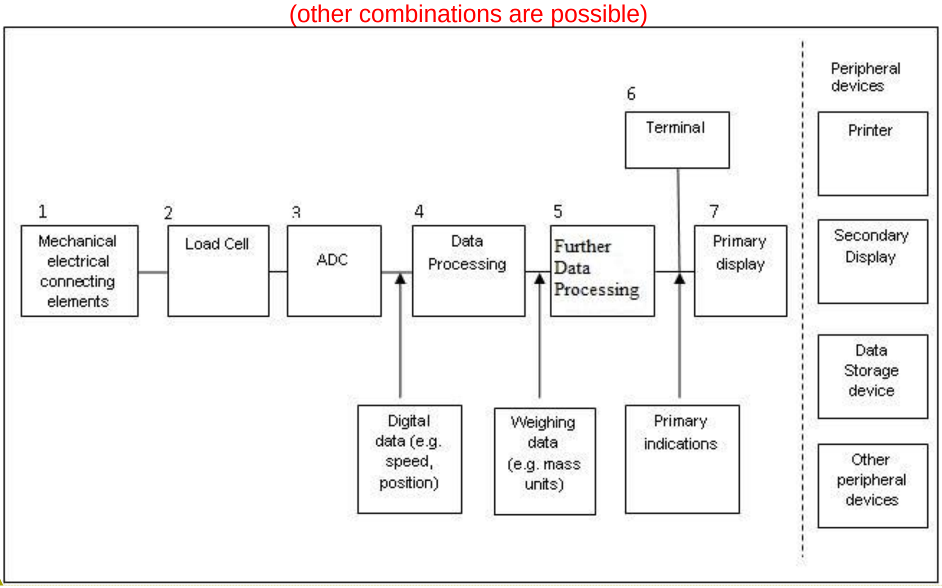
identifiable part of an instrument or device that performs a specific function or functions, and that can be separately evaluated according to the metrological and technical performance requirements in this Recommendation. VIML 4.04 [2]

NOTE: The modules of the AGFI may be subject to specified partial error limits.

Typical modules of the AGFI are: load cell, indicator, analogue or digital processors, weighing module, remote display, software.

Figure 1

Definition of typical modules according to 3.2.11 and 5.1.6
(other combinations are possible)



load cell	(3.3.11.1)	2 + 3 + (4)*)
indicator	(3.3.11.2)	(3) + 4 + (5) + (6) + 7
analogue data processing device	(3.3.11.3)	3 + 4 + (5) + (6)
digital data processing device	(3.3.11.4)	(4) + 5 + (6)
primary display	(3.3.11.5)	7
Terminal	(3.3.11.6)	(5) + 6 + 7
weighing module	(3.3.11.7)	1 + 2 + 3 + 4 + (5) + (6)

*) Numbers in brackets indicate options

3.3.11.1 load cell

measuring transducer that, in response to an applied load will produce an output. This output may be converted by another device into measurement units such as mass. Refer to OIML R 60 [5], for further details.

3.3.11.1.1 load cell equipped with electronics

Formatted: Font: (Default) Arial, 11 pt, Font color: Auto load cell employing an assembly of electronic components having a recognizable function of its own.

NOTE: Load cells equipped with electronics that produce an output in digital form are often referred to as “digital load cells” (see Figure 1). Refer to OIML R 60 [5], for further details.

3.3.11.2 indicator

electronic device that may perform the analogue-to-digital conversion of the output signal of the load cell, and further process the data, and display the weighing results.

3.3.11.3 analogue data processing device

electronic device that performs the analogue-to-digital conversion of the output signal of the load cell, and further processes the data, and supplies the weighing result in a digital format via a digital interface without displaying it.

3.3.11.4 digital data processing device

electronic device that processes digital data.

3.3.11.5 primary display

digital display, either incorporated in the indicator housing, or in the terminal housing or realized as a display in a separate housing (i.e. terminal without keys), e.g. for use in combination with a weighing module.

3.3.11.6 terminal

digital device equipped with operator interface(s) such as a keypad, mouse, touch-screen, etc. used to monitor the operations of the instrument. Also equipped with a display to provide feedback to the operator, such as: weighing results; belt speed; flow rate; etc. transmitted via the digital interface of a weighing module or an analogue data processing device.

3.3.11.7 weighing module

device which provides information on the mass of the load to be measured that may consist of all or part of a non-automatic weighing instrument.

3.4 metrological characteristics

3.4.1 scale interval (d)

value, expressed in units of the measured quantity of the difference between:

a) the values corresponding to two consecutive scale marks for analogue indication, or
b) two consecutive indicated values for digital indication.

VIML, 5.01 [2]

3.4.2 reference ~~particle~~ mass of a product

object having a mass equal to the mean of ten of the largest ~~particles or~~ pieces of the product taken from one or more fills.

3.4.3 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.

3.4.4 static set point

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

3.4.5 weighing cycle

the combination of operations including:

a) delivery of material to the load receptor,
b) a weighing operation, and
c) the discharge of a single discrete load

after the completion of which the AGFI is in its initial state.

3.4.6 final feed time

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

3.4.7 minimum capacity (Min)

smallest discrete load that can be weighed automatically on a load receptor of the AGFI.

NOTE: For AGFIs which effect the fill by one weighing cycle minimum capacity (Min) is equal to the rated minimum fill (Minfill).

3.4.8 maximum capacity (Max)

largest discrete load that can be weighed automatically on a load receptor of the AGFI.

3.4.9 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 AGFIs which effect the fill by more than one weighing cycle Minfill is larger than the minimum capacity (Min).

3.4.10 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.

3.4.11 static test load

load that is used in static tests only.

3.4.12 minimum discharge

smallest load that can be discharged from a subtractive weigher.

3.4.13 warm-up time

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

3.5 indications and errors

3.5.1 indication of a measuring instrument

quantity value provided by a measuring instrument or measuring system VIM, 4.1 [1].

NOTE: “Indication”, “indicate” or “indicating” includes both displaying, and/or printing.

3.5.1.1 primary indications

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

3.5.1.2 secondary indications

indications, signals and symbols that are not primary indications.

3.5.1.3 analogue indication

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

3.5.1.4 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.

3.5.1.5 digital display

digital display (device) is an output device visualizing actual information in volatile digital format.

NOTE 1: A digital display may concern a primary display or a secondary display.

NOTE 2: The terms “primary display” and “secondary display” should not be confused with the terms “primary indication” and “secondary indication” (3.4.1.1 and 3.4.1.2).

3.5.1.6 secondary display

additional (optional) digital peripheral device, which repeats the weighing result and any other primary indication, or provides further, non-metrological information.

3.5.2 error

3.5.2.1 measurement error

measured quantity value minus a reference quantity value. VIM 2.16 [1]

NOTE 1: The concept of 'measurement error' can be used both:

a) when there is a single reference quantity value to refer to, which occurs if a calibration is made by means of a measurement standard with a measured quantity value having a negligible measurement uncertainty or if a conventional quantity value is given, in which case the measurement error is known, and
b) if a measurand is supposed to be represented by a unique true quantity value or a set of true quantity values of negligible range, in which case the measurement error is not known.

NOTE 2: Measurement error should not be confused with production error or mistake.

3.5.2.2 intrinsic error

error of a measuring instrument, determined under reference conditions. VIML, 0.06 [2]

3.5.2.3 initial intrinsic error

intrinsic error of a measuring instrument as determined prior to performance tests and durability evaluations VIML 5.10 [2]

3.5.2.4

maximum permissible error (mpe)

extreme value of measurement error, with respect to a known reference quantity value, permitted by specifications or regulations for a given measurement, measuring instrument, or measuring system

NOTE 1: usually, the term "maximum permissible errors" or "limits of error" is used where there are two extreme values.
NOTE 2: the term "tolerance" should not be used to designate 'maximum permissible error'. VIM 4.26 [1]

3.5.2.4.1 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.

3.5.2.4.2 maximum permissible preset value error (mpse)

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

3.5.2.4.3 maximum permissible error for influence factor tests

maximum permissible error for weighing results during influence factor tests.

3.5.2.5 fault

difference between the error of indication and instrinsic error of a measuring instrument. [VIML 5.12] [2]

NOTE 1: Principally, a fault is the result of an undesired change of data contained in or flowing through an electronic measuring instrument.
NOTE 2: From the definition it follows that a “fault” is a numerical value which is expressed either in a unit of measurement or as a relative value, for instance as a percentage.

3.5.2.6 fault limit

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

3.5.2.7 significant fault

fault exceeding the applicable fault limit value [VIML 5.14]

NOTE: For particular types of measuring instruments some faults exceeding the fault limit may not be considered a significant fault; the applicable Recommendation shall state when such exception applies. For example, the occurrence of one or some of the following faults may be acceptable:

- faults arising from simultaneous and mutually independent causes originating in
- a measuring instrument or in its checking facilities;
- faults implying the impossibility to perform any measurement;
- transitory faults being momentary variations in the indication, which cannot
- be interpreted, memorized or transmitted as a measurement result;
- faults giving rise to variations in the measurement result that are serious enough
- to be noticed by all those interested in the measurement result; the applicable Recommendation may specify the nature of these variations.

3.5.2.7 span stability

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

3.5.3 reference value for accuracy class (Ref(x))

value for accuracy class specified by the manufacturer for the purpose of static testing of the weighing module during influence quantity testing at type evaluation stage. Ref(x) is equal to the best accuracy class for which the AGFI may be verified for operational use.

3.6 influences and reference conditions

3.6.1 influence quantity

quantity that, in a direct measurement, does not affect the quantity that is actually measured, but affects the relation between the indication and the measurement result VIM 2.52 [1]

3.6.1.1 influence factor

influence quantity having a value within the rated operating conditions of a measuring instrument specified in this recommendation. VIML, 5.15 [2]

3.6.1.2 disturbance

influence quantity having a value within the limits specified in this Recommendation but outside the rated operating conditions of the measuring instrument. VIML, 5.16 [2]

3.6.2 rated operating conditions

operating condition that must be fulfilled during measurement in order that a measuring instrument or measuring system perform as designed. VIM, 4.9 [1]

NOTE: Rated operating conditions generally specify intervals of values for a quantity being measured and for any influence quantity.

3.6.3 reference conditions

operating condition prescribed for evaluating the performance of a measuring instrument or measuring system or for comparison of measurement results. VIM 4.11 [1]

NOTE: Reference operating conditions specify intervals of values of the measurand and of the influence quantities.

3.7 tests

3.7.1 material test

test carried out on a complete AGFI using the type of material which it is intended to weigh.

3.7.2 simulation test

test carried out on a complete AGFI or part of the AGFI in which any part of the weighing operation is simulated.

3.7.3 performance test

test to verify whether the equipment under test (EUT) is able to accomplish its intended functions. VIML, 5.18 [2]

3.7.4 span stability test

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

3.8 Abbreviations and Symbols

I	Indication
In	nth indication
L	Load
ΔL =	Additional load to next changeover point
F	Mass of fill
F_P	Preset value of fill
Pi	Fraction of the mpe(1) applicable to one part of the instrument which is examined separately
(x)	Class designation factor
mpe	Maximum permissible error (absolute value)
EUT	Equipment under test
mpe(1)	Maximum permissible error for influence factor tests for class X(1)
se	Preset value error (setting error)
mpse(1)	Maximum permissible preset value error for class X(1)
*md*max	Maximum of the actual deviations of each fill from the average of all fills
mpd(1)	Maximum permissible deviation of each fill from the average for class X(1)
$mp\Delta z$(1)	Maximum permissible zero change per 5 °C for class X(1)
AGFI	Automatic gravimetric filling instrument

3.9 Equations

$P = I + ½\, d – \Delta L$ = Indication prior to rounding (digital indication)
$E = I – L$ or $P – L$ = Error

4 Metrological requirements

~~3~~4.1 Units of measurement

The units of mass include:

a) ~~Milligram~~ milligram (mg),
b) ~~Gram~~ gram (g),
c) ~~Kilogram~~ kilogram (kg), and
d) ~~Tonne~~ tonne (t).

~~4 Metrological requirements~~

~~4.1~~4.2 Accuracy classes

The manufactuerer shall specify the accuracy class, X(x) and reference value for accuracy class, Ref(x) in accordance with the error limitation given in ~~4.2~~4.3 and marked on the AGFI in accordance with the descriptive markings given in 5.12.

Accuracy classes for AGFIs 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 (9.2.1), and operating rate (9.2.3).

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

~~4.2~~4.3 Error ~~limitation~~limits

~~4.2~~4.3.1 Maximum permissible deviation (~~MPD~~mpd) of each fill

At initial verification the AGFI shall comply with accuracy class X(x) specified by the manufacturer, for which the ~~MPD~~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 class designation factor (x) shall be ≤ 2 and in the form 1×10^k, 2×10^k, 5×10^k, k being a positive or negative whole number or zero.

Table 1- Maximum permissible deviation (~~MPD~~mpd) of each fill

Value of the mass of the fills F (g)	~~MPD~~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 ≤ 1000	12 g	15 g
1000 < F ≤ 10000	1.2 %	1.5 %
10000 < F ≤ 15000	120 g	150 g
15000 < F	0.8 %	1 %

(See 9.3 for the number of fills required to determine~~find~~ the average value).

~~4.2~~4.3.2 Maximum permissible error (~~MPE~~mpe) ~~for~~ of static loads for influence factor tests

The AGFI shall have a reference value for accuracy class, Ref(x), applicable for static testing at type evaluation stage, for which the ~~MPE~~mpe for influence factor tests shall be 0.25 ~~of the MPD~~mpd ~~for~~ in-service ~~inspection~~ for a fill equal to the static test load.

~~NOTE:~~ For AGFIs where the fill may not be equal to one load, the ~~MPE~~mpe applicable for a test on a static load shall be calculated in accordance with the test procedures in ~~A.6~~Annex C.2.

~~4.2~~4.3.3 Maximum permissible preset value error (~~MPSE~~mpse)

For AGFIs where it is possible to have a preset value the maximum difference between the preset value (~~as defined in~~ see ~~5.6~~9.6) and the average mass of all the fills in a test sequence (~~as defined in~~see 9.7) the maximum difference shall not exceed 0.25 ~~of the MPD~~mpd in-service of each fill from the average of the fills~~, as specified for in-service~~

~~inspection in~~(see ~~4.2~~4.3.1). These limits will apply for Initial verification and in-service ~~inspection tests~~.

~~4.3~~4.4 ~~Particle mass~~Reference mass correction (see ~~0.4~~3.4.2)

For material tests, when the ~~reference particle mass~~reference mass exceeds 0.1 of the maximum ~~MPD~~mpd in-service, the values derived from Table 1 shall be increased by 1.5 times the value of the ~~reference particle mass~~reference mass. However, the maximum value of the ~~MPD~~mpd shall not exceed the value derived from Table 1 multiplied by 9 %.

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

~~NOTE 2: AGFIs which are verified with particle mass correction may not be suitable for fills which need to comply with OIML R87 [24].~~

~~4.4~~4.5 Error limits for mutli-load AGFIs

The effect on the fill shall not be greater than the ~~significant fault~~fault limit value ~~specified~~ in ~~0.5.2.6~~4.7.4 and the ~~MPE~~mpe specified in ~~4.2~~4.3.2.

~~4.5~~4.6 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 AGFIs given in this Recommedation.

The Min shall be marked on the AGFI in accordance with the descriptive markings in 5.12.

NOTE: For AGFIs which effect the fill by one weighing cycle Min is equal to the Minfill.

~~4.6~~4.7 Rated Minimum Fill (Minfill)

The Minfill shall be specified by the manufacturer.

The ~~MPE~~mpe is applicable to each fill >= Minfill

NOTE: At least the following parameters are of influence to the value of the Minfill

- Temperature effect on no load indication
- Zero-setting accuracy
- Disturbances
- Warm-up time
- Product
- Scale Interval

For class X(x) AGFIs the minimum permissible values of Minfill for d values are given in Table 2 below:

Table 2 Minimum permissible value of Minfill (g)

d (g)	X(0.2)	X(0.5)	X(1)	X(2)
0.5	28.0	11.0	~~6~~5.5	3.0

1	111	22	11	6
2	334	44	22	12
5	1665	335	110	30
10	3330	1330	330	110
20	6660	2660	1340	340
50	25000	6650	3350	1650
100	50000	20000	6700	3300
200	100000	40000	20000	6600
≥500	500 d	200 d	100d	50 d
NOTES:	a) These values are dependent on the products, conditions of use and whether operational tests have demonstrated that the tolerances have been met for this value b) The gramme values are rounded to the d values which can be indicated ~~a)~~c) Provided that product test results are inside the mpes, smaller values of MinFills may be marked on an instrument". e.g., class X(0,5) with d=100 g, product results were good with 12 kg. This value is less than the "20000 g" given in Table 2.			

~~()~~

With a resolution in scale interval (d) and the equilibrium device the AGFI is able to meet the requirement of 5.8.2 with an error E = 0.25d, only if the test results show that the scale interval (d) is the largest contribution to the calculation of the Minfill the table is as presented. Since 5.8.2 require that 0.25 mpd ≤ 0.25 ~~MPD~~mpd in-service ~~.~~x Minfill, then you have the condition: Minfill ≥ d / ~~MPD~~mpd in-service (with ~~MPD~~mpd as relative value).

For calculating the Minfill value for class X(x) AGFIs the ~~MPD~~mpd and F values (value of the mass of the fills) in Table 1 are used. See Annex E for examples.

Provided that product test results are inside the mpes, smaller values of MinFills may be marked on an instrument.

~~4.7~~4.8 Influence factors

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

Refer to Annex A for test conditions.

AGFIs shall maintain their metrological and technical characteristics at a relative humidity of either 85 % (non condensing) or 93 % (condensing) (see ~~A.6.2.3~~A.6.2.4) at the upper limit of the temperature range of the ~~belt weigher~~AGFI.

~~4.7~~4.8.1 Temperature

~~4.7~~4.8.1.1 Prescribed temperature limits

If no particular working temperature is stated in the descriptive markings of the AGFI, then the AGFI 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 AGFI in accordance with the descriptive markings in 5.12.

~~4.7~~4.8.1.2 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.

~~4.7~~4.8.1.3 Temperature effect on no load indication

At specified temperatures the indication at zero shall not vary by more than the ~~MPE~~mpe for influence factor tests specified in ~~4.2~~4.3.2 for a load equal to the Minfill for a difference in ambient temperature of 5 °C.

~~4.7~~4.8.2 Supply voltage

An ~~electronic instrument~~electronic measuring instrument shall comply with the appropriate metrological and technical requirements, if the supply voltage varies from the nominal voltage, U_{nom} (if only one voltage is marked on the AGFI), or from the voltage range, U_{min} (lowest value), U_{max} (highest value), marked on the AGFI at:

a) AC mains voltage variation:
   1) lower limit = 0.85 U_{nom} or 0.85 U_{min}
   2) upper limit = 1.10 U_{nom} or 1.10 U_{max}

b) DC mains voltage variation:
   1) The upper voltage limit is the DC level at which the EUT has been manufactured to automatically detect high-level conditions.
   2) The lower limit will be the DC level at which the EUT has been manufactured to automatically detect low-level conditions.

c) Low voltage of internal battery (not connected to the mains power)
   The lower limit will be the minimum operating voltage specified by the manufacturer

d) Power from external 12V and 24 V road vehicle batteries
   The upper and lower limit are the specified maximum and minimum power supply voltage.

~~4.7~~4.8.3 Tilting

~~Mobile~~ AGFIs intended to be used outside in open locations (e.g. on roads) or AGFIs without a level indicator ~~liable to be tilted 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 %.

a) Where a levelling device and a level indicator ~~is~~ are present the limiting value of tilting shall be defined by a marking (e.g. for an air bubble level indicator: a ring on the level indicator which shows that the maximum permissible tilt has been exceeded when the bubble is displaced from a central position and the edge touches the marking). The limiting value of the level indicator shall be obvious, so that tilting is easily noticed. The level indicator shall be fixed firmly on the AGFI in a place clearly visible to the user and representative for the tilt sensitive part.

b) If the AGFI is fitted with an automatic tilt sensor the limiting value of tilting is defined by the manufacturer. The tilt sensor shall release a display switch-off or other appropriate alarm signal (e.g. error signal) and shall inhibit the printout and data transmission if the limiting value of tilting has been exceeded

c) Where an automatic tilt sensor is also used to compensate the effect of tilting by adding a correction to the weighing result, this sensor is regarded as an essential part of the AGFI that shall be submitted to influence factors and disturbance tests during the type ~~approval~~ evaluation procedure.

~~4.7~~4.8.4 Fault limit value

For each fill, the value of fault greater than 0.25 mpd in-service is that appropriate to each fill (see 4.3.1), equal to the minimum capacity or rated minimum fill.

5 Technical requirements

5.1 Suitability for use

AGFIs 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 maintain it metrological characteristics when properly installed and used in an environment for which it is intended.

5.2 Security of operation

5.2.1 Fraudulent use

AGFIs shall have no characteristics likely to facilitate its fraudulent use.

5.2.2 Accidental maladjustment

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

5.2.3 Security

Means shall be provided for securing components, interfaces, software devices and pre-set controls of the AGFI, to which unauthorised access is prohibited or is detected and made evident by an audit trail or similair.

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

5.3 Indication of weighing results

5.3.1 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.

5.3.2 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 AGFIs 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.

5.3.3 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.

5.3.4 Scale interval (d)

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

The scale interval for a measured value shall be in the form 1×10^n, 2×10^n, or 5×10^n, where n is any integer or zero.

5.4 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 the requirements of OIML R 111 ~~[5]~~[4] ~~requirements~~ or purpose-designed of any nominal value, distinguishable by shape and identified with the AGFI.

5.5 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.

5.6 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.

5.7 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.

AGFIs 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 AGFI, they must be kept in the vicinity of the AGFI.

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

5.8 Zero-setting and tare devices

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

a) Non-automatic (tare balancing), or
b) Semi-automatic, or
c) Automatic

For combined zero-setting and tare devices, the same key operates the semi-automatic zero-setting device and the semi-automatic tare device. In these cases, the accuracy requirements specified in 5.8.2 and in 5.8.4 apply at any load

5.8.1 Range of adjustment

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

The range of adjustment of zero-setting devices shall not exceed 4 %, and of the initial zero-setting device not more than 20 %, of the Max of the AGFI.

5.8.2 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 d~~0.25 mpd ~~for~~ in-service ~~inspection~~ as specified in ~~4.2~~4.3.1 ~~for a fill equal to the Min or Minfill respectively of the AGFI~~.

After zero or tare setting the effect of zero deviation on the result of the weighing shall be not more than ± ~~0.25 d~~0.25 mpd.

5.8.3 Control of the zero-setting and tare devices

5.8.3.1 Non-automatic and semi-automatic devices

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

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

5.8.3.2 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 a utomatic 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~~mpe in 5.8.2.

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 this device 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~~A.5.2.5, 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~~A.5.2.5 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.

5.8.4 Zero-tracking device

A zero-tracking device shall operate only when:

a) the indication is at zero, or at a negative net value equivalent to gross zero, and
b) the corrections are not more than ~~0.25 d in-service inspection for a fill equal to the Min or Minfill respectively of the AGFI~~0.5 mpd/sec.

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

NOTE: Zero-tracking is functionally similar to automatic zero setting. The differences are important in applying the requirements of 5.8. Automatic zero-setting and zero-tracking are defined in ~~0.3~~3.3.4.3 and ~~0.3~~3.3.4.5. Specifically:

a) Automatic zero setting is activated by an event, such as part of every automatic weighing cycle or after a programmed interval.
b) 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~~0.5 mpd/sec~~ to prevent interaction with the normal weighing process~~.

5.8.5 Tare device

5.8.5.1 Accuracy and control of tare devices

Accuracy and operation of the tare device shall be as specified in 5.8.2 and 5.8.3.

5.8.5.2 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 AGFI above its maximum capacity or indicate that this capacity has been reached.

5.8.5.3 Automatic tare device

An automatic tare 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 tare device (e.g. the maximum programmable time interval) should be included in the type approval certificate.

The automatic tare device shall operate sufficiently often to ensure that tare is properly taken into account along the production of a batch.

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 this device to operate at time intervals.

Where the automatic tare device operates after a programmable time interval, the manufacturer shall specify the maximum programmable time interval.

5.8.6 Preset tare device

5.8.6.1 Scale interval

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

5.8.6.2 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).

5.9 Data storage

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

The storage of primary indications for subsequent indication, data transfer, totalizing, etc. shall be inhibited when the equilibrium is not stable.

To ensure adequate security the following conditions shall apply:

a) the requirements for security of software given in 5.10 are applied as appropriate;
b) if software realizing short or long term data storage can be transmitted to or downloaded into the AGFI these processes shall be secured in accordance with requirements of 5.2.3;
c) external storage devices identification and security attributes shall be automatically verified to ensure integrity and authenticity;
d) exchangeable storage media for storing measurement data need not be sealed provided that the stored data is secured by a specific checksum or key code;
e) when storage capacity is exhausted, new data may replace oldest data provided that overwriting the old data has been archived and/or authorized.
f) the additional requirements in Annex B apply.

5.10 Software

The legally relevant software of the AGFI shall be identified by the manufacturer, i.e. the software that is critical for measurement characteristics, measurement data and metrologically important parameters, stored or transmitted, and software programmed to detect system fault (software and hardware), is considered as an essential part of the AGFI and shall meet the requirements for securing software specified in 5.10.2. The additional requirements in Annex B apply.

5.10.1 Software documentation

The software documentation submitted by the manufacturer shall include:

a) description of the legally relevant software;
b) description of suitable system configuration and minimal required resources;
c) description of the accuracy of the measuring algorithms;
d) description of the user interface, menus and dialogues;
e) the unambiguous software identification;
f) description of the embedded software;
g) overview of the system hardware, e.g. topology block diagram, type of computer(s), types of software functions, etc. if not described in the operating manual;
h) description of the accuracy of the algorithms (e.g. filtering of A/D conversion results, price calculation, rounding algorithms, etc.);
i) description of data sets stored or transmitted;
j) list of commands of each hardware interface of the measuring instrument / electronic device / sub-assembly including a statement of completeness;
k) means of securing software;
l) if fault detection is realized in the software, a list of faults that are detected and a description of the detecting algorithm;
m) operating manual.

NOTE: It shall be possible to check the software identification whilst the AGFI is in use.

5.10.2 Means of securing

There shall be adequate security to ensure that:

a) legally relevant software shall be adequately protected against accidental or intentional changes. The requirements for securing given in 5.2.3 apply;

b) the software shall be assigned with appropriate software identification (see 5.3.6.5). This software identification shall be adapted in the case of every software change that may affect the functions and accuracy of the AGFI;

c) functions performed or initiated via connected interfaces, i.e. transmission of legally relevant software, shall comply with the securing requirements for interfaces of 7.9.

5.11 Equilibrium mechanism

The equilibrium mechanism may be provided with detachable masses which shall be either weights in accordance with the requirements of OIML R 111 ~~[5]~~[4] ~~requirements~~ or purpose designed ~~masses~~ weights of any nominal value, distinguishable by shape and identified with the AGFI.

5.12 Descriptive markings

AGFIs shall bear the following markings, with some markings shown in full and some in code.

- Name or identification mark of the manufacturer
- Name or identification mark of the importer (if applicable)
- Date of manufacture of the AGFI
- Serial number and type designation of the AGFI
- Product(s) designation (i.e. materials that may be weighed)
- Temperature range (if applicable, see ~~4.7~~4.8.1) in the form: ....°C / ....°C
- Voltage supply in the form: V
- Voltage 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
- Type approval sign
- Indication of the accuracy class in the form X(x) =…….
- Reference value for 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 = - ....

5.12.3 Supplementry markings

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

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.

5.12.4 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 AGFI.

They shall be grouped together in a clearly visible place on the AGFI, either on a descriptive plate or on the AGFI 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 AGFI 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 provided that

a) at least ~~max~~Max, ~~minfill~~Minfill, Ref(x) and d shall be displayed as long as the ~~AFGI~~AGFI is switched on;
b) the other marking may be shown on manual command;
c) it must be described in the type approval certificate; and
d) the markings are considered as device-specific parameters (see ~~0.3.6.2~~3.3.6.4) and shall comply with the requirements for securing in 5.9 and 5.10.

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

a) type approval sign in accordance with national requirements;
b) name or identification mark of the manufacturer;
c) serial number;
d) temperature range;
e) type approval number;
f) voltage supply;
g) voltage supply frequency, (if applicable)
h) pneumatic/hydraulic pressure (if applicable).

5.13 Verification marks

5.13.1 Position

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

a) be the part on which the mark is located and it cannot be removed from the AGFI without damaging the marks,
b) allow easy application of the mark without changing the metrological qualities of the AGFI,

c) be visible without the AGFI or its protective covers having to be removed.

5.13.2 Mounting

AGFIs 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.

6 Control instruments

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

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.

7 Requirements for measuring instruments with respect to their environment

The type of measuring instrument is presumed to comply with the following general requirements if it passes the examination and tests specified in Annex A.

7.1 Rated operating conditions

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

7.2 Disturbances

Measuring 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~~fault limit ~~specified in 0.5.2.6~~(3.5.2.7), or

b) Significant faults are detected and acted upon.

NOTE: A fault equal to or less than the value specified in ~~0.5.2.6~~3.5.2.7 is allowed irrespective of the value of the error of indication.

7.3 Durability

The requirements in 7.1, 7.2 and 7.5 shall be met durably in accordance with the intended use of the instrument.

7.4 Application

The requirements in 7.2 may be applied separately to:

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

b) Each part of the ~~electronic instrument~~electronic measuring instrument.

The choice of whether measuring instruments are designed to: (a) withstand disturbances or (b) detect and act on significant faults is left to the manufacturerof the instrument.

7.5 Influence factors

An ~~electronic instrument~~electronic measuring instrument shall comply with the influence factors requirements of ~~4.7~~4.8 and shall also comply with appropriate metrological and technical requirements at a relative humidity of either 85 % (non-condensing) or 93 % (condensing) at the upper limit of the temperature range of the instrument.

7.6 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 sufficient time to be easily observed by the operator.

7.7 Acting upon a significant fault

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

7.8 Warm-up time

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

7.9 Interfaces

AGFIs may be equipped with interfaces which allow~~s~~ 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 AGFI 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 6.

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

a) Display unclear data,

b) Falsify displayed, processed or stored weighing results,

c) Unauthorised adjustment of the AGFI.

Other interfaces shall be secured in accordance with 5.2.3.

7.10 Examination and tests

Examination and testing of ~~electronic instrument~~electronic measuring instruments is intended to verify compliance with the applicable requirements of this Recommendation ~~and with the requirements of clause 8~~.

7.10.1 Examinations

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

7.10.2 Performance tests

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

Tests are to be carried out on the whole AGFI except when the size and/or configuration of the AGFI 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 AGFI.

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

7.10.3 Span stability

When an ~~electronic instrument~~electronic measuring 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 maximum permissible error for influence factor tests for a near maximum capacity load.

PART 2 – METROLOGICAL CONTROLS AND PERFORMANCE TESTS

8 METROLOGICAL CONTROLS

8.1 General

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

a) type ~~approval~~evaluation,

b) initial verification,

c) subsequent verification

d) in-service inspection.

Tests should be applied uniformly by the metrological authority and should form a uniform program. Guidance for the conduct of type ~~approval~~ evaluation and initial verification is provided in OIML International Documents D 19 ~~[8]~~[7] and D 20 [~~20~~9] respectively.

For the purposes of testing, the metrological authority may require from the applicant the product (i.e. the material to be weighed), the handling equipment, the control instrument (as defined in ~~5.14~~6 and A.3.6) and the personnel to assist in performing the tests.

Measures to ensure durability shall be taken subject to national regulations, which shall include assessments under items (a) to (d) above.

Further information about durability testing is given in ~~Annex D~~Annex E.

8.2 Type ~~Approval~~Evaluation

8.2.1 Documentation

The application for type approval shall include documentation comprising:

NOTE: The numbers in parentheses in the table below refer to clauses in this Recommendation.

Item	Documentation required
1	General description of the instrument, description of the function, intended purpose of use, kind of instrument.
2	General characteristics (manufacturer; Class, Max, Min, X(x), Ref(x), temperature range, voltage, etc.).
3	List of descriptions and characteristic data of all devices and modules of the AGFI.
4	Drawings of general arrangement and details of metrological interest including details of any interlocks, safeguards, restrictions, limits, etc.
4.1	Securing components, adjustment devices, controls, etc. (5.2.2), protected access to set-up and adjustment operations (5.2.3).
4.2	Place for application of control marks, securing elements, descriptive markings, identification, conformity and/or approval marks (5.12.4, 5.13.2).
5	Devices of the AGFI.
5.1	Auxiliary, or extended indicating devices (9.5.2).
5.2	Multiple use of indicating devices (5.2, 5.3.9).
5.3	Printing devices (5.5.3).
5.4	Memory storage devices (5.9).
5.5	Zero-setting, zero-tracking devices (5.8).
5.6	Tare devices and preset tare devices (5.8.5).
5.7	Leveling device and level indicator, tilt sensor, upper limit of tilting (~~4.7~~4.8.3).
5.8	Locking devices and auxiliary verification devices.
5.9	Connection of different load receptors (5.7, A.8.1.2).
5.10	Interfaces (types, intended use, immunity to external influences

	instructions (7.9)).
5.11	Peripheral devices, e.g. printers, secondary displays, for including in the type approval certificate and for connection for the disturbance tests (7.10.2, 8.2.2).
5.12	Functions of price-computing instruments (e.g. for direct sales to the public), self-service, price labeling.
5.13	Other devices or functions, e.g. for purposes other than determination of mass (not subject to conformity assessment).
5.14	Detailed description of the stable equilibrium function (5.11) of the AGFI.
6	Information concerning special cases.
6.1	Subdivision of the AGFI in modules - e.g. load cells, mechanical system, indicator, display - indicating the functions of each module and the fractions *p*i. For modules that have already been approved, reference to test certificates or type approval certificates (8.3.3), reference to evaluation to R 60 for load cells.
6.2	Special operating conditions (5.12.3).
6.3	Reaction of the AGFI to significant faults (7.3, 7.4, 7.7).
6.4	Functioning of the display after switch-on (7.6).
7	Technical description, drawings and plans of devices, sub-assemblies, etc. particularly those in 5.12 – 5.13.
7.1	Load receptor, (5.7) force transmitting devices.
7.2	Load cells, if not presented as modules.
7.3	Electrical connection elements, e.g. for connecting load cells to the indicator, including length of signal lines.
7.4	Indicator: block diagram, schematic diagrams, internal processing and data exchange via interface, keyboard with function assigned to any key.
7.5	Declarations of the manufacturer, e.g. for interfaces (5.10.11, 7.9), for protected access to set-up and adjustment (5.2.3), for other software based operations.
7.6	Samples of all intended printouts.
8	Results of tests performed by the manufacturer or from other laboratories, on protocols from R 76-2 [6], including proof of competence.
9	Certificates of other type approvals or separate tests, relating to modules or other parts mentioned in the documentation, together with test protocols.
10	For software controlled AGFIs or modules, additional documents according to 5.10 and Annex B).
11	Drawing or photo of the AGFI showing the principle and the location of verification and securing marks are to be applied, which is necessary to be included in the OIML Certificate or Test Report.

8.2.2 General requirements

Type evaluation shall be carried out on one or more and normally not more than three AGFIs that represent the definitive type. At least one of the AGFIs 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 module may be included.

The evaluation shall consist of the tests specified in 8.2.3.

~~MPE~~mpe for static tests shall be apportioned in accordance with 8.2.3.3 to parts of the AGFI that are tested seperately.

8.2.3 Type evaluation

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

a) ~~The~~ requirements specified for static tests in 4 and 5,

b) ~~The~~ technical requirements in 6,

c) ~~The~~ requirements in 8 for ~~electronic instrument~~electronic measuring instruments, where applicable.

The metrological authority shall:

a) Conduct the tests in a manner which prevents an unnecessary commitment of resources,

b) Permit the results of these tests to be assessed for initial verification

8.2.3.1 Operational tests for type evaluatiuon

Tests for type evaluation shall be conducted:

~~c)~~a) In accordance with the appropriate parts of 6.

~~d)~~b) Under the normal conditions of use for which the AGFI is intended, and

~~e)~~c) In accordance with the material test methods given in 6, using material that is representative of a product for which the AGFI is designed to assess compliance with the technical requirements of 6.

For software-controlled AGFIs, the additional requirements in 5.10 and in Annex B apply.

8.2.3.2 Influence factor tests

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

~~d)~~a) ~~4.7~~4.8 for all AGFIs,

~~e)~~b) ~~4.6~~7 for electronic AGFIs.

8.2.3.3 Apportioning of errors

Where parts of the AGFI are examined separately in the process of type ~~approval~~evaluation, the following requirements apply:

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

The fractions pi shall satisfy the following equation:

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

The fraction pi 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 has been evaluated in accordance with the requirements of any OIML International Recommendation (e.g. OIML R 60 ~~[6]~~[5] for load cells), that evaluation shall be used to aid in the type evaluation if so requested by the applicant.

NOTE: As the requirements of this clause only apply to the AGFI 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 maximum permissible error 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, or
- The use of change point weights, or
- Any other means mutually agreed.

Acceptable solution

For AGFIs incorporating the typical modules (see ~~0.3~~3.3.11) the fractions p_i may have the values given in Table 3, which takes into account the fact that the modules are affected in a different manner depending on the different performance criteria.

Table 3

Performance criteria	Load cell	Electronic indicator	Connecting elements, etc.
Combined effect[1]	0.7	0.5	0.5
Temperature effect on no load indication	0.7	0.5	0.5
Voltage supply variation	-	1	-
Effect of creep	1	-	-
Damp heat	0.7[2]	0.5	0.5
Span stability	-	1	-

NOTE 1: Combined effects: non-linearity, hysteresis, temperature effect on span, repeatability, etc. After the warm-up time specified by the manufacturer, the combined effect error fractions apply to modules.

NOTE 2: According to OIML R 60 ~~[6]~~[5] valid for SH or CH tested load cells (p_{LC} = 0.7).
NOTE 3: The sign "–" means "not applicable".

8.2.4 Place of testing for type ~~approval~~evaluation

AGFIs submitted for type ~~approval~~ evaluation may be tested either:

a) On the premises of the metrological authority to which the application has been submitted, or

b) In any other suitable place agreed between the metrological authority concerned and the applicant.

8.2.5 Type approval certificate and determination of classes (~~4.1~~4.2 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 at initial verification.

8.3 Initial verification

8.3.1 General requirements

AGFIs shall be examined for conformity with the approved type and shall where applicable ~~and shall~~ be tested for compliance with 4 and 5 ~~(excluding 4.2.2)~~ 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 AGFI fully assembled and fixed in the position in which it is intended to be used.

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

The requirements of 4.8.3 apply if the instrument is liable to be tilted (refer to A.6.2.9).

8.3.2 Material tests for initial verification

In-situ material tests shall be done:

a) In accordance with the descriptive markings given in 5.12,

b) Under the normal conditions and with the products for which the AGFI is intended.

c) In accordance with the test method in ~~6~~ 9 and the material tests procedure given in A.8.2.

Accuracy requirements shall be applied in accordance with the appropriate parts of ~~5~~4.

8.3.3 Conduct of the tests

The metrological authority:

~~c)~~a) Shall conduct the tests in a manner which prevents an unnecessary commitment of resources,

~~d)~~b) May, where appropriate and to avoid duplicating tests previously done on the AGFI for type evaluation under 8.2, use the test results from type evaluation for initial verification.

8.3.4 Determination of accuracy class X(x)

For class X(x) AGFIs the metrological authority shall:

a) Determine the accuracy class for the materials used in the tests in accordance with 8.2.5 by reference to the material test results from A.8 and the error limitation specified in ~~4.2~~4.3.1 and ~~4.2~~4.3.3 for initial verification,

Verify that accuracy classes marked in accordance with descriptive markings in 5.12 show a value of "*x* " equal to or greater than the value(s) of "*x* "~~are equal to or greater than the accuracy classes~~ determined as above.

b) The operational accuracy class marking required in accordance with 5.12 shall show a value of "*x* ":

- equal or greater than "x_{ref}" of the reference accuracy class for which the type was approved and which was laid down in the approval certificate, and
- not greater than 2 or the value prescribed by national legislation (see note of 4.2) whichever is less"~~The accuracy class marking required in accordance with 5.12 shall show the same accuracy class as for which the type was approved and which was laid down in the approval certificate~~.

~~8.3.5 Appropriate material designation~~

~~Marking shall be such that the materials and alternative class or operating parameters are clearly associated with the appropriate material designation in accordance with 5.12.~~

8.4 Subsequent verification

Subsequent verifcation shall be carried out in accordance with the same provisions as in 8.3 for initial verification.

Further information regarding durability testing as part of subsequent control is given in ~~Annex D~~Annex E.

8.5 In-service inspection

In-service Inspection shall be carried out in accordance with the same provisions as in 8.3.1 and 8.3.2

9 ~~TEST METHODS~~PERFORMANCE TESTS

9.1 Determination of the mass of individual fills

The mass of individual fills is determined using either the separate verification method given in 9.5.1 or the integral verification method given in 9.5.2.

9.2 Conduct of material tests

9.2.1 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 AGFI.

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 ~~0.4~~3.4.10).

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

9.2.2 Types of test loads

For type evaluation, the materials used for test loads shall be as specified in 8.2.3.1 and for initial verification and in-service ~~inspection~~ material used for test loads shall be as specified in 8.3.2.

9.2.3 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 AGFI 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 AGFI 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 AGFI bears a clear warning to discard the stated number of fills after a change to the AGFI's settings.

9.3 Number of fills

The minimum number of individual test fills depends upon the preset value (F_P) as specified in Table 4.

Table 4 – 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

9.4 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 one third of the ~~MPD~~mpd and ~~MPSE~~mpse (as appropriate) for automatic weighing (details as given in ~~4.2~~4.3.2 and ~~4.2~~4.3.3 respectively).

NOTE: it is recommended that the control instrument or the device used for control purposes are verified immediately prior to the material test.

9.5 Material test methods

9.5.1 Separate verification method

The separate verification method requires the use of a (separate) control instrument (details as given in ~~5.14~~6 and A.3.6) to find the conventional ~~true~~ value of the mass of the test fill.

9.5.2 Integral verification method

With this method the AGFI being tested is used to determine the conventional 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 maximum permissible error for the AGFI.

NOTE 1: The integral verification method depends on determining the mass~~es~~ of the loads. Error limitation as specified in ~~4.2~~4.3 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 9.5.1) must be used.

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

9.5.2.1 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 the AGFI where the fill is weighed in the load receptor
   - after filling the load receptor (a)
   - after discharge of the load receptor (b)

b) on the AGFI where the load is weighed in a container on the load receptor
   - ~~After~~ after tare balancing the empty container (b)
   - ~~After~~ after filling the container (a)

c) on a subtractive weigher
   - after tare balancing the filled load receptor (a)
   - ~~After~~ 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~~1) 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 AGFI switched back to automatic operation.

(~~b~~2) 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 AGFI switched back to automatic operation.

9.6 Preset value

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

9.7 Mass and average mass 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~~ mass value of the test fill. The average value of all the test fills ~~in the test~~ shall be calculated and noted.

9.8 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 ~~4.2~~4.3.1) shall be the difference between the conventional value of the mass of the test fill (as defined in 9.7) and the average value of all the fills in the test.

9.9 Preset value error for automatic weighing

The preset value error for automatic weighing used to determine compliance with ~~4.2~~4.3.3 shall be the difference between the average value of the conventional value of the mass of the test fills (as defined in 9.7) and the preset value of the fills.

ANNEX A

PROCEDURES FOR TESTS ON AGFIs
(Mandatory)

A.1 Examination for type ~~approval~~ evaluation

A.1.1 Documentation

Review the documentation that is submitted to determine if it is adequate and correct. For type ~~approval~~ evaluation the documentation shall be as specified in 8.2.1.

A.1.2 Compare construction with documentation

Examine the various devices of the AGFI to ensure compliance with the documentation in accordance with ~~7.3~~7.10.

A.1.3 Metrological requirements

Note the metrological characteristics using the checklist in the test report format in OIML R 61-3

A.1.4 Technical requirements

Examine the AGFI for conformity with the technical requirements of 5 and 8, using the checklist given in the test report format R 61-3.

A.1.5 Functional requirements

Examine the AGFI for conformity with functional requirements according to details given in 8, using the checklist given R 61-3 *Test report format*.

A.2 Examination for initial verification

A.2.1 Compare construction with documentation

Examine the AGFI for conformity with the approved type in accordance with the requirements in 8.3.1.

A.2.2 Descriptive markings

Check the descriptive markings in accordance with 5.12~~ and use the checklist given in OIML R 61-3~~.

A.3 General test requirements

A.3.1 Power supply (~~in accordance with 4.7~~4.8.2)

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 energised for the duration of each test.

A.3.2 Zero-setting (~~in accordance with ~~5.8)

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 4.7~~4.8.1)

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 AGFI without being greater than 5 °C, and the rate of change does not exceed 5 °C per hour.

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

A.3.4 Recovery

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

A.3.5 Pre-loading

Before each weighing test the AGFI shall be pre-loaded to Max, except for the tests in ~~A.5.2~~A.6.2.1 and ~~A.6.2.2~~A.6.2.3.

A.3.6 Control instruments (~~0.2~~3.2.2.4 and 6)

A.3.6.1 Accuracy of test system (~~in accordance with~~ 9.4)

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~~mpe of the AGFI in accordance with 9.4 (a) or (b) for material tests

NOTE: Accuracy requirements for the test system depend on the error limitation which depends 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 say 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:

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

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

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

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, f~~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.3.7 Indication of a digit smaller than d

If an instrument with digital indication has a device for displaying temporarily the indication with a smaller scale interval (not greater than 0.2 d), this device may be used to determine the error. If a device is used, it should be noted in the Test Report.

NOTE: Such indication is only for test purposes.

A.4 **Test program**

A.4.1 Type evaluation (~~in accordance with~~ 8.2.2 and 8.2.3)

The following tests shall normally be applied for type evaluation:

Examination for type ~~approval~~evaluation in A.1,

a) Static tests in A.5,

b) Influence factor and disturbance tests given in A.6,

c) Span stability test in A.7, and

d) Material tests in A.8.1

A.4.2 Non-automatic weighing instruments (~~in accordance with~~ 2)

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For instruments in which the weighing function is provided by a non-automatic weighing instrument that has been approved in respect of conformity with OIML R 76 ~~[7]~~[6], the tests specified in A.4.1 may be omitted where equivalent test results specified in OIML R 76 ~~[7]~~[6] prove conformity with the relevant parts of OIML R 61. Use of OIML R 76 ~~[7]~~[6] test results shall be recorded in the test report checklist and summary in OIML R 61-3.

A.4.3 Initial verification (~~in accordance with~~ 8.3)

The following tests shall normally be applied for initial verification:

a) Examination for initial verification in A.2, and

b) Material tests at initial verification in A.8.2.

Static weighing test method (as detailed in ~~A.5.4~~A.5.3) may also be used if necessary to verify the indicator for the integral verification method of material tests.

If the AGFI is liable to be tilted, the test in A.6.2.9 may also be performed (refere to A.6.2.9).

A.5 Static tests (type ~~approval~~evaluation stage)

A.5.1 General (~~in accordance with~~ 8.2.2 and 8.2.3.2)

~~Electronic instrument~~Electronic measuring 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 ~~4.2~~4.3, 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 8.2.5.

~~**A.5.2** Warm-up time (in accordance with 7.8)~~

~~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.~~

~~(f) Disconnect instrument from the power supply for a period of at least 8 hours prior to the test.~~
~~(g) Reconnect instrument and switch on while observing the load indicator.~~
~~(h) Check that it is not possible to initiate automatic weighing until the indicator has stabilized.~~

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

~~(j) 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.~~

~~(k) From (e) verify that E_{0I} is not greater than the MPE specified in 5.8.2.~~

~~(l) 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.~~

~~(m) Repeat steps (e), (f) and (g) (every minute within the first 5 minutes, between 5 and 15 minutes every two minutes, after 15 minutes take the readings every five minutes. Observe whether the drift has stopped after 30 minutes. If not, continue taking the readings until warm-up process has completely finished and the indication both at zero and Max remain stable (show no further drift).~~

~~(n) From (g) and (h) verify that:~~

~~1. The error (corrected for zero error) for a static load close to Max is not greater than the MPE specified in 4.2.2,~~
~~2. After each time interval the zero-variation error ($E_0 - E_{0I}$) is not greater than the MPE specified in 5.8.2.~~

~~A.5.3~~A.5.2 Zero-setting and tare devices (~~in accordance with~~ 5.8)

~~A.5.3~~A.5.2.1 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:

a) Nonautomatic or semi-automatic,

b) Automatic at switch-on,

c) Automatic at start of automatic operation,

d) Automatic at programmable time intervals,

e) 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 AGFI to operate through the appropriate part of the automatic cycle and then to halt the AGFI 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~~A.5.2.2 Range of zero-setting

~~A.5.3~~A.5.2.2.1 Initial zero-setting

(a) Positive range

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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, reset to zero~~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 be considered.
7) Reassemble or recalibrate the instrument for normal use after the above tests.

~~A.5.3~~A.5.2.2.2 Automatic zero-setting range

Remove the non-essential parts of the load receptor or re-calibrate the instrument as described in ~~A.5.3~~A.5.2.2.1 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~~A.5.2.3 Accuracy of zero-setting

a) When the load receptor is empty, zero the AGFI in a mode as determined by ~~A.5.3~~A.5.2.1.
b) 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.
c) Calculate the error at zero according to the method described in A.3.6.2.1.
d) Verify that the zero-setting error is within the limit specified in 5.8.2

~~A.5.3~~A.5.2.4 Accuracy of taring

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

a) Place the maximum tare load on the load receptor, operate the tare function key immediately in a mode as determined by ~~A.5.3~~A.5.2.1 to enable the equilibrium device to release the tare function.
b) 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.
c) Calculate the error according to the method described in A.3.6.2.1.
d) Verify that the zero-setting error is within the limit specified in 5.8.2

~~A.5.3~~A.5.2.5 Frequency of automatic zero-setting and taring

This test does not need to be performed for AGFIs 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 determied 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) The maximum zero-setting error (5.8.2) is determined as follows:

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

c) The maximum zero-checking error (5.8.3.2) is determined as follows:

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

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

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

d) In accordance with ~~A.6.2.2~~A.6.2.3, the maximum zero-variation (Δz_{max}) per 5°C is less than or equal to 0.25 ~~MPD~~mpd in-service:

Δz_{max} per 5 °C $\leq$ 0.25 ~~MPD~~mpd in-service ~~x~~ at Minfill x Ref(x) (4)

e) Substituting the 5 °C per hour steady ambient temperature from paragraph (a)

For Δz_{max} per 5 °C in equation (4) gives:

Δz_{max} per hour $\leq$ 0.25 ~~MPD~~mpd in-service ~~x~~ at Minfill x Ref(x) (5)

Since equations (5) and (4) are identical, an AGFI which needs the maximum allowable variation given in ~~A.6.2.2~~A.6.2.3 has a maximum programmable time interval of automatic zero-setting or taring 1 hour. If the AGFI needs less or more of the maximum zero-variation given in ~~A.6.2.2~~A.6.2.3, 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

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~~A.5.4~~A.5.3 Static weighing test method for type evaluation (~~in accordance with~~ 8.2.3)

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 9.2.1(c), subject to 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~~A.5.4 Determination of reference accuracy class, Ref(x) (~~in accordance with~~ 8.2.5)

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

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

~~d)~~b) Determine the ~~MPE~~mpe for influence factor tests for class X(1), ~~MPE~~mpe$_{(1)}$ for each load as follows:

~~MPE~~mpe$_{(1)}$ = 0.25 ~~MPD~~mpd$_{(1)}$ ~~*~~x (pi, if applicable) in-service ~~inspection~~ for the fill value equal to the load.

For example, with a load of 10kg, the ~~MPE~~mpe for influence factor tests as specified in ~~4.2~~4.3.2 will be calculated thus:

$$\text{~~MPE~~mpe}_{(1)} = pi \times (0.25 \times 1.5\,\% \times 10{,}000\text{g})$$

where

pi (as specified in 8.2.3.3) is a fraction of the ~~MPE~~mpe applied to a part of the AGFI which is examined seperately

~~MPE~~mpe$_{(1)}$ is error limit specified in Table 1 for mass of fill.

~~e)~~c) (Calculate [│Error│ / ~~MPE~~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.

d) From (~~3~~c) determine the maximum value of [│Error│ / ~~MPE~~mpe$_{(1)}$] for all the influence factor tests,

i.e. [│Error│ / ~~MPE~~mpe$_{(1)}$]$_{Max}$ for all influence factor tests

e) Determine Ref(~~x~~1) from [│Error│ / ~~MPE~~mpe$_{(1)}$]$_{Max}$ such that:

$$\mathrm{Ref}(x) \geq [\,|\mathrm{Error}|\ /\ \cancel{\mathrm{MPE}}\mathrm{mpe}_{(1)}]_{Max} \text{ and}$$

$$\mathrm{Ref}(x) = 1 \times 10^{k},\ 2 \times 10^{k},\ \text{or } 5 \times 10^{k},$$

the index k being a positive or negative whole number or zero. Fault limit values~~Values for significant fault~~ shall then be calculated from the ~~MPD~~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 7.2 and 7.5 are intended to verify that ~~electronic instrument~~electronic measuring 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 AGFIs which are processing material automatically. The AGFI 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 AGFI shall be allowed to recover sufficiently before the following test.

Where parts of the AGFI are examined separately, errors shall be apportioned in accordance with details given in 8.2.3.3.

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

When the AGFI 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

A number of tests can be performed with either a load cell or a simulator but both have to fulfill the requirements in the following paragraph. However the disturbance tests should be performed with a load cell or a weighing platform with load cell being the most realistic case.

If a simulator is used to test a module, the repeatability and stability of the simulator should make it possible to determine the performance of the module with at least the same accuracy as when a complete instrument is tested with weights, the mpe to be considered being those applicable to the module. If a simulator is used, this shall be noted in the Test Report Format and its traceability referenced.

A.6.1.2.3 Interfaces (details as given in 7.9)

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 3m of interface cable terminated to simulate the interface impedance of the other equipment or instead suitable peripheral equipment may be connected to the interfaces~~.

A.6.1.2.4 Documentation

Simulators shall be defined in terms of hardware and functionality by reference to the AGFI 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 Multi-load AGFIs and test limits

For AGFIs where the fill may consist of more than one load, the metrological authority or manufacturer shall consider the design of the AGFI and the method of test, to ensure that the requirements in ~~4.4~~4.5 are met.

A.6.1.3.1 Multi-load AGFIs and ~~significant~~ fault limit ~~vlaue~~

The ~~f~~ examples in ~~Annex F~~Annex C.1 show how to determine the ~~value of a significant~~ fault ~~on~~limit on selective combination weighers and cumulative weighers when testing.

A.6.1.3.2 Multi-load AGFIs and influence factor mpe determination

The examples in ~~Annex F~~Annex C.2 and E.5 show how to determine the maximum permissible error for influence factor testing for selective combination weighers and cumulative weighers when testing.

A.6.2 Influence factor tests

Summary of tests

§	Test	Characteristic under test	Conditions applied
A.6.2.1	Warm-up time	Influence factor	mpe
~~A.6.2.1~~A.6.2.2	Temperature with static load	Influence factor	~~MPE~~mpe
~~A.6.2.2~~A.6.2.3	Temperature effect on no-load indication	Influence factor	~~MPE~~mpe
~~A.6.2.3~~A.6.2.4	Damp heat ~~test~~	Influence factor	~~MPE~~mpe

~~A.6.2.4~~A.6.2.5	AC mains voltage variation	Influence factor	~~MPE~~mpe
~~A.6.2.5~~A.6.2.6	DC mains voltage variation	Influence factor	~~MPE~~mpe
~~A.6.2.6~~A.6.2.7	Low voltage of internal battery (not connected to the mains supply)	Influence factor	~~MPE~~mpe
~~A.6.2.7~~A.6.2.8	Power from external 12V and 24V road vehicle batteries	Influence factor	~~MPE~~mpe
~~A.6.2.8~~A.6.2.9	Tilting	Influence factor	~~MPE~~mpe

NOTE: Although IEC Standards are mentioned, the requirements of OIML R 61 have to be fulfilled. Differences should be taken into account.

A.6.2.1 Warm-up time (7.8)

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.

a) Disconnect instrument from the power supply for a period of at least 8 hours prior to the test.
b) Reconnect instrument and switch on while observing the load indicator.
c) Check that it is not possible to initiate automatic weighing until the indicator has stabilized.
d) As soon as the indication has stabilized, set the instrument to zero if this is not done automatically.
e) 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.
f) From (e) verify that E_{0I} is not greater than the mpe specified in 5.8.2.
g) 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.
h) Repeat steps (e), (f) and (g) (every minute within the first 5 minutes, between 5 and 15 minutes every two minutes, after 15 minutes take the readings every five minutes. Observe whether the drift has stopped after 30 minutes. If not, continue taking the readings until warm-up process has completely finished and the indication both at zero and Max remain stable (show no further drift).
i) From (g) and (h) verify that:
    1) The error (corrected for zero error) for a static load close to Max is not greater than the mpe specified in 4.3.2,
    2) After each time interval the zero-variation error (E_0 - E_{0I}) is not greater than the mpe specified in 5.8.2.

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~~A.6.2.1~~A.6.2.2 Prescribed temperatures (~~in accordance with 4.7~~4.8.1.1)

Prescribed temperatures for static tests are carried out according to ~~basic standard IEC Publication 60068-2-1[10], IEC Publication 60068-2-2[11], and and IEC 60068-3-1[12],and~~ according toTable 5.

~~Table 5 – Static temperature tests~~

~~Environmental Phenomena~~	~~Test specification~~	~~Test set-up~~
~~Temperature~~	~~Reference of 20 °C~~	
	~~Specified high for 2 hours~~	~~IEC 60068-2-2~~
	~~Specified low for 2 hours~~	~~IEC 60068-2-1~~
	~~Temperature of 5 °C, if the specified low temperature is ≤ 0 °C~~	~~IEC 60068-2-1~~
	~~Reference of 20 °C~~	
~~NOTE 1: Use IEC 60068-3-1[12] for background information.~~ ~~NOTE 2: The static temperatures test is considered as one test.~~		

Supplementary information to the IEC test procedures:

Table 5 Temperature test (dry heat and cold)

Applicable standards	IEC 60068-2-1 [8], IEC 60068-2-2 [9], IEC 60068-3-1 [10]
Test method	Gradual exposure to high and low temperatures not allowing condensation to occur
Applicability	General
Object of the test	Verification of compliance with the provisions in 4.3.2 under conditions of high and low temperature specified in 4.8.1.1
Precondition	The electrical power of the EUT is switched on for at least a 16 hours time period while taking into account the warm-up time specified by the manufacturer.
Condition of the EUT	The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test. This test may be combined with test on temperature effect on no-load indication. In such case the automatic zero-setting or zero-tracking, where available, shall not be enabled. When this test is not combined with the test on temperature effect on no-load indication the automatic zero-setting or zero-tracking, where available, shall be enabled as for normal operation
Test procedure in brief	The test comprises exposure to the specified high temperature under “free air” conditions during the period of at least 2 hours (the period specified is the period following the moment at which the EUT has reached temperature stability). “Free air” conditions meaning sufficient air circulation to keep the temperature at a stable level. The change in temperature shall not exceed 1 °C/min during heating up and cooling down. The stabilizing time at each

	temperature is at least 2 hours. The absolute humidity of the test atmosphere shall not exceed 20 g/m3. When tests are performed at temperatures below 35 °C, the relative humidity shall not exceed 50 %. Sequence: 1. Reference temperature of T_R 2. Specified high temperature T_H 3. Specified low temperature T_L 4. Intermediate temperature T_I 5. Reference temperature T_R				
Test levels	The following high temperature test levels may be specified:				
Level index high (I_H)	1	**2**	3	4	Unit
Temperature (T_H)	30	**40**	55	70	°C
	The following low temperature test levels may be specified:				
Level index low (I_L)	-1	**-2**	-3	-4	
Temperature (T_L)	5	**-10**	-25	-40	°C
NOTES	I_H concerns the index for T_H; I_R concerns the index for T_R; I_I concerns the index for T_I; I_L concerns the index for T_L. By default: T_R = 20 °C and I_R = 0, I_H = 2, I_I = 1 and I_L = -2 $I_R = (I_H + I_L)/2$ (rounded to an integer by deleting the mantissa) and $I_I = (I_R - 1)$				
EUT performance	After stabilization at the relevant temperature and again at each specified temperature conduct the following: 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 has to be respectively increased or decreased monotonically record the following data: a) date and time, b) temperature, c) relative humidity, d) test load value, e) indicated values, f) error values, g) functional performance				
Permitted maximum deviation	All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 4.3.2				

~~Object of the test:~~ ~~To verify compliance with the provisions given in 4.7.1.1 under conditions of dry heat (non condensing) and cold. The test A.6.2.2 may be combined with this test.~~

~~Condition of the EUT:~~ ~~16 hours switched on at reference environmental conditions~~

~~The EUT is switched on for at least the warm-up time specified by the manufacturer. During the test the electrical power supplied to the EUT shall not be switched off.~~

	~~The zero-setting and zero-tracking facilities shall be enabled as for normal operation.~~ ~~If the test is performed together with A.7.2.2 automatic zero-setting and zero tracking shall not be in operation.~~
~~Stabilization:~~	~~Minimum of 2 hours at each temperature under "free air" conditions. "Free air" conditions mean a minimum air circulation to keep the temperature at a stable level.~~
~~Temperature:~~	~~As specified in 4.7.1.1.~~
~~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:~~ ~~e) Date and time~~ ~~f) Temperature~~ ~~g) Relative humidity~~ ~~h) Test load~~ ~~i) Indications~~ ~~j) Errors~~ ~~k)~~a) ~~Functional performance~~
~~Maximum allowable variations:~~	~~All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 4.2.2.~~

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A.6.2.3 Temperature effect on no-load indication (~~4.7~~4.8.1.3)

Table 5a Temperature test at no load condition (dry heat and cold)

Applicable standards	IEC 60068-2-1 [8], IEC 60068-2-2 [9], IEC 60068-3-1 [10]
Test method	Gradual exposure to high and low temperatures not allowing condensation to occur
Applicability	General applicable. This test should not be performed for instruments that have automatic zero - setting as part of every automatic weighing cycle. This test may be combined with the general temperature test specified in Table 5.
Object of the test	Verification of compliance with the provisions in 4.3.2 under

	conditions of high and low temperature specified in 4.8.1.3				
Precondition	The electrical power of the EUT is switched on for at least a 16 hours time period while taking into account the warm-up time specified by the manufacturer.				
Condition of the EUT	The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test. The automatic zero-setting or zero-tracking, where available, shall not be enabled.				
Test procedure in brief	The test comprises exposure to the specified high and low temperature under "free air" conditions during the period of at least 2 hours (the period specified is the period following the moment at which the EUT has reached temperature stability). The change in temperature shall not exceed 1 °C/min during heating up and cooling down. The stabilizing time at each temperature is at least 2 hours. The absolute humidity of the test atmosphere shall not exceed 20 g/m3. When tests are performed at temperatures below 35 °C, the relative humidity shall not exceed 50 %. Sequence: 1. Reference temperature of T_R; 2. Specified high temperature T_H 3. Specified low temperature T_L 4. Intermediate temperature T_I 5. Reference temperature T_R After the first time setting at reference temperature and stabilization the EUT is set to zero.				
Test levels	The following high temperature test levels may be specified:				
Level index high (I_H)	1	**2**	3	4	Unit
Temperature (T_H)	30	**40**	55	70	°C
	The following low temperature test levels may be specified:				
Level index low (I_L)	-1	**-2**	-3	-4	
Temperature (T_L)	5	**-10**	-25	-40	°C
NOTES	I_H concerns the index for T_H; I_R concerns the index for T_R; I_I concerns the index for T_I; I_L concerns the index for T_L. By default: T_R = 20 °C and $I_R = 0$, $I_H = 2$, $I_I = 1$ and $I_L = -2$ $I_R = (I_H + I_L)/2$ (rounded to an integer by deleting the mantissa) and $I_I = (I_R - 1)$				
EUT performance	Determine the error at zero, each time just before changing to a next temperature level. After stabilization at each specified temperature conduct the following: - determine the error at zero indication and - calculate the change in zero indication per 5 °C. These zero error gradients (per 5 °C) shall be calculated for any two consecutive temperatures of this test. At each temperature record the following data: a) date and time, b) temperature, c) relative humidity,				

	d) zero error, e) calculated zero error gradient
Permitted maximum deviation	All functions shall operate as designed. The change in zero indication shall over a temperature difference of 5 °C not vary by more than the maximum permissible error specified in 4.3.2 for the Minfill of the AGFI.

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

~~Object of the test: To verify compliance with the provisions given in 4.7.1.3 under conditions of dry heat (non condensing) and cold. This test may be combined with the test in A.6.2.1.~~

~~The instrument is set to zero, the temperature is then 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.~~

~~The errors at zero shall then be additionally determined immediately before changing to the next temperature and after the 2-hour period after the instrument has reached stability at this temperature.~~

~~Maximum allowable variations:~~ ~~The change in zero indication shall not vary by more than the MPE for influence factor tests as specified in 4.2.2 for the Minfill of the AGFI, for a temperature difference of 5 °C.~~

~~Condition of EUT:~~ ~~The EUT is switched on for at least the warm-up time specified by the manufacturer. During the test the electrical power supplied to the EUT shall not be switched off. Power is to be on for the duration of the test.~~

~~A.6.2.3~~A.6.2.4 Damp heat test (7.2)

The tests in ~~A.6.2.3~~A.6.2.4.1 or ~~A.6.2.3~~A.6.2.4.2 may be performed alternatively in accordance with ~~4.5~~4.6.1, the option chosen being mentioned in the type approval certificate.

~~A.6.2.3~~A.6.2.4.1 Damp heat, steady state

Damp heat, steady state test are carried out ~~according to basic standard IEC Publication 60068-2-78[13] and IEC Publication 60068-3-4[14], and~~ according to Table 6.

Table 6 Damp heat, steady-state (non condensing)

Applicable standards	IEC 60068-2-78 [11], IEC 60068-3-4 [12]
Test method	Exposure to damp heat in steady-state
Applicability	This test is considered general applicable where the measuring instrument is expected to be used in a non-controlled climatic

	environment, where adsorption or absorption play the main part.	
Object of the test	Verification of compliance with the provisions in 4.3.2 under conditions of high humidity and constant temperature specified in 7.5.	
Precondition	The electrical power of the EUT is switched on for at the warm-up time specified by the manufacturer.	
Condition of the EUT	The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test. The automatic zero-setting or zero-tracking, where available, shall be enabled as for normal operation.	
Test procedure in brief	The test comprises exposure to the specified high level temperature and the specified constant relative humidity for a certain fixed period of time as defined by the test level chosen. The EUT shall be handled such that no condensation of water occurs on it. Climate test sequence: 1. Set at reference temperature and at 50 % relative humidity, 2. Maintain for 3 hours at reference temperature and 50 % humidity, 3. Set at specified high temperature at 85 % humidity, 4. Maintain during 48 hours this high temperature and 85 % relative humidity, 5. Set at reference temperature and at 50 % relative humidity, 6. Maintain for 3 hours at reference temperature at 50 % relative humidity.	
	Relative humidity (RH)	Duration
Test level	**85**	**2**
unit	%	24-hours period
EUT performance	After stabilization at the relevant temperature and humidity at no load and subsequently at test load condition record the following data: a) date and time, b) temperature, c) relative humidity, d) test load value, e) indicated values, f) error values, g) functional performance	
Permitted maximum deviation	The error of the EUT is determined once per day under test conditions and at the end of the test after a recovery period of one hour. All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 4.3.2	

~~Table 6 – Damp heat, steady state test~~

~~Environmental~~	~~Test specification~~	~~Test set-up~~

~~Phenomena~~		
~~Damp heat, steady state test~~	~~Upper limit temperature And relative humidity of 85 % for 48 hours~~	~~IEC 60068-2-78~~ ~~IEC 60068-3-4~~
~~Use IEC 60068-3-4 for guidance for damp heat tests and refer to Bibliography [14] 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 7.5 under conditions of high humidity and constant temperature.~~
~~Condition of the EUT:~~	~~The EUT is switched on for at least the warm-up time specified by the manufacturer. During the test the electrical power supplied to the EUT shall not be switched off.~~ ~~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.~~
~~Test load:~~	~~A complete weighing test in accordance with A.5.4 and 9.2.1.~~
~~Stabilization:~~	~~3 hours at reference temperature and 50 % humidity.~~ ~~Exposure for 48 hours at the upper limit temperature as specified in 4.7.1.1.~~
~~Temperature:~~	~~Reference temperature and at the upper limit as specified in 4.7.1.1.~~
~~Temperature/ humidity 48 hour 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 stabilisation of the EUT at reference temperature and 50 % humidity apply the test load.~~ ~~Record the following data:~~ ~~i) Date and time~~ ~~j) Temperature~~ ~~k) Relative humidity~~ ~~l) Test load~~ ~~m) Indications~~

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~~n) 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 48 hours. Following the 48 hours, 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 maximum permissible errors specified in 4.2.2.~~

~~A.6.2.3~~A.6.2.4.2 Damp heat, cyclic test (condensing)

Damp heat, cyclic tests are carried out ~~according to basic standard IEC Publication 60068-3-4 [14] and IEC Publication IEC 60068-2-30 [26] and~~ according to Table 6a.

Table 6a Damp heat, cyclic (condensing)

Applicable standards	IEC 60068-2-30 [23], IEC 60068-3-4 [12]
Test method	Exposure to damp heat with cyclic temperature variation
Applicability	Applicable where condensation is concerned and/or when the penetration of vapour is expected which especially applies to outdoor used instruments.
Object of the test	Verification of compliance with the provisions in 4.3.2 under conditions of high humidity combined with cyclic temperature changes specified in 7.5.
Precondition	The electrical power of the EUT is switched on for at least the warm-up time specified by the manufacturer.
Condition of the EUT	The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test. The automatic zero-setting or zero-tracking, where available, shall be enabled as for normal operation.
Test procedure in brief	The test comprises exposure to cyclic temperature variation between 25 °C and the appropriate upper temperature while maintaining the relative humidity above 95 % during the temperature change and the low temperature phases and at or above 93 % RH at the upper temperature phases. Condensation is expected to occur on the EUT during the temperature rise. The 24 h cycle comprises: 1) temperature rise during 3 hours, 2) temperature maintained at upper value until 12 hours from the start of the cycle, 3) temperature lowered to lower temperature level within a period of 3 to 6 hours, the declination (rate of fall) during the first hour and a half being such that the lower temperature level would be reached in a 3 hour period, 4) temperature maintained at the lower level until the 24 h period is completed. The stabilizing period before and recovery period after the cyclic exposure shall be such that the temperature of all parts of the

	EUT is within 3 °C of its final value. Special electrical conditions and recovery conditions may need to be specified. The stabilizing period before and recovery after the cyclic exposure shall be such that all parts of the EUT are approximately at their final temperature.		
	Test level		Unit
Upper temperature	**40**	**55**	°C
Duration	**2**		24-hour cycle(s)
EUT performance	After the exposure to damp heath, at no load and subsequently at test load condition record the following data: a) date and time, b) temperature, c) relative humidity, d) test load value, e) indicated values, f) error values, g) functional performance		
Permitted maximum deviation	The error of the EUT is determined once per day under test conditions and at the end of the test after a recovery period of one hour. All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 4.3.2		

~~Table 6a - Damp heat, cyclic test (condensing)~~

~~Environmental phenomena~~	~~Test specification~~	~~Test set-up~~
~~Damp heat, cyclic test (condensing)~~	~~24 hour cyclic temperature variations between 25 °C and the appropriate upper temperature, maintaining the relative humidity above 95 % during the temperature change and low temperature phases, and at 93 % at the upper temperature phases~~	~~IEC 60068-2-30~~ ~~IEC 60068-3-4~~
~~Note: Use IEC 60068-3-4 for guidance for damp heat tests.~~		

~~Supplementary information to the IEC test procedures:~~

~~Object of the test:~~ ~~To verify compliance with the provisions given in 7.5 under conditions of high humidity when combined with cyclic temperature changes. Damp heat, cyclic tests shall be applied in all the cases where condensation is important or when the penetration of vapour will be accelerated by the breathing effect.~~

~~Preconditioning:~~ ~~None required.~~

~~Condition of the EUT:~~	~~The EUT is connected to the mains power supply and switched on for at least the warm-up time specified by the manufacturer. During the test the electrical power supplied to the EUT shall not be switched off.~~ ~~The zero-setting facilities shall be enabled as for normal operation.~~ ~~Condensation should occur on the EUT during the temperature rise.~~
~~Test procedure in brief~~	~~The 24 hours cycle consists of:~~ ~~1. Temperature rise during the first 3 hours~~ ~~2. Temperature maintained at upper value until 12 hours from the start of the cycle~~ ~~3. Temperature lowered to lower value within 3 to 6 hours, the rate of fall during the first hour and a half being such that the lower value would be reached in 3 hours~~ ~~4. Temperature maintained at lower value until the 24 hours cycle is completed.~~ ~~The stabilizing period before and recovery after the cyclic exposure shall be such that all parts of the EUT are within 3 °C of their final temperature.~~ ~~At least two test cycles are conducted~~
~~Test information:~~	~~After stabilisation of the EUT at reference temperature and 50 % humidity apply the test load. Record:~~ ~~1. date and time;~~ ~~2. temperature;~~ ~~3. relative humidity;~~ ~~4. test load;~~ ~~5. indications (as applicable);~~ ~~6. errors;~~ ~~7. functional performance~~ ~~8. barometric pressure.~~ ~~Repeat the above for the second test cycle.~~ ~~Allow full recovery of the EUT before any other tests are performed.~~
~~Maximum allowable variations:~~	~~All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 4.2.2.~~

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~~A.6.2.4~~A.6.2.5 AC mains voltage variation (~~in accordance with 4.7~~4.8.2)

AC mains voltage variation tests are carried out ~~according to basic standard IEC/TR Publication 61000-2-1 [15] and IEC Publication 61000-4-1[16],and~~ according to Table 7.

Table 7 AC mains voltage variation

Applicable standards	IEC/TR3 61000-2-1 [13], IEC 61000-4-1 [14]
Test method	Applying low and high level AC mains power voltage (single phase)

Applicability	Applicable for measuring instruments which are temporarily or permanently connected to an AC mains power network while in operation. This test is not applicable to equipment powered by a road vehicle battery.	
Object of the test	Verification of compliance with the provisions in 4.3.2 under conditions of AC mains network voltage changes between upper and lower limit specified in 4.8.2	
Precondition	The electrical power of the EUT is switched on for at least the warm-up time specified by the manufacturer.	
Condition of the EUT	The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test. The automatic zero-setting or zero-tracking, where available, shall be enabled as for normal operation.	
Test procedure in brief	The test comprises exposure of the EUT to the lower and upper limit power supply condition for a period sufficient for achieving temperature stability and subsequently performing the required measurements. Test Sequence: 1. Reference voltage level, 2. Upper voltage level, 3. Lower voltage level, 4. Reference voltage level, In the case of three phase power supply, the voltage variation shall apply for each phase successively.	
Test level	Upper limit	U_{nom1} + 10 % [1)]
	Lower limit	U_{nom2} – 15 % [1)]
NOTES	[1)] The values of U_{nom} are those as marked on the measuring instrument. If a range is specified U_{nom1} concerns the highest and U_{nom2} concerns the lowest value. If only one nominal mains voltage value (U_{nom}) is specified then U_{nom1} = U_{nom2} = $U_{nom.}$ The reference voltage level is equal to (U_{nom1} + U_{nom2}) / 2.	
Permitted maximum deviation	The errors shall be determined when the breath alcohol analyzer is powered up at the upper limit of the voltage and when it is powered up at the lower limit of the voltage. All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 4.3.2	

~~Table 7 - AC mains voltage variation tests~~

~~Environmental Phenomena~~	~~Test specification~~	~~Test set-up~~
~~AC mains voltage variation~~	~~U_{nom}~~	~~IEC 61000-2-1~~ ~~IEC 61000-4-1~~
	~~Upper limit: 110 % of U_{nom} or U_{max}~~	
	~~Lower limit: 85 % of U_{nom} or U_{min}~~	
	~~U_{nom}~~	
~~NOTE: Where an instrument is powered by a three phase supply, the voltage variations shall apply for each phase successively.~~		

~~Supplementary information to the IEC test procedures:~~

~~Object of the test:~~	~~To verify compliance with the provisions given in 4.7.2 under conditions of voltage variations.~~
~~Condition of the EUT:~~	~~The EUT is connected to the mains power supply and switched on for at least the warm-up time specified by the manufacturer. During the test the electrical power supplied to the EUT shall not be switched off.~~ ~~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.~~
~~Weighing test:~~	~~The EUT shall be tested with a test load approximately equal to the minimum capacity, and one load between ½ Max and Max. Zero-setting function shall be in operation.~~
~~Test sequence:~~	~~Stabilize the power supply voltage at the nominal voltage within the defined limits and apply the test load. Record the following data:~~ ~~a. Date and time~~ ~~b. Temperature~~ ~~c. Voltage supply~~ ~~d. Test load~~ ~~e. Indications (as applicable)~~ ~~f. Errors~~ ~~g. Functional performance~~ ~~Repeat the test weighing for each of the voltages defined in IEC 61000-4-1[16] 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 maximum permissible errors specified in 4.2.2.~~

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~~A.6.2.5~~A.6.2.6 DC mains voltage variation (~~4.7~~4.8.2)

AGFIs operating from DC mains power supply shall fulfil the tests in A.6.2, with the exception of ~~A.6.2.4~~A.6.2.6 which is to be replaced by the test ~~according to basic standard IEC Publication 60654-2 [17] and according~~ to Table 8.

Table 8 Ripple on DC mains power

Applicable standard	IEC 61000-4-17 [31]
Test method	Introducing a ripple voltage on the DC input power port.
Applicability	Applicable for measuring instruments which are temporarily or permanently connected to a DC mains power network (distribution system) supplied by external rectifier systems while

	in operation and generally only applicable in industrial environment. This test is only applicable to equipment powered by DC mains supply and is not applicable to equipment powered by a road vehicle battery.	
Object of the test	Verification of compliance with the provisions in 4.3.2 under conditions of the introduction of a ripple on the DC mains voltage to simulate the ripple introduced by rectifiers applied in a DC mains power network. This test is not applicable for instruments connected to battery charger systems with incorporated switch mode converters.	
Precondition	The electrical power of the EUT is switched on for at least the warm-up time specified by the manufacturer.	
Condition of the EUT	The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test. The automatic zero-setting or zero-tracking, where available, shall be enabled as for normal operation.	
Test procedure in brief	A test generator as defined in the referred standard shall be used. Before starting the tests, the performance of the generator shall be verified. The test comprises subjecting the EUT to ripple voltages such as those generated by traditional rectifier systems and/or auxiliary service battery chargers overlaying on DC power supply sources. The frequency of the ripple voltage is the applicable power frequency or a multiple (2, 3 or 6) dependant on the rectifier system used for the mains. The waveform of the ripple, at the output of the test generator, has a sinusoid-linear character. The test level is a peak-to-peak voltage expressed as a percentage of the nominal DC voltage, UDC.	
Test level	Percentage of the nominal DC voltage	**2** %
EUT performance	After stabilization at the relevant a) date and time, b) temperature, c) relative humidity, d) test load value, e) indicated values, f) error values, g) functional performance	
Permitted maximum deviation	Either significant faults do not occur or checking facilities detect and act on potential significant faults, thus preventing such faults to occur.	

~~Table 8 – DC mains voltage variation test~~

~~Environmental phenomena~~	~~Test specification~~	~~Test set-up~~
~~DC mains voltage~~	~~U_{nom}~~	~~IEC 60654-2~~

~~variations~~	~~Upper limit: DC level at which the EUT has been manufactured to automatically detect high-level conditions~~	
	~~Lower limit: Minimum operating that automatically detect low-level conditions~~	
	~~U_{nom}~~	
~~NOTE: If a voltage-range is marked, use the average value as the nominal voltage, U_{nom}.~~		

~~Supplementary information to the IEC test procedures:~~

~~Object of the test:~~ ~~To verify compliance with the provisions in 4.7.2 under conditions of DC mains voltage supply variations.~~

~~Condition of the EUT~~ ~~The EUT is connected to the DC mains power supply and switched on for at least the warm-up time specified by the manufacturer. During the test the electrical power supplied to the EUT shall not be switched off.~~

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

~~Number of test cycles:~~ ~~At least one cycle.~~

~~Test information:~~ ~~Stabilize the EUT at the nominal voltage, U_{nom}, and record the following data at no load and with a small test load:~~

- ~~g) Date and time;~~
- ~~h) Temperature;~~
- ~~i) Relative humidity;~~
- ~~j) Voltage supply;~~
- ~~k) Test load;~~
- ~~l) Indications (as applicable);~~
- ~~m) Errors;~~
- ~~n) Functional performance.~~

~~Maximum allowable variations:~~ ~~All functions shall operate as designed.~~

~~All errors shall be within the maximum permissible errors specified in 4.2.1 for initial verification.~~

~~A.6.2.6~~A.6.2.7 Low voltage of internal battery (not connected to the mains power) (4.7.2)

AGFIs supplied by internal battery shall fulfil the tests in A.6.2, in accordance with Table 9.

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Table 9 Low voltage of internal battery (not connected to the mains power)

Applicable standards	No standard is available
Test method	Applying minimum supply voltage
Applicability	Applicable to all measuring instruments supplied by internal battery
Object of the test	Verification of compliance with the provisions in 4.3.2 during low battery voltage specified in 4.8.2
Precondition	The electrical power of the EUT is switched on for at least the warm-up time specified by the manufacturer. The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test. The automatic zero-setting or zero-tracking, where available, shall be enabled as for normal operation.
Test procedure in brief	The test comprises exposure of the EUT to the specific low battery level condition during a period sufficient for achieving temperature stability and for performing the required measurements. The maximum internal impedance of the battery and the minimum battery supply voltage level (U_{bmin}) shall be specified by the manufacturer of the instrument. In case of simulating the battery, by using an alternative power supply, the internal impedance of the specified type of battery shall also to be simulated. The alternative power supply shall be capable of delivering sufficient current at the applicable supply voltage. The test sequence is as follows: • Let the power supply stabilize at a voltage as defined within the rated operating conditions and apply the measurement and/or loading condition. • Record: – the data defining the actual measurement conditions including date, time and environmental conditions, – the actual power supply voltage. • Perform measurements and record the error (-s) and other relevant performance parameters. • Verify compliance with 4.3.2 • Repeat the above procedure with actual supply voltage at U_{bmin} and again at 0,9 U_{bmin} Verify compliance with 4.3.2.
Lower limit of the voltage	The lowest voltage at which the EUT functions properly according to the specifications
Number of test cycles	At least one test cycle for each functional mode
EUT performance	After stabilization at the relevant voltage at no load and subsequently at test load condition record the following data: a) date and time, b) temperature, c) relative humidity, d) supplied voltage e) test load value, f) indicated values,

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	g) error values, h) functional performance
Permitted maximum deviation	All errors shall be within the maximum permissible errors specified in 4.3.2 For voltages at and above U_{bmin}, all functions shall operate as designed; for voltages below U_{bmin}, the instrument may automatically resume normal operation. During all phases of the test the loss of any previous measurement data is not acceptable.

~~Table 9 – Battery voltage variation test~~		
~~Environmental phenomena~~	~~Test specification~~	~~Test set-up~~
~~Battery voltage variation~~	~~U_{nom}~~	~~No reference to standards for this test~~
	~~Lower limit: Minimum operating specified by the manufacturer~~	
	~~U_{nom}~~	

~~Supplementary test information:~~

~~Object of the test:~~ ~~To verify compliance with the provisions in 4.7.2 under conditions of battery voltage variations.~~

~~Condition of the EUT~~ ~~The EUT is connected to the battery voltage supply, fully charged or at the maximum voltage as specified by the manufacturer and switched on for at least the warm-up time specified by the manufacturer. During the test the electrical power supplied to the EUT shall not be switched off.~~

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

~~Number of test cycles:~~ ~~At least one cycle.~~

~~Test information:~~ ~~Stabilize the EUT at the nominal voltage, U_{nom}, and record the following data at no load and with a small test load:~~

~~d) Date and time;~~
~~e) Temperature;~~
~~f) Relative humidity;~~
~~g) Voltage supply;~~
~~h) Test load;~~

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~~i) Indications (as applicable);~~
~~j) Errors;~~
~~k) Functional performance.~~

~~Reduce the voltage of the battery until the instrument:~~

~~1. automatically resumes normal operation producing a clear warning~~
~~2. ceases to function properly~~

~~Record the indications and response of the instrument just before and after it responds to the low voltage condition.~~

~~Maximum allowable variations:~~ ~~For voltages above the lower limit, all functions shall operate as designed; for voltages below the lower limit, the instrument shall automatically resume normal operation without loss of any previous measurement data.~~

~~All errors shall be within the maximum permissible errors specified in 4.2.1 for initial verification.~~

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~~A.6.2.7~~A.6.2.8 Power from external 12V and 24V road vehicle batteries (~~4.7~~4.8.2)

Road vehicle battery operated instruments shall fulfil the tests in A.6.2, with the exception of ~~A.6.2.4~~A.6.2.5 which is to be replaced by the following test conducted in accordance with ISO 16750-2 [~~27~~24] and according to Table 10.

Table 10 Voltage variations

Applicable standard	ISO 16750-2 [24]				
Test method	Variation in supply voltage				
Applicability	Applicable to all measuring instruments supplied by the internal battery of a vehicle and charged by use of a combustion engine driven generator				
Object of the test	Verification of compliance with the provisions in 4.3.2 under conditions of high while charging) and low battery voltage specified in 4.8.2				
Precondition	The electrical power of the EUT is switched on for at least the warm-up time specified by the manufacturer.				
Condition of the EUT	The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test. The automatic zero-setting or zero-tracking, where available, shall be enabled as for normal operation.				
Test procedure in brief	The test comprises exposure to the specified maximum and minimum power supply voltage conditions for a period sufficient for achieving temperature stability and performing the required measurements at these conditions.				
Nominal battery voltage	**U_{nom} = 12**		**U_{nom} = 24**		V
	Lower limit	Upper limit	Lower limit	Upper limit	
Test level	**9**	**16**	**16**	**32**	V
EUT performance	After stabilization at the relevant voltage record the following parameters: a) date and time,				

	b) temperature, c) relative humidity, d) test load value, e) indicated values, f) error values, g) functional performance
Permitted maximum deviation	All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 4.3.2

Table 10a Electrical transient conduction along supply lines

Applicable standard	ISO 7637–2 [28]				
Test method	Electrical transient conduction along supply lines.				
Applicability	Applicable to all measuring instruments while in operation are supplied by the internal battery of a vehicle which may at the same time be charged by use of a combustion engine driven generator				
Object of the test	Verification of compliance with the provisions in 7.2 under the following conditions: - transients due to a sudden interruption of currents in a device connected in parallel with the device under test due to the inductance of the wiring harness (pulse 2a); - transients from DC motors acting as generators after the ignition is switched off (pulse 2b); - transients on the supply lines which occur as a result of the switching processes (pulses 3a and 3b).				
Precondition	The electrical power of the EUT is switched on for at least the warm-up time specified by the manufacturer.				
Condition of the EUT	The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test except for a reset when a significant fault has been indicated.				
Test procedure in brief	The test comprises exposure to disturbances on the power voltage by direct coupling into the supply lines.				
	Test pulse	U_{nom} [1]	**12**	**24**	V
Test level	2a	U_s [2]	**+ 50**	**+ 50**	V
	2b	U_s [2]	**10**	**20**	V
	3a	U_s [2]	**- 150**	**- 200**	V
	3b	U_s [2]	**+ 100**	**+ 200**	V
NOTES	[1] U_{nom} = nominal battery voltage [2] As specified in ISO 7637-2				
EUT performance	Sequentially during and after the exposure to the transient record the following parameters: a) date and time, b) temperature, c) relative humidity, d) test load value, e) indicated values, f) error values,				

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	g) functional performance
Permitted maximum deviation	Either significant faults do not occur or checking facilities detect and act on potential significant faults, thus preventing such faults to occur. It is acceptable when during the disturbance test the AGFI is not providing a measurement result.

Table 10b Electrical transient conduction via lines other than supply lines

<table>
<tr><td>Applicable standard</td><td colspan="5">ISO 7637–3 [29], § 3.5.1: fast transient test pulses a and b</td></tr>
<tr><td>Test method</td><td colspan="5">Electrical transient conduction along lines other than supply lines</td></tr>
<tr><td>Applicability</td><td colspan="5">Applicable to analogue I/O cabling of modular measuring instruments installed in vehicles (1)</td></tr>
<tr><td>Object of the test</td><td colspan="5">Verification of compliance with the provisions in 7.2 under conditions of transients which occur on other lines as a result of the switching processes (pulses a and b)</td></tr>
<tr><td>Precondition</td><td colspan="5">The electrical power of the EUT is switched on for at least the warm-up time specified by the manufacturer.</td></tr>
<tr><td>Condition of the EUT</td><td colspan="5">The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test except for a reset when a significant fault has been indicated.</td></tr>
<tr><td>Test procedure in brief</td><td colspan="5">The test consists of exposure to bursts of voltage spikes by capacitive and inductive coupling via lines other than supply lines.
Only the Capacitive Coupling Clamp method shall be applied.</td></tr>
<tr><td rowspan="3">Test level</td><td>Test pulse</td><td>U_{nom} [1)]</td><td>12</td><td>24</td><td>V</td></tr>
<tr><td>pulse a</td><td>U_s [2)]</td><td>-60</td><td>-80</td><td>V</td></tr>
<tr><td>pulse b</td><td>U_s [2)]</td><td>40</td><td>80</td><td>V</td></tr>
<tr><td>NOTES</td><td colspan="5">[1)] U_{nom} = nominal battery voltage
[2)] As specified in ISO 7637-3</td></tr>
<tr><td>EUT performance</td><td colspan="5">Sequentially during and after the exposure to the transient record the following parameters:
a) date and time,
b) temperature,
c) relative humidity,
d) value of the measurand
e) exposed conductors,
f) indicated values,
g) error values,
h) functional performance</td></tr>
<tr><td>Permitted maximum deviation</td><td colspan="5">Either significant faults do not occur or checking facilities detect and act on potential significant faults, thus preventing such faults to occur.
It is acceptable when during the disturbance test the AGFI is not providing a measurement result.</td></tr>
</table>

Table 10c Battery voltage variations during starting up a vehicle engine

Applicable standard	ISO 16750-2 [24]					
Test method	Supply voltage variation due to energizing the starter motor of a vehicle					
Applicability	Measuring instruments powered by on board DC battery and may be in operation while the vehicle engine is started					
Object of the test	Verification of compliance with the provisions in 7.2 under conditions of starting the vehicle engine (during and after cranking)					
Precondition	The electrical power of the EUT is switched on for at least the warm-up time specified by the manufacturer.					
Condition of the EUT	The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test except for a reset when a significant fault has been indicated.					
Test procedure in brief	The test comprises exposure to a typical supply voltage characteristic simulating the voltage variation while cranking the engine using a DC electrical starter motor.					
	U_{nom} 1)	**12**		**24**		V
Test levels	Test profile 2)	**I**	**III**	**I**	**III**	
	U_S	**8**	**3**	**10**	**6**	V
	U_A	**9,5**	**5**	**20**	**10**	V
	t_8	**1**	**1**	**1**	**1**	s
	t_f	**40**	**100**	**40**	**40**	ms
NOTES	1) U_{nom} = nominal battery voltage 2) As specified in ISO 16750-2					
EUT performance	Sequentially during and after the exposure to the disturbance record the following parameters: a) date and time, b) temperature, c) relative humidity, d) test load value, e) indicated values, f) error values, g) functional performance					
Permitted maximum deviation	Either significant faults do not occur or checking facilities detect and act on potential significant faults, thus preventing such faults to occur. It is acceptable when during the disturbance test the AGFI is not providing a measurement result.					

Table 10d "Load dump" test

Applicable standard	ISO 16750-2 [24]
Test method	Supply voltage variation due to disconnecting a discharged battery

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Applicability	Measuring instruments powered by on board DC battery and may be in operation while the vehicle engine is running					
Object of the test	Verification of compliance with the provisions in 7.2 under conditions of disconnecting a discharged vehicle battery while the charging alternator is running.					
Precondition	The electrical power of the EUT is switched on for at least the warm-up time specified by the manufacturer.					
Condition of the EUT	The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test except for a reset when a significant fault has been indicated.					
Test procedure in brief	The test comprises exposure to a typical pulse on the supply voltage, simulating the voltage peak due to the impedance of connected loads when disconnecting the battery.					
	U_{nom} 1)	**12**		**24**		V
	Test pulse shape 2)	**I**	**II**	**I**	**II**	
	U_S	**80**	**100**	**150**	**200**	V
	R_i	**0,5**	**4**	**1**	**8**	V
	t_r	**10**	**10**	**10**	**10**	ms
	t_d	**40-400**	**40-400**	**100-350**	**100-350**	ms
NOTES	1) U_{nom} = nominal battery voltage 2) As specified in ISO 16750-2					
EUT performance	Sequentially during and after the exposure to the disturbance record the following parameters: a) date and time, b) temperature, c) relative humidity, d) test load value, e) indicated values, f) error values, g) functional performance					
Permitted maximum deviation	Either significant faults do not occur or checking facilities detect and act on potential significant faults, thus preventing such faults to occur. It is acceptable when during the disturbance test the AGFI is not providing a measurement result.					

~~Table 10 – Voltage variation from 12 V and 24 V road vehicle batteries~~

~~Environmental phenomena~~	~~Test specification~~			~~Test set-up~~
	~~U_{nom}~~	~~Upper limit~~	~~Lower limit~~	
~~Voltage variation from 12 V and 24 V road vehicle batteries~~	~~12 V~~	~~16 V~~	~~minimum operating voltage~~	~~ISO 16750-2~~
	~~24 V~~	~~32 V~~		
~~Note:~~	~~The nominal voltage (U_{nom}) of the electrical system in road vehicles is usually 12 V or 24 V. But the practical voltage at the battery-connection points can vary considerably.~~			

~~Supplementary information to the ISO test procedures:~~

~~Object of the test:~~	~~To verify compliance with the provisions in 4.7.2 under conditions of road vehicle battery voltage variations.~~
~~Test procedure in brief:~~	~~The test consists of exposure to the specified voltage supply condition for a period sufficient for achieving temperature stability and for performing the required measurements.~~
~~Preconditioning:~~	~~None~~
~~Condition of the EUT~~	~~EUT is connected to the voltage supply and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test and do not readjust at any time during the test except to reset if a significant fault has been indicated.~~
~~Number of test cycles:~~	~~At least one cycle for each functional mode.~~
~~Test information:~~	~~Stabilize the EUT at the nominal voltage and record the following data at no load and with one load or simulated load:~~ ~~a) date and time;~~ ~~b) temperature;~~ ~~c) relative humidity;~~ ~~d) voltage supply;~~ ~~e) test loads;~~ ~~f) indications (as applicable);~~ ~~g) errors;~~ ~~h) functional performance.~~ ~~Reduce the voltage supply to the EUT until the instrument clearly ceases to function properly according to the specifications and metrological requirements, and record the indication.~~
~~Maximum allowable variations:~~	~~For voltages above the lower limit, all functions shall operate as designed; for voltages below the lower limit, the instrument shall automatically resume normal operation without loss of any previous measurement data.~~ ~~All errors shall be within the maximum permissible errors specified in 4.2.1 for initial verification.~~

~~A.6.2.8~~A.6.2.9 Tilting (~~4.7~~4.8.3)

If 4.8.3 b) applies, the mentioned requirements must be tested in addition.

~~A.6.2.8~~A.6.2.9.1 Tilting of ~~AFGI~~AGFIs fitted with a level indicator or automatic tilt sensor (~~4.7~~4.8.3 a) and b))

~~A.6.2.8~~A.6.2.9.1.1 Tilting at no-load

The ~~AFGI~~AGFI shall be set to zero in its reference position (not tilted). The ~~AFGI~~AGFI shall then be tilted longitudinally up to the limiting value of tilting. The zero indication is noted. This test shall be repeated for each direction (longitudinally backwards and forwards, transversally leftside and rightside)~~The test shall be repeated with transverse tilting~~.

A.6.2.9.1.2~~A.6.2.8.2~~ Tilting when loaded

The ~~AFGI~~AGFI shall be set to zero in its reference position and two weighings shall be carried out at a load close to the lowest load where the maximum permissible error changes, and at a load close to Max. The AGFIs is then unloaded and tilted longitudinally and set to zero. The tilting shall be equal to the limiting value of tilting. Weighing tests as described above shall be performed. This test shall be repeated for each direction (longitudinally backwards and forwards, transversally leftside and rightside)~~The test shall be repeated with transverse tilting~~.

~~A.6.2.8.3~~A.6.2.9.2 ~~AFGI~~AGFIs not fitted with a level indicator or an automatic tilt sensor (~~4.7~~4.8.3 c)

The test in A.6.2.9.1 ~~A.6.2.8.3~~ only applies for ~~AFGI~~AGFIs liable to be tilted and not fitted with a level indicator which clearly indicates when the maximum permissible tilt has been exceeded nor with an automatic tilt sensor which clearly indicates when the maximum permissible tilt has been exceeded (e.g. by producing an error code or signal) and inhibits any printout and transmission of measurement data.

Object of the test:	To verify compliance with the provisions given in ~~4.7~~4.8.3.
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 a tilt of 5 % at Min (load close to the lowest load where the maximum permissible error changes) and Max ~~at a tilt of 5%~~. In case of AGFIs intended for installation in vehicles the test shall be conducted at a tilt of 10 %.
Maximum allowable variations:	All indications shall be within maximum permissible errors specified in ~~4.2~~4.3.2.
Condition of EUT:	The EUT is switched on for at least the warm-up time specified by the manufacturer. During the test the electrical power supplied to the EUT shall not be switched off.
	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 for each of the test set-ups as prescribed above:

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~~ 7.2)

Summary of disturbance tests

§	Test	Condition applied

A.6.3.1	AC mains voltage dips, short interruptions and reductions	Significant fault
A.6.3.2	Bursts (fast transient tests) on mains power lines and on signal, data and control lines	Significant fault
A.6.3.3	Electrostatic discharge	Significant fault
A.6.3.4	Immunity to electromagnetic fields	Significant fault
A.6.3.5	Surges on AC and DC mains power lines and on signal, data and control lines	Significant fault

NOTE 1:	Tests shall be conducted to the appropriate classification for electrical tests. The severity level stated in the tests A.6.3.1 to A.6.3.5 apply to AGFIs installed and used in locations with significant or high levels of electromagnetic disturbances corresponding to those likely to be found in industrial environments, class E2 of OIML D11 ~~[4]~~[3].
NOTE 2:	If there are interfaces on the instrument (or simulator), the use of these interfaces to other equipment shall be simulated in the tests. For this purpose, either an appropriate peripheral device or 3 m of interface cable to simulate the interface impedance of the other equipment shall be connected to each different type of interface.
NOTE 3:	In case of transient faults due transient disturbances it shall be considered whether these could make the AGFI detect that the preset value of the fill is reached. To that end the preset value of the fill may be set to a value that exceeds the test load by exactly the ~~significant~~ significant fault . In case of ~~exceeding~~the occurance of a ~~the~~ significant fault the AGFI would signal that the preset value has been reached by e.g. setting a digital output. Thus a significant fault due to transient disturbances can be detected.

A.6.3.1 AC mains voltage dips, short interruptions and reductions

AC mains voltage dips and short interruptions tests are carried out ~~according to basic standard IEC Publication 61000-4-11[18], and~~ according to Table 11.

Table 11 AC mains voltage dips, short interruptions and reductions	
Applicable standards	IEC 61000-4-11 [20], IEC 61000-6-1 [27], IEC 61000-6-2 [28]
Test method	Introducing short-time reductions of mains voltage using the test set-up defined in the applicable standard
Applicability	Applicable for measuring instruments with rated input current of less than 16 A per phase which are temporarily or permanently connected to an AC mains power network while in operation. This test is only applicable to equipment powered by AC mains supply and is not applicable to equipment powered by a road vehicle battery.
Object of the test	Verification of compliance with the provisions in 7.2 under conditions of short time mains voltage reductions.
Precondition	The electrical power of the EUT is switched on for at least the warm-up time specified by the manufacturer.
Condition of the EUT	The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test except for a reset when a significant fault has been indicated.

Test procedure in brief	A test generator is to be used which is suitable to reduce the amplitude of the AC mains voltage for the required period of time. The performance of the test generator shall be verified before connecting the EUT. The mains voltage reduction tests shall be repeated 10 times with intervals of at least 10 s between the tests. The tests shall be applied continuously during the measurement time. The interruptions and reductions are repeated throughout the time necessary to perform the whole test; for this reason, more than ten interruptions and reductions may be necessary.			
		Reduction of nominal voltage (U_{nom})		unit
Tests and levels	Test a	Reduction to	**0**	V
		Duration	**0.5**	cycles
	Test b	Reduction to	**0**	V
		Duration	**1**	cycles
	Test c	Reduction to	**40**	% of U_{nom}
		Duration	**10/12**	cycles
	Test d	Reduction to	**70**	% of U_{nom}
		Duration	**25/30**	cycles
	Test e	Reduction to	**80**	% of U_{nom}
		Duration	**250/300**	cycles
Short interruptions	Reduction to		**0**	V
	Duration		**250/300**	cycles
EUT performance	The fault of the EUT is determined separately for each of the different dips and reductions. Sequentially during and after the exposure to the disturbance record the following parameters: a) date and time, b) temperature, c) relative humidity, d) value of the measurand e) percentage of voltage reduction and duration, f) indicated values, g) error values, h) functional performance			
Permitted maximum deviation	Either significant faults do not occur or checking facilities detect and act on potential significant faults, thus preventing such faults to occur.			

~~Table 11 - AC mains voltage dips and short interruptions~~

~~Environmental phenomena~~	~~Test specification~~			~~Test set-up~~
	~~Test~~	~~Reduction of amplitude to~~	~~Duration / Number of cycles~~	~~IEC 61000-4-11~~
~~Voltage dips and~~	~~Test a~~	~~0 %~~	~~0.5~~	

~~short interruptions~~	~~Test b~~	~~0 %~~	~~1~~	
	~~Test c~~	~~40 %~~	~~10/12~~[2]	
	~~Test d~~	~~70 %~~	~~25/30~~[2]	
	~~Test e~~	~~80 %~~	~~250/300~~[2]	
	~~Short interruption~~	~~0 %~~	~~250/300~~[2]	

~~NOTE 1: A test generator suitable to reduce for a defined period of time the amplitude of one or more half cycles (at zero crossings) of the AC mains voltage shall be used. The test generator shall be adjusted before connecting the EUT. The mains voltage reductions shall be repeated ten times with an interval of at least ten seconds.~~

~~NOTE 2: These values are depending on national AC mains frequency~~

~~NOTE 3: In case of transient faults due transient disturbances it shall be considered whether these could make the AGFI detect that the preset value of the fill is reached. To that end the preset value of the fill may be set to a value that exceeds the test load by exactly the significant fault. In case of exceeding the significant fault the AGFI would signal that the preset value has been reached by e.g. setting a digital output. Thus a significant fault due to transient disturbances can be detected.~~

~~Supplementary information to the IEC test procedures:~~

~~Object of the test:~~ ~~To verify compliance with the provisions given in 7.2 under conditions of short mains voltage interruptions and reductions while observing the weight indication for a small static load.~~

~~Test procedure in brief:~~

~~Condition of the EUT:~~ ~~The EUT is connected to the mains power supply and switched on for at least the warm-up time specified by the manufacturer. During the test the electrical power supplied to the EUT shall not be switched off.~~

~~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:~~ ~~The EUT shall be tested with a small static test load.~~

~~Stabilize all factors at nominal reference conditions. Apply the test load and record the following data:~~

1. ~~Date and time~~

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~~2. Temperature~~
~~3. Relative humidity;~~
~~4. Voltage supply~~
~~5. Test load~~
~~6. Indications~~
~~7. Errors~~
~~8. Functional performance~~

~~Interrupt the power supply voltage to zero voltage for a period equal to one half cycle and conduct the test as detailed in IEC 61000-4-11[18] section 8.2.1. During interruption observe the effect on the EUT and record as appropriate.~~

~~Reduce the voltage 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 0.5.2.6, or the EUT shall detect and act upon a significant fault.~~

A.6.3.2 Bursts (fast transient tests) on mains power lines and on signal, data and control

Electrical bursts tests (fast transient tests) are carried out ~~according to basic standard IEC 61000-4-4[19] for 2 minutes with a positive polarity and for 2 minutes with a negative polarity, and~~ according to Tables 12.1 and Table 12.2.

Table 12.1 Bursts (transients) on AC and DC mains

Applicable standards	IEC 61000-4-4 [17]
Test method	Introducing transients on the mains power lines
Applicability	Applicable for electronic measuring instruments which are temporarily or permanently connected to a mains power network while in operation
Object of the test	Verification of compliance with the provisions in 7.2 during conditions where electrical bursts are superimposed on the mains voltage.
Precondition	The electrical power of the EUT is switched on for at least the warm-up time specified by the manufacturer.
Condition of the EUT	The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test except for a reset when a significant fault has been indicated.
Test procedure in brief	A burst generator as defined in the referred standard shall be used.

	The characteristics of the generator shall be verified before connecting the EUT. The test comprises exposure to bursts of voltage spikes for which the output voltage on 50 Ω and 1000 Ω load are defined in the referred standard. Both positive and negative polarity of the bursts shall be applied. The duration of the test shall not be less than 1 minute for each amplitude and polarity. The injection network on the mains shall contain blocking filters to prevent the burst energy being dissipated in the mains. At least 10 positive and negative randomly phased bursts shall be applied. The bursts are applied during all the time necessary to perform the test; therefore, more bursts than indicated above may be necessary.	
	Amplitude (peak value) [kV]	Repetition rate [kHz]
Test level	**2**	**5**
EUT performance	Sequentially during and after the exposure to the bursts record the following parameters: a) date and time, b) temperature, c) relative humidity, d) test load value, e) indicated values, f) error values, g) functional performance	
Permitted maximum deviation	Either significant faults do not occur or checking facilities detect and act on potential significant faults, thus preventing such faults to occur. It is acceptable when during the disturbance test the AGFI is not providing a measurement result.	

~~Table 12.1: Bursts (transients) on on signal, data and control lines~~

~~Environmental phenomena~~	~~Test specification~~	~~Test set-up~~
~~Fast transient common mode~~	~~1.0 kV (peak)~~ ~~5/50 ns T_1 / T_h~~ ~~5 kHz rep. 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 12.2 Bursts (transients) on signal, data and control lines

Applicable standards	IEC 61000-4-4 [17]
Test method	Introducing transients on signal, data and control lines
Applicability	Applicable for electronic measuring instruments containing active electronic circuits which during operation are permanently

	or temporarily connected to external electrical signal, data and/or control lines. Burst tests on signal lines are applicable only for I/O signal, data and control ports, with a cable length exceeding 3 m (as specified by the manufacturer).	
Object of the test	Verification of compliance with the provisions in 7.2 during conditions where electrical bursts are superimposed on I/O and communication ports.	
Precondition	The electrical power of the EUT is switched on for at least the warm-up time specified by the manufacturer.	
Condition of the EUT	The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test except for a reset when a significant fault has been indicated.	
Test procedure in brief	A burst generator as defined in the referred standard shall be used The characteristics of the generator shall be verified before connecting the EUT. The test comprises exposure to bursts of voltage spikes for which the output voltage on 50 Ω and 1000 Ω load are defined in the referred standard. Both positive and negative polarity of the bursts shall be applied. The duration of the test shall not be less than 1 min for each amplitude and polarity. A capacitive coupling clamp as defined in the standard shall be used for the coupling of the bursts into the I/O and communication lines,	
	Test level	unit
Amplitude (peak value)	**1**	kV
Repetition rate	**5**	kHz
EUT performance	Sequentially during and after the exposure to the Bursts Record the following parameters: a) date and time, b) temperature, c) relative humidity, d) value of the measurand e) exposed conductors, f) indicated values, g) error values, h) functional performance	
Permitted maximum deviation	Either significant faults do not occur or checking facilities detect and act on potential significant faults, thus preventing such faults to occur. It is acceptable when during the disturbance test the AGFI is not providing a measurement result.	

~~Table 12.2: Bursts (transients) on signal, data and control lines~~

~~Environmental phenomena~~	~~Test specification~~	~~Test set-up~~
~~Fast transient common mode~~	~~– 2.0 kV (peak)~~ ~~– 5/50 ns T_1 / T_h~~ ~~– 5 kHz rep. frequency~~	~~IEC 61000-4-4~~

~~NOTE: Not applicable to battery operated appliances that cannot be connected to the mains while in use.~~

~~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 7.2 under conditions where electrical bursts (fast transients) are superimposed on the mains voltage while observing the weight indication for a small static test load.~~
~~Test procedure in brief:~~	
~~Condition of the EUT:~~	~~The EUT is switched on for at least the warm-up time specified by the manufacturer. During the test the electrical power supplied to the EUT shall not be switched off.~~ ~~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:~~ • ~~Date and time~~ • ~~Temperature~~ • ~~Test load~~ • ~~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 0.5.2.6, or the AGFI shall detect and act upon a significant fault.~~

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A.6.3.3 Electrostatic discharge

Electrostatic discharge tests are carried out ~~according to basic standard IEC 61000-4-2 [21],~~ with test signals and conditions as given in Table 13.

Table 13 Electrostatic discharge

Applicable standard	IEC 61000-4-2 [15]
Test method	Exposure to electrostatic discharge (ESD)
Applicability	Applicable to all electronic measuring instruments

Object of the test	Verification of compliance with the provisions in 7.2 in case of direct exposure to electrostatic discharges or such discharges in the neighbourhood of the EUT.		
Precondition	The electrical power of the EUT is switched on for at least the warm-up time specified by the manufacturer.		
Condition of the EUT	The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test. The automatic zero-setting or zero-tracking, where available, shall be enabled as for normal operation.		
Test procedure in brief	The test comprises exposure of the EUT to electrical discharges. An ESD generator as defined in the referred standard shall be used and the test set-up shall comply with the dimensions, materials used and conditions as specified in the referred standard. Before starting the tests, the performance of the generator shall be verified. At least 10 discharges per preselected discharge location shall be applied. An EUT not equipped with a safety ground connection shall first be fully discharged before being exposed to a next discharge. The time interval between successive discharges shall be at least 1 second. Contact discharge is the preferred test method. Air discharge is far less defined and reproducible and therefore shall be used only where contact discharge cannot be applied. ***Direct application***: In the contact discharge mode to be carried out on conductive surfaces, the electrode shall be in contact with the EUT before activation of the discharge. In such a case the discharge spark occurs in the vacuum relays of the contact discharge tip. On insulated surfaces only the air discharge mode can be applied. The EUT is approached by the charged electrode until a spark discharge occurs. ***Indirect application***: The discharges are applied in the contact mode only on coupling planes mounted in the vicinity of the EUT. Conventionally 3 cycles of tests are performed starting each test at a different moment of the measuring cycle.		
	One of the following test levels may be specified:		
		Charge voltage	unit
Test level	Contact discharge	**6**	kV
	Air discharge	**8**	kV
EUT performance	Five measurements shall be performed at each surface exposed to the disturbance. Sequentially during and after the exposure to the discharges record the following parameters: a) date and time, b) temperature, c) relative humidity, d) test load e) value of the measurand, f) discharge type, level and side/surface exposed, g) indicated values, h) error values, i) functional performance		

Permitted maximum deviation	Either significant faults do not occur or checking facilities detect and act on potential significant faults, thus preventing such faults to occur. It is acceptable when during the disturbance test the AGFI is not providing a measurement result.

~~Table 13 – Electrostatic discharge tests~~

~~Environmental phenomena~~	~~Test specification~~	~~Test set-up~~
~~Electrostatic discharge~~	~~8 kV air discharge~~ ~~6 kV contact discharge~~	~~IEC 61000-4-2~~
~~NOTE 1: Tests shall be performed at the specified lower levels, starting with 2 kV and proceeding with 2 kV steps up to and including the level specified above in accordance with IEC 61000-4-2.~~ ~~NOTE 2: The 6 kV contact discharge shall be applied to conductive accessible parts. Metallic contacts, e.g. in battery compartments or in socket outlets are excluded from this requirement.~~		

~~Contact discharge is the preferred test method. 20 discharges (10 with positive and 10 with negative polarity) shall be applied on each accessible metal part of the enclosure. The time interval between successive discharges shall be at least 10 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 [21]. Air discharges shall be used where contact discharges cannot be applied. Tests with other (lower) voltages than those given in Table 13 are not required.~~

~~Supplementary information to the IEC test procedures:~~

~~Object of the test:~~ ~~To verify compliance with the provisions given in 7.2 under conditions where electrostatic discharges are applied while observing the weight indication for a small static test load.~~

~~Test procedure in brief:~~

~~Condition of the EUT:~~ ~~The EUT is connected to the voltage supply and switched on for at least the warm-up time specified by the manufacturer. During the test the electrical power supplied to the EUT shall not be switched off.~~

~~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:~~

- ~~Date and time~~
- ~~Temperature~~
- ~~Test load~~

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~~• 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 0.5.2.6, or the AGFI shall detect and act upon a significant fault.~~

A.6.3.4 Immunity to electromagnetic fields

A.6.3.4.1 Immunity to radiated (RF) electromagnetic fields

Radiated, radio frequency electromagnetic immunity tests are carried out ~~to IEC 61000-4-3 [22], and~~ according to Table 14.

~~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 14 Radiated RF electromagnetic fields

Applicable standard	IEC 61000-4-3 [16]; IEC 61000-4-20 [21]		
Test method	Exposure to radiated radio frequency electromagnetic fields		
Applicability	Applicable for electronic measuring instruments containing active electronic circuits		
Object of the test	Verification of compliance with the provisions in 7.2 while exposed to electromagnetic fields.		
Precondition	The electrical power of the EUT is switched on for at least the warm-up time specified by the manufacturer.		
Condition of the EUT	The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test. The automatic zero-setting or zero-tracking, where available, shall be enabled as for normal operation.		
Test procedure in brief	The EUT is exposed to electromagnetic fields with the required field strength and the field uniformity as defined in the referred standard. The level of field strength specified refers to the field generated by the unmodulated carrier wave. The EUT shall be exposed to the modulated wave field. The frequency sweep shall be made only pausing to adjust the RF signal level or to switch RF-generators, amplifiers and antennas if necessary. Where the frequency range is swept incrementally, the step size shall not exceed 1 % of the preceding frequency value. The dwell time of the amplitude modulated carrier at each frequency shall not be less than the time necessary for the EUT to be exercised and to respond, but shall in no case be less than 0.5 s. Adequate EM fields can be generated in facilities of different type and set-up the use of which is limited by the dimensions of the EUT and the frequency range of the facility.		
Test level	Frequency range	RF amplitude	AM, sine wave modulation

	(26) 80 - 3000	**10**	80	1
	MHz	V/m	%	kHz
NOTES	The tests according to IEC 61000-4-3 and IEC 61000-4-6 are complementary test. It implies that in the range 26 MHz up to 80 MHz the type evaluation authority may decide to choose a transition frequency in this range for instruments equipped with external electrical wiring (mains power, signal, data and control lines) In such case beneath this chosen transition frequency the test method according to IEC 61000-4-6 described in the above Table 15 is to be applied be applied at least down to 26 MHz.			
EUT performance	Sequentially during and after the exposure to the EM field record the following parameters: a) date and time, b) temperature, c) relative humidity, d) value of the measurand, e) field strength level, f) indicated values, g) error values, h) functional performance			
Permitted maximum deviation	Either significant faults do not occur or checking facilities detect and act on potential significant faults, thus preventing such faults to occur. It is acceptable when during the disturbance test the AGFI is not providing a measurement result.			

~~Table 14 - Immunity to radiated (RF) electromagnetic fields~~

~~Test specification~~			
~~Environmental phenomena~~	~~Frequency ranges (MHz)~~	~~Field strength (V/m)~~	~~Test set-up~~
~~Radiated electromagnetic immunity tests~~	~~80 to 2700~~[(1)]	~~10~~	~~IEC 61000-4-3~~
	~~26 to 80~~[(2)]		
~~Modulation~~	~~80 % AM, 1 kHz sine wave~~		

~~Supplementary information to the IEC test procedures:~~

~~Object of the test:~~ ~~To verify compliance with the provisions given in 7.2 under conditions of specified electromagnetic fields applied while observing the weight indication for a small static test load.~~

~~Test procedure in brief:~~

~~Condition of the EUT:~~ ~~The EUT is connected to the voltage supply and switched on for at least the warm-up time specified by the manufacturer. During the test the electrical power~~

	~~supplied to the EUT shall not be switched off.~~
	~~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 0.5.2.6, or the AGFI shall detect and act upon a significant fault.~~

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A.6.3.4.2 Immunity to conducted electromagnetic fields

Conducted, radio frequency, electromagnetic field immunity tests are carried out ~~in accordance to IEC 61000-4-6[23] and~~ according to Table 15.

Table 15 Conducted (common mode) currents generated by RF EM fields

Applicable standard	IEC 61000-4-6 [19]
Test method	Injection of RF currents representing exposure to RF electromagnetic fields
Applicability	Applicable for electronic measuring instruments containing active electronic circuits and equipped with ports for throughput or connection of external electrical wiring (mains power, signal, data and control lines)
Object of the test	Verification of compliance with the provisions in 7.2 while exposed to electromagnetic fields.
Precondition	The electrical power of the EUT is switched on for at least the warm-up time specified by the manufacturer.
Condition of the EUT	The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test. The automatic zero-setting or zero-tracking, where available, shall be enabled as for normal operation.
Test procedure in brief	An RF EM current, simulating the influence of EM fields shall be coupled or injected into the power ports and I/O ports of the EUT using coupling/decoupling devices as defined in the referred standard. The characteristics of the test equipment consisting of an RF generator, (de-)coupling devices, attenuators, etc. shall be verified before connecting the EUT.

	If the EUT comprises several devices the tests shall be performed at each extremity of the cable if both of the elements are part of the EUT.			
	Frequency range	RF amplitude	AM, sine wave modulation	
Test level	0.15 – 80	10	80	1
Unit	MHz	V (e.m.f.)	%	kHz
EUT performance	Sequentially during and after the exposure to the RF current record the following parameters: a) date and time, b) temperature, c) relative humidity, d) value of the measurand, e) applied RF (e.m.f.) voltage level , f) indicated values, g) error values, h) functional performance			
Permitted maximum deviation	Either significant faults do not occur or checking facilities detect and act on potential significant faults, thus preventing such faults to occur. It is acceptable when during the disturbance test the AGFI is not providing a measurement result.			

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

~~Table 15 – Immunity to conducted electromagnetic fields~~

~~Test specification~~			
~~Environmental phenomena~~	~~Frequency range MHz~~	~~RF amplitude (50 ohms) V (e.m.f)~~	~~Test set-up~~
~~Conducted electromagnetic immunity tests~~	~~0.15 to 80~~	~~10~~	~~IEC 61000-4-6~~
~~Modulation~~	~~80 % AM, 1 kHz sine wave~~		
~~NOTE: This test is not applicable when the EUT has no mains or other input port.~~			

~~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 7.2 under conditions of specified conducted electromagnetic fields while observing the weight indication for a static test load.~~

~~Test procedure in brief:~~

~~Condition of the EUT:~~	~~The EUT is connected to the voltage supply and switched on for at least the warm-up time specified by the manufacturer. During the test the electrical power supplied to the EUT shall not be switched off.~~ ~~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:~~ ~~1. Date and time~~ ~~2. Temperature~~ ~~3. Test load~~ ~~4. 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 0.5.2.6, or the AGFI shall detect and act upon a significant fault.~~

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A.6.3.5 Surges on AC and DC mains power lines and on signal, data and control lines

Electrical surge tests are carried out ~~according to IEC 61000-4-5 [20] and~~ according to Tables 16.1 and Table 16.2.

Table 16.1 Surges on AC and DC mains power lines

Applicable standard	IEC 61000-4-5 [18]
Test method	Introducing electrical surges on the mains power lines
Applicability	Applicable for electronic measuring instruments which are temporarily or permanently connected to a mains power network while in operation This test is not applicable to instruments connected to a local power source through an indoor network
Object of the test	Verification of compliance with the provisions in 7.2 during conditions where electrical surges are superimposed on the mains voltage
Precondition	The electrical power of the EUT is switched on for at least the warm-up time specified by the manufacturer.
Condition of the	The electrical power supplied to the EUT shall not be switched

EUT	off and the EUT shall not be readjusted at any time during the test except for a reset when a significant fault has been indicated.
Test procedure in brief	A surge generator as defined in the referred standard shall be used The characteristics of the generator shall be verified before connecting the EUT. The test comprises exposure to electrical surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impedance load and the minimum time interval between two successive pulses are defined in the referred standard. At least 3 positive and 3 negative surges shall be applied. On AC mains supply lines the surges shall be synchronised with the AC supply frequency and shall be repeated such that injection of surges on all the 4 phase shifts: 0°, 90°, 180° and 270° compared to the mains phase is covered. The injection network circuit depends on the applicable conductor and is defined in the referred standard. The surges are applied during all the time necessary to perform the test; to that purpose more surges than indicated above may be necessary.

Mains mode	AC		DC		
	Line to line	Line to ground	Line to line	Line to ground	unit
Test level	**1.0**	**2.0**	**1.0**	**2.0**	V

EUT performance	Sequentially during and after the exposure to the surges record the following parameters: a) date and time, b) temperature, c) relative humidity, d) test load value, e) indicated values, f) error values, g) functional performance.
Permitted maximum deviation	Either significant faults do not occur or checking facilities detect and act on potential significant faults, thus preventing such faults to occur. It is acceptable when during the disturbance test the AGFI is not providing a measurement result.

Table 16.2 Surges on signal, data and control lines

Applicable standard	IEC 61000-4-5 [18]
Test method	Introducing electrical surges on signal, data and control lines
Applicability	Applicable for electronic measuring instruments containing active electronic circuits which during operation are temporarily or permanently connected to electrical signal, data and/or control lines that may exceed a length of 10 m. This test is not applicable to instruments connected to a local power source through an indoor network.

Object of the test	Verification of compliance with the provisions in 7.2 during conditions where electrical surges are superimposed on I/O and communication ports.				
Precondition	The electrical power of the EUT is switched on for at least the warm-up time specified by the manufacturer.				
Condition of the EUT	The electrical power supplied to the EUT shall not be switched off and the EUT shall not be readjusted at any time during the test except for a reset when a significant fault has been indicated.				
Test procedure in brief	A surge generator as defined in the referred standard shall be used. The characteristics of the generator shall be verified before connecting the EUT. The test comprises exposure to electrical surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impedance load and the minimum time interval between two successive pulses are defined in the referred standard. At least 3 positive and 3 negative surges shall be applied. The applicable injection network depends on the kind of wiring the surge is coupled into and is defined in the referred standard.				
	Unsymmetrical lines		Symmetrical lines	Shielded I/O and communication lines	
Test Level	Line to line	Line(s) to ground	Line(s) to ground	Line(s) to ground	Unit
	1.0	**2.0**	**2.0**	**2.0**	kV
EUT performance	Sequentially during and after the exposure to the surges record the following parameters: a) date and time, b) temperature, c) relative humidity, d) value of the measurand e) exposed conductors, f) indicated values, g) error values, h) functional performance				
Permitted maximum deviation	Either significant faults do not occur or checking facilities detect and act on potential significant faults, thus preventing such faults to occur. It is acceptable when during the disturbance test the AGFI is not providing a measurement result.				

~~Table 16 - Surges on AC and DC mains power lines and on signal, data and control lines~~

~~Environmental phenomena~~	~~Test specification~~	~~Test set-up~~
~~Surges on mains power lines and on signal and communication~~	~~(g) 1.0 kV line to line~~ ~~(h) 2.0 kV line to earth~~ ~~(i) 3 positive and 3 negative surges applied synchronously with AC supply voltage in~~	~~IEC 61000-4-5~~

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~~lines~~	~~angles 0°, 90°, 180° and 270°.~~ ~~(j) 3 positive and 3 negative surges applied on DC voltage lines and on signal and communication lines.~~	
~~Note:~~	~~This test is only applicable in those cases where, based on typical situations of installation, the risk of a significant influence of surges can be expected. This is especially relevant in cases of outdoor installations and/or indoor installations connected to long signal lines (lines longer than 30 m or those lines partially or fully installed outside the buildings regardless of their length).~~	

~~Supplementary information to the IEC test procedures:~~

~~Object of the test:~~ ~~To verify compliance with the provisions in 7.2 under conditions where electrical surges are applied separately to the mains voltage lines and to the signal and communication lines (if any), while observing the weight indication for a small static test load.~~

~~Condition of the EUT:~~ ~~The characteristics of the test generator shall be verified before connecting the EUT.~~

~~The EUT is connected to the power supply and switched on for at least the warm-up time specified by the manufacturer. During the test the electrical power supplied to the EUT shall not be switched off.~~

~~Adjust the EUT as close to zero indication as practicable, prior to the test. Zero-setting functions shall not be in operation and are not to be adjusted at any time during the test except to re-set if a significant fault has occurred.~~

~~Number of test cycles:~~ ~~At least one cycle.~~

~~Test information:~~ ~~The test consists of exposure to surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impendence load and minimum time interval between two successive pulses are defined in IEC 61000-4-5. The injection network depends on the lines the surge is coupled to and is defined in IEC 61000-4-5.~~

~~Before any test stabilize the EUT under constant environmental conditions. Changes in barometric pressure shall be taken into account. With the single static load in place record the following with and without the surges:~~

- ~~e) Date and time;~~
- ~~f) Temperature;~~
- ~~g) Relative humidity;~~
- ~~h) Supply voltage;~~
- ~~i) Test load;~~
- ~~j) Indications (as applicable);~~

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~~k) Errors;~~
~~l) Functional performance;~~
~~m) Barometric pressure~~

~~Maximum allowable variations:~~ ~~The difference between the indication due to the disturbance and the indication without the disturbance (intrinsic error) either shall not exceed the fault specified in 0.5.2.6, or the EUT shall detect and react to a significant fault.~~

A.6.3.6 Special EMC requirements for instruments powered from a road vehicle power supply

A.6.3.6.1 Electrical transient conduction along supply line of external 12 V and 24 V batteries

The test consists in exposing the EUT to conducted transient disturbances along supply lines.

Test equipment: See ISO 7637-2 [25]
Test set-up: See ISO 7637-2 [25]
Test procedure: See ISO 7637-2 [25]

Applicable standard: ISO 7637-2 [25]

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

The EUT shall be exposed to conducted disturbances of the strength and character as specified by the severity level.

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

Test pulses : Test pulses: 2a+2b, 3a+3b, 4
Objective of the test : To verify compliance with the provisions mentioned under "maximum allowable variations" under the following conditions:

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

Test severity: Level IV of 7637-2 [25]:

Battery voltage	Test pulse	Conducted voltage
12 V	2a	+50 V
	2b	+10 V

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	3a	-150 V
	3b	+100 V
	4	-7 V
24 V	2a	+50 V
	2b	+20 V
	3a	-200 V
	3b	+200 V
	4	-16 V

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

Reference: [28]

A.6.3.6.2 Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines

The test consists in exposing the EUT to conducted disturbances along lines other than supply lines.

Test equipment: See ISO 7637-3 [26]
Test set-up: See ISO 7637-3 [26]
Test procedure: See ISO 7637-3 [26]

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Applicable standard: ISO 7637-3 [26]

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

The EUT shall be exposed to conducted disturbances of the strength and character as specified by the severity level.

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

Test severity: according to ISO 7637-3 [26]

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Test pulses : Test pulses: a and b
Objective of the test : To verify compliance with the provisions mentioned under "maximum allowable variations" under conditions of transients which occur on other lines as a result of the switching processes (pulses a and b)

Test severity: Level IV of ISO 7637-3 [26]

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Battery voltage	Test pulse	Conducted voltage
12 V	a	-60 V
	b	+40 V
24 V	a	-80 V
	b	+80 V

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

A.7 Span stability test (~~in accordance with~~ 7.10.3)

Test method:	Span stability.
Object of the test:	To verify compliance with the provisions given in 7.10.3 after the EUT has been subjected to the performance tests.
Reference to standard:	No reference 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 power supply 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 AGFI 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:	$0.5 \leq t \leq 10$
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~~mpe for influence factor tests (~~4.2~~4.3.2) 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

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And 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~~ 8.2.3.1)

Operational tests with material shall be done on a complete AGFI to assess compliance with the requirements of clause 6 with material for the test load as specified in 8.2.3.1.

A.8.1.1 Feeding device (details as given in 5.6)

Check that the feeding device provides 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 AGFIs using the subtractive weighing principle check that residual material retained at the feeding device after each load is delivered, is negligible relative to error limitation.

A.8.1.2 Load receptor (details as given in 5.7)

For AGFIs 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 error limitation.

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~~ 8.3.2)

Metrological tests with material shall be done on a complete AGFI, fully assembled and fixed in the position in which it is intended to be used and as specified in 8.3.2.

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

A.8.2.1 Requirements for metrological material tests:

(a) Types of loads shall be as specified in 9.2.2.

(b) Mass of test loads and fills shall be as specified in 9.2.1 a), b) and c).

(c) Condition of material tests shall be as specified in 9.2.3

(d) Number of fills shall be as specified in 9.3.

A.8.2.2 Methods for metrological material tests (as given in 9.5)

One of the following verifications methods shall be used:

a) Separate verification method: the separate verification method is as defined in 9.5.1.

b) Integral verification method: the integral verification method is as defined in 9.5.2.

A.8.2.3 Procedure for metrological material tests

(a) Set up the AGFI in accordance with the conditions of test given in 9.2.3.

(b) 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 9.2.1. Record the indicated preset value.

(c) Run the AGFI to produce a number of fills as specified in 9.3 using types of test loads specified in 9.2.2.

(d) Weigh all the fills by either:

(1) Separate verification method specified in 9.5.1 or

(2) The integral verification method specified in 9.5.2

to determine the mass of fill in accordance with 9.7 so that the result of weighing the test fill on the control ~~AGFI~~ instrument shall be considered as the conventional true value of the test fill.

(e) In accordance with 9.7 calculate the average value of all the fills in the test as follows:

$$\sum_{i=1}^{n} F_i \Big/ n$$

where:

F is the mass of the fill (conventional true value), in units of mass

n is the number of fills in the test

~~(e)~~(f) In accordance with 9.8 calculate the deviation of each fill from the average of all the fills in the test as follows:

$$|md| = F_i - \left(\sum_{i=1}^{n} F_i \Big/ n \right)$$

where:

md is the deviation from average, in units of mass

~~(k)~~(g) Repeat stages (~~2~~b) to (~~6~~f) for other loads as specified for values of the mass of the fills in 9.2.1.

A.8.2.4 Determination of accuracy class, X(x) (~~in accordance with~~ 8.2.5)

(a) For each preset value of the test fill (F_P):

(1) Calculate the preset value error specified in ~~4.2~~4.3.3 in accordance with 9.9 as follows:

$$|se| = \left(\sum_{i=1}^{n} F_i \Big/ n \right) - F_P$$

where:

se is the preset value error.

(2) Determine the maximum permissible preset value error for class X(1), ~~MPSE~~$mpse_{(1)}$ as follows:

~~MPSE~~$mpse_{(1)}$ = 0.25 ~~MPD~~$mpd_{(1)}$ ~~for~~ in-service ~~inspection~~, corresponding to the value of a fill equal to F_P

(3) Then calculate: [$|se|$ / ~~MPSE~~$mpse_{(1)}$]~~-~~.

(b) For each preset value of the test fill (F_P):

(1) Determine the maximum (largest) of the absolute values of the actual deviation from the average i.e. md_{max}

(2) Determine the maximum permissible deviation from the average for class X(1), ~~MPD~~mpd$_{(1)}$.

(3) Then calculate: $[md_{max}$ / ~~MPD~~mpd$_{(1)}]$.

(c) From (a) determine the maximum (largest) value of $[|se|$ / ~~MPSE~~mpse$_{(1)}]$,

i.e. $[|se|$ / ~~MPSE~~mpse$_{(1)}]_{max}$ from all the preset test fills

(d) From (b) determine the maximum (largest) value of $[md_{max}$ / ~~MPD~~mpd$_{(1)}]$,

i.e. $[md_{max}$ / ~~MPD~~mpd$_{(1)}]_{max}$ from all the preset test fills

(e) Determine the accuracy class X(x) such that

$(x) \geq [|se|$ / ~~MPSE~~mpse$_{(1)}]_{max}$

and $(x) \geq [md_{max}$/ ~~MPD~~mpd$_{(1)}]_{max}$

and $(x) = 1 \times 10^k$, 2×10^k, or 5×10^k,

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

Annex B: Requirements for software controlled AGFIs
(Mandatory)

The specific software terminology is defined in OIML D 31~~:2008 Chapter 3~~ [29].

B.1 General requirements

B.1.1 Software identification

The legally relevant parts of the software of a AGFI and/or its ~~constituents~~ modules shall be clearly identified with the software version or any other token. The identification may apply to more than one part but at least one part shall be dedicated to the legal purpose.

The identification shall be inextricably linked to the software and shall be:

- presented or printed on command, or
- displayed during operation, or
- displayed at switch-on for those AGFIs that can be switched on and off.

If a ~~constituent~~ module of the AGFI has no display, the identification shall be sent to some other device via a communication interface in order to be displayed on this display of the AGFI or printout~~device~~.

As an exception, an imprint of the software identification on the AGFI shall be an acceptable solution if it satisfies the following three conditions:

~~e)~~a) The user interface does not have any control capability to activate the indication of the software identification on the display, or the display does not technically allow the identification of the software to be shown (analogue indicating device or electromechanical counter).

~~f)~~b) The AGFI does not have an interface to communicate the software identification.

~~g)~~c) After production of the AGFI a change of the software is not possible, or only possible if the hardware or a hardware component is also changed.

~~h)~~d) The software identification and the means of identification shall be stated in the type approval certificate.

B.1.2 Correctness of algorithms and functions

The measuring algorithms and functions of the AGFI and~~/or~~ its ~~constituents~~ modules shall be appropriate and functionally correct.

It shall be possible to examine algorithms and functions either by metrological tests, software tests or software examination.

B.1.3 Software protection (against fraud)

The legally relevant software part shall be secured against unauthorized modification, loading, or changes by swapping the memory device. In addition to mechanical sealing, technical means may be necessary to protect AGFIs equipped with an operating system or an option to load software.

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

Parameters that fix the legally relevant characteristics of the AGFI shall be secured against unauthorized modification. For the purpose of verification, displaying and printing of the current parameter settings shall be possible.

NOTE*:* Device-specific parameters may be adjustable or selectable only in a special operational mode of the AGFI. They may be classified as those that should be secured (unalterable) and those that may be accessed (alterable parameters) by an authorized person, e.g. the AGFI owner or product vendor. ~~Software protection comprises appropriate sealing by mechanical, electronic and/or cryptographic means, making an unauthorized intervention impossible or evident.~~

B.1.3.1 Support of fault detection

The detection by the checking facilities of significant faults may be achieved by software. In such a case, this detecting software is considered legally relevant.

The documentation to be submitted for type evaluation shall contain a list of the anomalies that might result in a significant fault but that will be detected by the software. The documentation shall include information on the expected reaction and in case needed for understanding its operation, a description of the detecting algorithm.

B.2 Requirements for specific configurations

B.2.1 Specifying and separating relevant parts and specifying interfaces of parts

Metrologically relevant parts of a AGFI – whether software or hardware parts – shall not be inadmissibly influenced by other parts of the AGFI.

This requirement applies if the AGFI and~~/or~~ its ~~constituents~~modules have interfaces for communicating with other electronic devices, with the user, or with other software parts next to the metrological critical parts.

B.2.1.1 Separation of ~~constituents~~modules of an AGFI

B.2.1.1.a ~~Constituents~~Modules of a AGFI that perform functions which are relevant to legal metrology shall be identified, clearly defined, and documented. These modules form the legally relevant part of the AGFI.

B.2.1.1.b It shall be demonstrated that those relevant functions and data of ~~constituents~~modules cannot be inadmissibly influenced by commands received via an interface.

This implies that there is an unambiguous assignment of each command to all initiated functions or data changes in the constituent.

B.2.1.2 Separation of software parts

B.2.1.2.a All software modules (programs, subroutines, objects, etc.) that perform functions which are relevant to legal metrology or that contain legal metrology relevant

data domains are considered to be legal metrology relevant software part of an AGFI. This part shall be made identifiable as described in B.1.1.
If the separation of the software is not possible, all software is considered legally relevant.

B.2.1.2.b If the legal metrology relevant software part communicates with other software parts, a software interface shall be defined. All communication shall be performed exclusively via this interface. The legal metrology relevant software part and the interface shall be clearly documented. All legally relevant functions and data domains of the software shall be described to enable a type evaluation authority to decide whether this software is sufficiently separated.

The interface comprises program code and dedicated data domains. Defined coded commands or data are to be exchanged between the software parts through storing to the dedicated data domain by one software part and reading from it by the other. Writing and reading program code is considered part of the software interface.

The data domain forming the software interface shall be clearly defined and documented and include the code that exports from the legally relevant part to the interface and the code that imports from the interface to this legally relevant part. The declared software interface shall not be circumvented.

The manufacturer is responsible for respecting these constraints. Technical means (such as sealing) of preventing a program from circumventing the interface or programming hidden commands shall not be possible. The programmer of the legal metrology relevant software part as well as the programmer of the legally non-relevant part shall be provided with instructions concerning these requirements by the manufacturer.

B.2.1.2.c There shall be an unambiguous assignment of each command to all initiated functions or data changes in the legally relevant part of the software. Commands that communicate through the software interface shall be declared and documented. Only documented commands are allowed to be activated through the software interface. The manufacturer shall state the completeness of the documentation of commands.

B.2.1.2.d Where legal metrology relevant software has been separated from non-relevant software, the legal metrology relevant software shall have priority using the resources over non-relevant software. The measurement task (realized by the legal metrology relevant software part) must not be delayed or blocked by other tasks.

The manufacturer is responsible for respecting these constraints. Technical means for preventing a legally non-relevant program from disturbing legally relevant functions shall be provided. The programmer of the legally relevant software part as well as the programmer of the legal metrology non-relevant part shall be provided with instructions concerning these requirements by the manufacturer.

B.2.2 Shared indications

A display may be employed for presenting both information from the legal metrology relevant part of software and other information.

Software that realizes the indication of measurement ~~values~~ results and other legally relevant information belongs to the legally relevant part.

B.2.3 Storage of data, transmission via communication systems

If measurement ~~values~~ results will be used at a location different from the place of measurement or at a stage later than the time of measurement, they may need to be retrieved from the AGFI and be stored ~~or transmitted in an insecure environment~~ before they are used for legal purposes. In that case the following requirements apply:

B.2.3.1 The measurement ~~value~~ result stored ~~or transmitted~~ shall be accompanied by all relevant information necessary for the future legally relevant use.

B.2.3.2 The data shall be protected by software means to guarantee the authenticity, integrity and, if necessary, the correctness of the information concerning the time of measurement. The software that displays or further processes the measurement ~~values~~ results and the accompanying data shall check the time of measurement, authenticity, and integrity of the data after having read them from the ~~insecure~~ storage ~~or after having received them from an insecure transmission channel~~.

The memory device shall be fitted with a checking facility to ensure that if an irregularity is detected, the data shall be discarded or marked unusable.

Software modules that prepare data for storing ~~or sending~~, or that check data after reading or receiving are considered part of the legally relevant software.

B.2.3.3 When transferring measurement ~~values~~ results through an open network, it is necessary to apply cryptographic methods. Confidentiality key-codes employed for this purpose shall be kept secret and secured in the measuring AGFIs, electronic devices, or sub-assemblies involved. Security means shall be provided whereby these keys can only be input or read if a seal is broken.

B.2.3.4 Transmission delay

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

B.2.3.5 Transmission interruption

If communication network services become unavailable, no measurement data shall be lost. The loss of measurement data shall be prevented.

B.2.4 Automatic storage

When, considering the application, data storage is required, measurement data must be stored automatically, B.e. when the final value used for the legal purpose has been generated.

The storage device must have sufficient permanency to ensure that the data are not corrupted under normal storage conditions. There shall be sufficient memory storage for any particular application.

When the final value used for the legal purpose results from a calculation, all data that are necessary for the calculation must be automatically stored with the final value.

B.2.5 Deleting of data

Stored data may be deleted when the transaction is settled.

Only after this condition is met and insufficient memory capacity is available for storage of successive data, it is permitted to delete memorized data when both the following conditions are met:

1. the sequence of deletion of data will be in the same order as the recording order (fifo) while the rules established for the particular application are respected;
2. with the consent of the user the required deletion will start either automatically or after a specific manual operation.

B.3 Maintenance and re-configuration

Updating:

1. the legally relevant software of an instrument in service shall be considered as:
2. a modification of the instrument, when exchanging the software with another approved version;
3. a repair of the instrument, when re-installing the same version.

An instrument which has been modified or repaired while in service may require initial or subsequent verification, dependant on national regulations.

This clause does not concern software which has or will have no influence on metrological relevant functions or functioning of the instrument.

Annex C - Error calculation for multi-load AGFIs (Mandatory)

C.1 Fault limit for multi-load AGFIs

a) Fault limit for selective combination weighers:

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A fault greater than 0.25 mpd in-service of each fill (Table 1) 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) AGFI with Min = 200 g designed for an average of 8 loads per fill, fill = 1 600 g, the mpd in-service of each fill from the average fill (Table 1) is 1.5 % = 24 g. Hence the fault limit is:

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

b) Fault limit for cumulative weighers:

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A fault greater than 0.25 mpd in-service of each fill (Table 1), 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) AGFI 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 (in Table 1) for the Minfill of 8 kg is 1.5 % or 120 g. Hence the fault limit is:

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

NOTE: This calculation of the fault limit value for cumulative weighers does not include Min. A cumulative weigher would normally be used at or near to Max.

C.2 Influence factor tests mpes for multi-load AGFIs

This method determines the maximum permissible error for influence factor testing for a fill consisting of more than one static test load.

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

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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 in-service is 3 %, i.e. 12 g. Hence the mpe for influence factor tests is:

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

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

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Example: For a class X(1) AGFI 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 maximum permissible 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.

~~Annex C~~Annex D (Informative)

Equipment Under Test

~~C.1~~D.1 Selection of EUTs

AGFIs shall be categorized primarily by the fundamental engineering design they are constructed upon. The categories of design may include but are not limited to the following basic operating principles:

1. Mechanical – no electronics;
2. Analogue, strain gauge type load cells;
3. Digital load cells.

Those AGFIs using load cell technology may further be categorized by using the method that the load cells are mounted / connected to the weight receiving element and supporting structures. Examples may include but are not limited to:

1. Direct mounting of load cells without check rods;
2. Connection of the weighing elements to load cell via lever system;
3. Isolated from load cell and with check rods or flexures.

The selection of EUTs to be tested shall be such that at least the EUT that represents the “worst case” sample from that family is selected along with a EUT representing a best (or better) casefrom the family. ~~,~~ It is recommended that the worst case EUT be selected based on the following:

For testing performed in a laboratory setting:

1. Lowest input signal from the force transducer(s);
2. Unit with all the interfaces (i.e. peripheral equipment, hardware components);
3. Unit with all the necessary load cells.

~~C.2~~D.2 Other metrological features to be considered

~~For example, it is not acceptable to test the temperature effect on no-load indication on one EUT and the combined effect on a different one.~~ Variations in metrologically relevant features and functions such as different:

- housings;
- load receptors;
- temperature and humidity ranges;
- AGFI functions;
- displacement transducer;
- indications; etc.;

may require additional partial testing of those factors which are influenced by that feature. These additional tests should preferably be carried out on the same EUT, but if this is not possible, tests on one or more additional EUTs may be performed under the responsibility of the testing authority.

The ability of the AGFI to withstand all required performance tests during the evaluation may be a good indication of the durability.

~~Annex D~~Annex E (Informative)
Considerations concerning durability

~~D.1~~E.1 Type ~~Approval~~ Evaluation

A durability assessment performed under type evaluation should take into account that (lack of) durability may be a characteristic of a particular installation. Hence a decision not to type approve an AGFI may only be justified where the unacceptable level of durability is clearly a characteristic of the type.

Where measures to ensure durability are taken, this shall be recorded in ~~R60-3~~R 61-3 Test Report format.

~~D~~E.2 Subsequent metrological control

To reduce the risks of non-durable AGFIs the arrangements for subsequent metrological control shall incorporate means for reviewing intervals for subsequent verification and in-service inspection, based on performance of an AGFI over time. ILAC-G24/OIML D 10 [~~25~~30] indicates methods (see clause ~~3~~4) which are useful for this purpose."

Should an AGFI (installed in a particular location) be found to be of unacceptable durability, that AGFI shall be withdrawn from use. If unacceptable durability was found to be a characteristic of the type (unacceptable durability regardless of the installation), withdrawal of the type approval shall be considered.

E.3 Tests of importance for conversion

Basic conditions:

- A module including the A/D converter (indicator analog data processing unit) has been tested, to which neither a verification scale interval "e" nor a scale interval "d" in units of mass has been assigned but only a minimum signal voltage in microvolt per "e" or "d" and a maximum number of scale intervals.
- The manufacturer wants to build a wide range of types of instruments with different maximum loads (Max), minimum load (Min) and scale intervals (d), as well as different Minfills.
- Minfill is unknown.

Influence factors and disturbances having an effect on the result of the fill:

1. The change of span

Tests to be considered: temperature and damp heat

2. The change of zero

Tests to be considered: accuracy of zero / tare setting, temperature (drift of zero), warm up (drift of zero)

3. Faults due to disturbances

Tests to be considered: short time power reductions, bursts, surge, electrostatic discharges, radiated electromagnetic fields, conducted radio-frequency fields

NOTE: Transitory faults can be very critical to filling machines, but these are not considered while testing according to R 76 [6] since they are regarded as being obvious to the user. Yet, with filling machines this is different, since the instrument could consider the set value to be reached due to a temporary disturbance increasing the weight indication, and thus might open the flaps of the weighing hopper. This would lead to incorrect fillings. Therefore, the results of R 76 [6] disturbance tests cannot be generally accepted for conversion to R 61, unless the transitory faults have been taken into account in the R 76 [6] report.

E.4 Conversion of relevant test results

The error limits according R 76 [6] are based on the maximum number of scale intervals only, irrespective of the mass value of the scale interval, since they are given as fractions of the scale interval. This is not the case with R 61 which introduces a completely different error regime based on the concrete mass values of the fill. Therefore the minimum microvolt per e / d or a corresponding number of digits have to be assigned to a concrete value of d in gram. The d has to be listed in the type approval certificate since the attainable minimum fill (Minfill) depends on this value. The smaller d is, the smaller the permissible Minfill will be. The value of d is independent of the minimum microvolt per d (e) the indicator is specified for, since it is the load cell of which the Max is crucial, provided that its output signal is sufficiently high to fulfill the requirement not to fall below the minimum voltage per d.

Generally the fill is affected by influences on the span and on zero of the instrument. The latter is especially critical for gravimetric filling machines because zero setting is normally not part of every weighing cycle. Thus any drift of zero directly affects the fill. This effect may be more significant than any effect on the span. This can be well seen from a comparison of R 76 [6] error limits to R 61 error limits. Since the latter ones are (in principle) percentage error limits, the absolute maximum permissible error (mpe) for fills higher than 200 d according to R 61 (setting error 0.25 mpd $_{\text{in service}}$) is much higher than the mpe according to R 76 [6], depending on the fill. The higher the fill related to d, the more uncritical is the R 61 error limit compared to R 76 [6] (see Figure 2).

Remarks:
For all following example calculations the percentage values instead of absolute values given in Table 1 of OIML R 61 have been used. The reason can most easily be explained by giving the following example: The fill shall be e.g. 75 g. The maximum permissible deviation for this fill is 4.5 g. This is the maximum error also for the highest fill in this range (100 g) and would be the smallest relative (or percentage) permissible deviation of all fills between >50 g and ≤100 g. Thus taking this relative value of mpd$_{\text{in service}}$ is the worst case and will guarantee that for all fills smaller than 100 g within this range the mpd$_{\text{in service}}$ is not exceeded at any time.

All numbers of paragraphs appearing in the calculations are taken from the R 61/xxx unless otherwise marked.

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E.4.1. Change of span

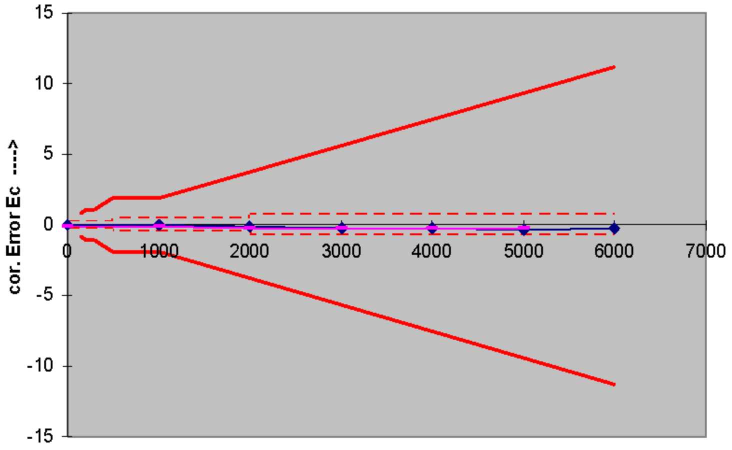
The error limits of R 76 [6] (weighing performance) compared to error limits of R 61 for influence factor test:

R 61, 4.3.2 says: mpd $_{\text{influence factors}}$ = 0.25 mpd $_{\text{in service}}$
Testing an indicator (module) p_i has to be considered: e.g. $p_i = 0.5$
Furthermore the reference accuracy class Ref(x) has to be considered.

The diagram (all values in gram) below shows the following example:

Based on d = 1 g and $p_i = 0.5$ and Ref(1) error limits according to R 61 (continuous line) and according to R 76 [6] (dashed line):

Figure 2: R 61 error limits (continuous line) in comparison to R 76 [6] error limits (dashed line)



Example fill: 2000 g

Error limit according to R 61:

mpd = Fill x mpd $_{\text{in-service}}$ x 0.25 (clause 4.3.2 of R 61) x Ref(x) x p_i

mpd = 2000 g x 1.5 % x 0.25 x 1 x 0.5

mpd = 3.75 g

Error limit according to R 76 [6] at a load corresponding to 2000 e:

mpe = 1 e x p_i = 1 e x 0.5 = 0.5 g

From the graph one can perceive that the higher the fill, the higher is the difference between the R 76 [6] error limits and the R 61 error limits. Therefore, it is sufficient to consider only small loads or, to be more precise, the minimum fill (Minfill). For automatic gravimetric filling machines the error at zero is more critical with regard to Minfill and thus first Minfill should be calculated on basis of the following ideas before checking whether e.g. span drift due to temperature has an effect.

E.4.2. The change of zero.

The change of zero is important to consider for every instrument that is not automatically set to zero before each weighing as the zero error is directly added to the weighing result.

Effects preventing the zero from being accurate:

A) Insufficient accuracy of zero / tare setting

from 5.8: mpd(zero) $\leq$ 0.25 x mpd$(X)_{\text{in service}}$ x Min(fill) (5.8.2)

$\Leftrightarrow$ Min(fill) $\geq$ mpd(zero) / 0.25 x mpd$(X)_{\text{in service}}$

The required accuracy for electronic weighing instruments according to R 76 [6] is limited to 0.25 e (or d). This fact leads to the absolutely smallest Minfills possible since the zero / tare setting error adds to the fill error under all conditions.

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Example:
Non-automatic weighing instrument with e = 1 g, zero setting error being 0.25 g. The reference accuracy class is Ref(x) = 1. Thus absolutely smallest Minfill is:

Minfill $\geq$ 0.25 g / (0.25 x $mpd(X)_{in\ service}$)

The problem is that $mpd(X)_{in\ service}$ is unknown since it depends on the (Min)fill. Thus as a first step the fill is estimated and a subsequent iteration is necessary. The iteration starts assuming that Minfill is smaller than 50 g, then

$mpd(X)_{in\ service}$ = 9 % (4.3.1, Table 1)

The first step of iteration:

Minfill $\geq$ 0.25 g / (0.25 x 9 %)

Minfill $\geq$ 11.1 g and rounded to d

Minfill $\geq$ 11 g

The Minfill of this instrument (having d = 1 g) can never be smaller than 11 g at a reference class Ref(X) = 1.

The same procedure must be followed for calculating all other possible Minfills depending on other values of scale interval d and other reference classes Ref(X).

B) Temperature effect on no-load indication

from A.6.2.3: $\Delta z_{max} \leq 0.25 \times mpd_{in\ service} \times Minfill \times p_i \times Ref(X)$

$\Leftrightarrow$ Minfill $\geq \Delta z_{max} / (0.25 \times mpd_{in\ service} \times p_i \times Ref(X))$

$mpd_{in\ service}$ $\rightarrow$ from Table 1 (4.3.1)

0.25 $\rightarrow$ from 4.3.2

The maximum zero drift depending on variation of temperature according to R 76 [6] is 1 e per 5 K (°C). The assumption made is that the maximum temperature drift is not more than 5 K / h. (This figure is taken from A.3.3 of R 61, see also R 76 [6], A.4.1.2). The maximum time interval assumed to be chosen by the manufacturer between two zero settings is 2 hours. Thus the maximum zero drift to be considered is the theoretical drift within two hours, that is, twice the maximum value taken from the R 76-2 [6] protocol.

From the R 76-2 [6] protocol form the maximum zero drift has to be taken, and then Minfill can be calculated by iteration.

Example: e = d = 1 g, Ref(X) = 1, p_i = 0.5, zero drift 1 e / 5 K, $mpd_{in\ service}$ = 9 % (assumption that Minfill ≤ 50 g)

from A.6.2.2: $\Delta z_{max} \leq 0.25 \times mpd_{in\ service} \times Minfill \times p_i \times Ref(X)$

$\Leftrightarrow$ Minfill $\geq \Delta z_{max} / (0.25 \times mpd_{in\ service} \times p_i \times Ref(X))$

Assuming that the instrument is not set to zero before 2 h have elapsed:

Minfill $\geq$ (2 h x 1 e / h) / (0.25 x 9 % x 0.5 x 1)

$\Leftrightarrow$ Minfill $\geq$ (2 h x 1 g / h) / (0.25 x 9 % x 0.5 x 1)

$\Leftrightarrow$ Minfill $\geq$ 2 g / (0.25 x 9 % x 0.5 x 1)

$\Leftrightarrow$ Minfill $\geq$ 177.78 g > 50 g (assumption with regard to Minfill has been wrong)

Next iteration step: Minfill ≤ 200 g and $mpd_{in\ service}$ = 4.5 % (obviously leading to double the value calculated before)

Minfill $\geq$ 2 g / (0.25 x 4.5% x 0.5 x 1)

$\Leftrightarrow$ Minfill $\geq$ 355.56 g > 200 g (assumption with regard to Minfill has been wrong)

Next iteration step: Minfill ≤ 500 g and $mpd_{in\ service}$ = 3 %

Minfill $\geq$ 2 g / (0.25 x 3% x 0.5 x 1)

$\Leftrightarrow$ Minfill $\geq$ 533.33 g > 500 g (assumption with regard to Minfill has been wrong)

Next iteration step: Minfill ≤ 1000 g and $mpd_{in\ service}$ = 15 g, corresponding to 1.5 % (obviously leading to double the value calculated before)

Minfill $\geq$ 2 g / (0.25 x 1.5% x 0.5 x 1)

$\Leftrightarrow$ Minfill $\geq$ 1066.67 g (more than 1000 g, however for fills between 1000 g and 10,000 g a deviation of 1.5% is acceptable, thus 1067 g is the final permissible Minfill)

Shorter zero setting intervals:
In a lot of cases a zero setting interval of 2 h may not be adequate especially when caking and adhesive material is filled. Some notified bodies require even an interval of not more than 15 minutes. The following example shows what happens to Minfill when the maximum time interval between two zero settings is reduced to for example 15 minutes or 0.25 h respectively.

The maximum zero drift per 5 K and therefore per 1 h has been assumed to be 1 e (e = 1 g). Thus in a quarter of an hour it cannot be more than 0.25 e. Minfill would then be:

Minfill $\geq \Delta z_{max}$ / (0.25 x $mpd_{in\ service}$ x p_i x Ref(X))

Minfill $\geq$ 1 g x 0.25 / (0.25 x 9% x 0.5 x 1)

$\Leftrightarrow$ Minfill $\geq$ 0.25 g / (0.25 x 9 % x 0.5 x 1)

$\Leftrightarrow$ Minfill $\geq$ 22.2 g

C) Warm up time

from A.6.2.1: $E_0 - E_{0\ init} \leq 0.25 \times mpd_{in\ service} \times Minfill \times p_i \times Ref(X)$

⇔ Minfill $\geq (E_0 - E_{0\ init}) / (0.25 \times mpd_{in\ service} \times p_i \times Ref(X))$

$mpd_{in\ service}$ → from Table 1 (4.3.1)

0.25 → from 4.3.2

Ref(X) → has to be chosen (may be given by manufacturer)

Remark: If ($E_0 - E_{0\ init}$) < 0 then the absolute value of ($E_0 - E_{0\ init}$) has to be used.

From the R 76-2 protocol form the maximum zero drift due to warm up has to be taken, and then Minfill can be calculated by iteration.

Example: e = d = 1 g, Ref(X) = 1, p_i = 0.5, zero drift due to warm up 3 e, $mpd_{in\ service}$ = 9 % (assumption that Minfill ≤ 50 g)

Minfill $\geq (E_0 - E_{0\ init}) / (0.25 \times mpd_{in\ service} \times p_i \times Ref(X))$

⇔ Minfill ≥ 3 g / (0.25 x 9 % x 0.5 x 1)

⇔ Minfill ≥ 266.6 g > 200 g,

Assumption being Minfill between >200 g and ≤ 300 g.
$mpd_{in\ service}$ = 9 g. For a new calculation that has to be put in relation to the highest fill of this range, i.e. 300 g. The maximum percentage deviation would then be: 9 g / 300 g = 0.03 = 3 %. (see remarks under E.4)

Minfill ≥ 3 g / (0.25 x 3 % x 0.5 x 1)

⇔ Minfill ≥ 800 g > 500 g, next iteration step.

Assumption being Minfill between >500 g and ≤ 1000 g.
$mpd_{in\ service}$ = 15 g. For a new calculation that has to be put in relation to the highest fill of this range, i.e. 1000 g. The maximum percentage deviation would then be: 15 g / 1000 g = 0.015 = 1.5 %. (see initial remarks)

Minfill ≥ 3 g / (0.25 x 1.5 % x 0.5 x 1)

⇔ Minfill ≥ 1600 g ≤ 10000 g, iteration stops here.

E.4.3. Faults due to disturbances

The significant fault for all disturbance tests is 0.25 of the maximum permissible deviation (mpd) of each fill for in-service verification, for a fill equal to the rated minimum fill (see 3.5.2.5). Thus the maximum deviation must be

$md_{disturbance} \leq 0.25 \times mpd_{in\ service} \times Ref(X) \times Minfill$

(p_i = 1 for disturbance tests; see WELMEC Guide 2.1)

⇔ Minfill $\geq md_{disturbance} / (0.25 \times mpd_{in\ service} \times Ref(X))$

The significant fault for nonautomatic weighing instruments is 1 e. However, when testing without high resolution this could amount even to 1.5 e.

The following example is based on the assumption that the significant fault amounts to 1.5 e, while e = 1 g. The reference class of the instrument shall again be Ref(x) = 1. The error fraction p_i, however, now is not 0.5 but 1 because the susceptibility to disturbances is a feature of the indicator alone as well as the influence of variation of the supply voltage (see R 76-1, C.2, Table 12). The expected Minfill is between >50 g and ≤ 100 g, so $mpd_{in\ service}$ = 4.5 %

Then:

Minfill $\geq md_{disturbance} / (0.25 \times mpd_{in\ service} \times Ref(X))$

⇔ Minfill $\geq 1.5\ g / (0.25 \times 4.5\ \% \times 1)$

⇔ Minfill $\geq 133.3\ g$

Since $mpd_{in\ service}$ for a fill of 133.3 g is 4.5% as well, no further calculations are necessary. A Minfill smaller than or equal to 50 g is not possible since maximum deviation due to disturbance would be:

$md_{disturbance} \leq 0.25 \times mpd_{in\ service} \times Ref(X) \times Minfill$

⇔ $md_{disturbance} \leq 0.25 \times 9\ \% \times 1 \times 50\ g$

⇔ $md_{disturbance} \leq 1.125\ g$

Summary of example test results and conclusions

The Minfills based on the calculations above are:

Based on accuracy of zero / tare setting:	11 g (rounded down)
Based on temperature effect on no-load indication	1067 g (rounded up)
Based on warm up time	400 g
Based on faults due to disturbances	133 g (rounded down)

The highest Minfill (1067 g) has to be selected as being the worst case. The R 61 error limit at this fill is 1067 g x 1.5 % x 0.5 = 8 g. Comparing the figure to the error limit according to R 76 [6] (considering p_i) being 0.5 g (1 g x 0.5) it is evident that normally the incorrect zero and the deviation due to disturbances are the crucial points. Thus the corresponding Minfills have to be calculated first and then the highest Minfill has to be compared to the R 61 error limits (see Figure 2) valid for temperature and damp heat tests.

E.5 Calculating of Minfills with Selective Combination Weighers

Selective combination weighers have to be handled slightly differently as the fill is composed of many partial fills. Each weighing unit producing a partial fill produces its own partial errors due to influence factors and disturbances. However, corresponding to the addition of error fractions p_i within the frame of the modular approach, the single errors of the weighing units are added geometrically (see R 61-1, A.6.1.3.1). The examples are based on the same data as for the single load filling instruments with the exception that the e = d of the single load instrument now is considered being the d_{WU} of the single weighing unit.

$d \geq d_{WU} \times sqr(i)$ (A.6.1.3.2)

E.5.1. The change of zero

from 5.8.2 and A.6.1.3.2:

$$mpd(zero) \leq 0.25 \times (mpd(X)_{in\ service} \times Min(fill) / sqr\ (lpf))$$

[sqr(lpf) is the square root of the number of loads per fill]

A) Insufficient accuracy of zero / tare setting

The required accuracy for electronic weighing instruments according to R 76 [6] is limited to 0.25 e (or d_{WU}). This fact leads to the absolutely smallest Minfills possible since the zero / tare setting error adds to the fill error under all conditions.

$$0.25\ d_{WU} \leq 0.25 \times (mpd(X)_{in\ service} \times Min(fill) / sqr\ (lpf))$$

$$\Leftrightarrow \quad d_{WU} \geq mpd(X)_{in\ service} \times Min(fill) / sqr\ (lpf)$$

$$\Leftrightarrow \quad Min(fill) \geq d_{WU} \times sqr\ (lpf) / mpd(X)_{in\ service}$$

Example:

Nonautomatic weighing instrument with d_{WU} = 1 g, zero setting error being 0.25 g. The reference accuracy class is Ref(x) = 1. The average number of partial fills (loads per fill, “lpf”) is 4. Thus absolutely smallest Minfill is:

$$Minfill \geq d_{WU} \times sqr\ (lpf) / mpd(X)_{in\ service}$$

The problem is that $mpd(X)_{in\ service}$ is unknown since it depends on the Minfill. Thus as a first step the fill is estimated and a subsequent iteration is necessary. The iteration starts assuming that Minfill is smaller than 50 g, then

$mpd(X)_{in\ service}$ = 9 % (4.3.2, Table 1)

The first step of iteration:

Minfill $\geq$ 1 g x sqr(4) / 9 %

Minfill $\geq$ 22.2 g and rounded to d

Minfill $\geq$ 22 g

The Minfill of this instrument (having d_{WU} = 1 g, average number of 4 loads per fill) can never be smaller than 22 g at a reference class Ref(X) = 1.

The same procedure must be followed for calculating all other possible Minfills depending on other values of scale interval d_{WU} and other reference classes Ref(X).

The following table is shows the absolute minimum Minfills of a selective combination weigher with 4 loads per fill, related to d_{WU}, depending on normal accuracy of zero setting of NAWIs:

d_{WU}	Minimum permissible value of Minfill (g) / lpf = 4

(g)	X(0.2)	X(0.5)	X(1)	X(2)
1	333	44	22	11
2	1 334	88	44	22
5	3 335	1 335	335	110
10	6 660	2 660	1 330	330
20	13 340	5 330	2 660	1340
50	50 000	13 350	6 650	1 650
100	100 000	40 000	20 000	6 600
200	200 000	80 000	40 000	20 000
≥ 500	1000 d	500 d	200 d	100 d

As an alternative to the method above all calculations could be based on the d of whole filling instrument instead of d_{WU} of the weighing unit.

d/sqr(lpf) lpf = 4	calculated d_{wu}	permissible d_{wu}	class X(1) d rounded up Minfill	**Minfill**
2 g/2	1 g	1 g	22 g	**22 g**
5 g/2	2,5 g	2 g	44 g	**45 g**
10 g/2	5 g	5 g	110 g	**110 g**
20 g/2	10 g	10 g	1 330 g	**1 340 g**
50 g/2	25 g	20 g	2 660 g	**2 700 g**
100 g/2	50 g	50 g	6 650 g	**6 700 g**
200 g/2	100 g	100 g	20 000 g	**20 000 g**
500 g/2	250 g	200 g	40 000 g	**40 000 g**

B) Temperature effect on no-load indication

from A.6.2.2 and A.6.1.3.2:

$\Delta z_{max} \leq 0.25 \times mpd_{in\ service} \times Minfill \times p_i \times Ref(X) / sqr(lpf)$

$\Leftrightarrow$ Minfill $\geq \Delta z_{max} \times sqr(lpf) / (0.25 \times mpd_{in\ service} \times p_i \times Ref(X))$

$mpd_{in\ service}$ $\rightarrow$ from Table 1 (4.3.2)

0.25 $\rightarrow$ from 4.3.2

The maximum zero drift depending on variation of temperature according to R 76 [6] is 1 e per 5 K (°C). The assumption made is that the maximum temperature drift is not more than 5 K / h. (This figure is taken from A.3.3 of R 61, see also R 76 [6], A.4.1.2). The maximum time interval assumed to be chosen by the manufacturer between two zero settings is 2 hours. Thus the maximum zero drift to be considered is the theoretical drift within two hours, that is twice the maximum value taken from the R 76-2 protocol.

From the R 76-2 protocol form the maximum zero drift has to be taken, and then Minfill can be calculated by iteration.

Example: $e = d_{WU} = 1$ g, Ref(X) = 1, $p_i = 0.5$, zero drift 1 e / 5 K,
$mpd_{in\ service} = 9$ % (assumption that Minfill ≤ 50 g)

from A.6.2.2 and A.6.1.3.2:

$\Delta z_{max} \leq 0.25 \times mpd_{in\ service} \times Minfill \times p_i \times Ref(X) / sqr(lpf)$

$\Leftrightarrow$ Minfill $\geq \Delta z_{max} \times sqr(lpf) / (0.25 \times mpd_{in\ service} \times p_i \times Ref(X))$

Assuming that the instrument is not set to zero before 2 h have elapsed:

Minfill $\geq (2\ h \times 1\ e / h) \times sqr(4) / (0.25 \times 9\ \% \times 0.5 \times 1)$

⇔ Minfill ≥ (2 h x 1 g / h) x 2 / (0.25 x 9 % x 0.5 x 1)

⇔ Minfill ≥ 4 g / (0.25 x 9 % x 0.5 x 1)

⇔ Minfill ≥ 355.56 g > 50 g (assumption with regard to Minfill has been wrong)

Next iteration step: Minfill ≤ 500 g and $mpd_{in\ service}$ = 3 % (obviously leading to three times the value calculated before)

Minfill ≥ 4 g / (0.25 x 3% x 0.5 x 1)

⇔ Minfill ≥ 1066.67 g > 500 g (assumption with regard to Minfill has been wrong)

Next iteration step: Minfill ≤ 10000 g and $mpd_{in\ service}$ = 1.5 %

Minfill ≥ 4 g / (0.25 x 1.5% x 0.5 x 1)

⇔ Minfill ≥ 2133.33 g < 10000 g (for fill between 1000 g and 10,000 g a deviation of 1.5% is acceptable, thus 2133 g is the final permissible Minfill)

C) Warm up time

from A.6.2.1: $E_0 - E_{0I} \leq 0.25 \times mpd_{in\ service} \times Minfill \times p_i \times Ref(X) / sqr(lpf)$

⇔ Minfill ≥ $(E_0 - E_{0I}) \times sqr(lpf) / (0.25 \times mpd_{in\ service} \times p_i \times Ref(X))$

$mpd_{in\ service}$ → from Table 1 (4.3.2)

0.25 → from 4.3.2

Ref(X) → has to be chosen (may be given by manufacturer)

Remark: If ($E_0 - E_{0I}$) < 0 then the absolute value of ($E_0 - E_{0I}$) has to be used.

From the R 76-2 protocol form the maximum zero drift due to warm up has to be taken, and then Minfill can be calculated by iteration.

Example: e = d = 1 g, Ref(X) = 1, p_i = 0.5, zero drift due to warm up 3 e, $mpd_{in\ service}$ = 9 % (assumption that Minfill ≤ 50 g)

Minfill ≥ $(E_0 - E_{0\ init}) \times sqr(lpf) / (0.25 \times mpd_{in\ service} \times p_i \times Ref(X))$

⇔ Minfill ≥ 3 g x sqr(4) / (0.25 x 9 % x 0.5 x 1)

⇔ Minfill ≥ 533.3 g > 500 g,

Assumption being Minfill between >500 g and ≤ 1000 g.
$mpd_{in\ service}$ = 15 g. For a new calculation that has to be put in relation to the highest fill of this range, i.e. 1000 g. The maximum percentage deviation would then be: 15 g / 1000 g = 0.015 = 1.5 %. (see remarks under E.4)

Minfill ≥ 3 g x sqr(4) / (0.25 x 1.5 % x 0.5 x 1)

⇔ Minfill $\geq$ 3200 g ≥ 1000 g, next iteration step.

Minfill between >1000 g and ≤ 10000 g, $mpd_{in\ service}$ = 1.5%,
thus Minfill is 3200 g, iteration stops here.

E.5.3. Faults due to disturbances

For selective combination weighers the significant fault for all disturbance tests is 0.25 of the maximum permissible deviation (mpd) of each fill for in-service verification, for a fill equal to the rated minimum fill (see 3.5.2.5), however divided by the square root of loads per fill. Thus the maximum deviation must be

$md_{disturbance} \leq 0.25 \times mpd_{in\ service} \times Ref(X) \times Minfill / sqr(lpf)$

⇔ Minfill $\geq md_{disturbance} \times sqr(lpf) / (0.25 \times mpd_{in\ service} \times Ref(X))$

Assuming again that the real fault for nonautomatic weighing instruments could amount to 1.5 e the following example is given.

While e = 1 g, the reference class of the instrument shall again be Ref(x) = 1, and the number of loads per fill shall be lpf = 4. The error fraction p_i, is again 1. (see R 76-1, C.2.2, Table 12). The expected Minfill is between >100 g and ≤ 200 g, so $mpd_{in\ service}$ = 4.5 %

Then:

Minfill $\geq md_{disturbance} \times sqr(lpf) / (0.25 \times mpd_{in\ service} \times Ref(X))$

⇔ Minfill ≥ 1.5 g x sqr(4) / (0.25 x 4.5 % x 1)

⇔ Minfill ≥ 266.6 g

Expectation has been wrong, thus next iteration:

Assumption Minfill between >300 g and ≤ 500 g, $mpd_{in\ service}$ = 3%

⇔ Minfill ≥ 1.5 g x sqr(4) / (0.25 x 3 % x 1)

⇔ Minfill ≥ 400 g

A Minfill smaller than or equal to 300 g is not possible since maximum deviation due to disturbance would be:

$md_{disturbance} \leq 0.25 \times mpd_{in\ service} \times Ref(X) \times Minfill$

⇔ $md_{disturbance} \leq 0.25 \times 3\,\% \times 1 \times 300$ g

⇔ $md_{disturbance} \leq 2.25$ g

The value of Minfill relates to a number of requirements.

These requirements are:
- Temperature effect on no load indication (4.8.1.3)
- Zero-setting accuracy (5.8.2)
- Disturbances (7.2 if applicable)
- Warm-up time (7.8 if applicable)

The value as defined by the manufacturer shall be confirmed, using the results of the corresponding test procedures.

If all required criteria are met and the zero-setting accuracy is ~~0.25 d~~0.25 mpd this leads to:

~~0.25 d~~0.25 mpd ≤ 0.25 ~~MPD~~mpd $_{\text{in-service}}$ ~~*~~x Minfill, or Minfill ≥ d / ~~MPD~~mpd $_{\text{in-service}}$

For class X(x) AGFIs the minimum permissible values of Minfill for d values are~~:~~ given in Table 2.

For calculating the Minfill value for class X(x) AGFIs the ~~MPD~~mpd and F values (masses of the fills in Table 1) are applied.

<u>Example 1</u>:
Estimated mass of the fills with 400 g
Class X(0.2) AGFI
d = 20 g and estimated ~~MPD~~mpd (3 % ~~*~~x 0.2) = 0.6 %

Combining the estimated ~~MPD~~mpd percentage and the value of d results in an absolute value of Minfill of: 20 g / 0.006 = 3330 g;
This value is in the F range having an $\text{MPD}_{\text{in-service}}$ of 1.5 % times the class; resulting in 0.3 % relative to the Fill, which is less than the 0.6 %.
Therefore further calculation is necessary as follows:
Applying the 0,3 % the resulting Minfill value will be: 20 g / 0.003 = 6660 g, which value is correct while F range and ~~MPD~~mpd are coherent.

Not for each absolute values of the ~~MPD~~mpd a Minfill can be obtained. Only the relative ~~MPD~~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~~mpd used in the calculation.

<u>Example 2:</u>

Class X(1) AGFI
d = 10 g
Estimated Minfill 250 g

From Table 1 a F of 250 g results in the constant value for ~~MPD~~mpd = 9 g.
which implies 9 g = 3.6 % for the estimated Minfill of 250 g.
Based on the d value (10 g) and using this ~~MPD~~mpd percentage the Minfill would be:
10 g / 0.036 = 280 g:
but for 280 g the ~~MPD~~mpd = 3.2 % therefore further calculation(iteration) is necessary;
using the last percentage the resulting Minfill value will be: 10 g / 0.032 = 310 g;
but for 310 g the ~~MPD~~mpd = 3.0 % ;therefore further calculation is necessary;

using the last percentage the resulting Minfill value will be: 10 g / 0.03 = 330 g; which value is correct because the F range and ~~MPD~~mpd are coherent.

~~Annex F - Error calculation for multi-load AGFIs~~

~~F.1 Significant fault for multi-load AGFIs~~

~~c) Significant fault for selective combination weighers:~~

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~~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) AGFI 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 × (24 / √8) = 2.12 g~~

~~d) Significant fault for cumulative weighers:~~

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~~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) AGFI 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 in Table 1) for the Minfill of 8 kg is 1.5 % or 120 g. Hence the value of significant fault is:~~

~~0.25 × (120 / √7) = 11.34 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.~~

~~F.2 Influence factor tests MPEs for multi-load AGFIs~~

~~This method determines the maximum permissible error for influence factor testing for a fill consisting of more than one static test load.~~

~~d) 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.~~

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~~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 × (12 g / √4) = 1.5 g~~

~~e) 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.~~

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~~Example: For a class X(1) AGFI 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:~~

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

~~NOTE: For cumulative weighers the average number of loads per fill is not known. Therefore it is not possible to define the maximum permissible 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.~~

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 AGFI.

Ref.	Standards and reference documents	Description
[1]	International Vocabulary of Metrology -Basic and General Concepts and Associated Terms (VIM) (2012)	Vocabulary, prepared by a joint working group consisting of experts appointed by BIPM, IEC, IFCC, ISO, IUPAC, IUPAP and OIML
[2]	International Vocabulary of Terms in Legal Metrology, ~~BIML~~VIML, Paris (2000)	Vocabulary including only the concepts used in the field of legal metrology. These concepts concern the activities of the legal metrology service, the relevant documents as well as other problems linked with this activity. Also included in this Vocabulary are certain concepts of a general character which have been drawn from the VIM

Ref.	Standards and reference documents	Description
~~[3]~~	~~OIML B 3:2011~~ *~~OIML Certificate System for Measuring Instruments~~* ~~(formerly OIML P 1)~~	~~Provides rules for issuing, registering and using OIML Certificates of conformity~~
~~[4]~~[3]	OIML D 11:~~2004~~2013 *General requirements for electronic measuring instruments - Environmental Conditions*	Contains general requirements for electronic measuring instruments
~~[5]~~[4]	OIML R 111:2004 *Weights of classes* E_1, E_2, F_1, F_2, M_1, M_{1-2}, M_2, M_{2-3} *and* M_3	Provides the principal physical characteristics and metrological requirements for weights used with and for the verification of weighing instruments and weights of a lower class
~~[6]~~[5]	OIML R 60:2000 *Metrological regulation for load cells*	Provides the principal static characteristics and static evaluation procedures for load cells used in the evaluation of mass
~~[7]~~[6]	OIML R 76~~-1~~:2006 *Non-automatic weighing instruments*	Provides the principal physical characteristics and metrological requirements for the verification of non-automatic weighing instruments
~~[8]~~[7]	OIML D 19:1988 *Type evaluation and type approval*	Provides advice, procedures and influencing factors on type evaluation and type approval
~~[9]~~	~~OIML D 20:1988~~ *~~Initial and subsequent verification of measuring instruments and processes~~*	~~Provides advice, procedures and influencing factors on the choice between alternative approaches to verification and the procedures to be followed in the course of verification~~
~~[10]~~[8]	IEC 60068-2-1 (1990-05) with amendments 1 (1993-02) and 2 (1994-06) Environmental testing, Part 2: Tests, Test A: Cold	Concerns cold tests on both non heat dissipating and heat dissipating equipment under test (EUT)
~~[11]~~[9]	IEC 60068-2-2 (2007-07) Ed. 5.0 Environmental testing Part 2: Tests, Test B: Dry heat	Contains test Ba: dry heat for non heat dissipating specimen with sudden change of temperature; test Bb dry heat for non heat dissipating specimen with gradual change of temperature; tests Bc: dry heat for heat dissipating specimen with sudden change of temperature; test Bd dry heat for heat dissipating specimen with gradual change of temperature

Ref.	Standards and reference documents	Description
[10]	IEC 60068-3-1 (1974-01) + Supplement A (1978-01): Environmental testing Part 3 Background information, Section 1: Cold and dry heat tests	Gives background information for Tests A: Cold (IEC 68-2-1), and Tests B: Dry heat (IEC 68-2-2). Includes appendices on the effect of: chamber size on the surface temperature of a specimen when no forced air circulation is used; airflow on chamber conditions and on surface temperatures of test specimens; wire termination dimensions and material on surface temperature of a component; measurements of temperature, air velocity and emission coefficient. Supplement A - gives additional information for cases where temperature stability is not achieved during the test
[11]	IEC 60068-2-78 (2001-08) Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state (IEC 60068-2-78 replaces the following withdrawn standards: IEC 60068-2-3, test Ca and IEC 60068-2-56, test Cb)	Provides a test method for determining the suitability of electro-technical products, components or equipment for transportation, storage and use under conditions of high humidity. The test is primarily intended to permit the observation of the effect of high humidity at constant temperature without condensation on the specimen over a prescribed period This test provides a number of preferred severities of high temperature, high humidity and test duration. The test can be applied to both heat-dissipating and non-heat dissipating specimens. The test is applicable to small equipment or components as well as large equipment having complex interconnections with test equipment external to the chamber, requiring a set-up time which prevents the use of preheating and the maintenance of specified conditions during the installation period

Ref.	Standards and reference documents	Description
~~14~~[12]	IEC 60068-3-4 (2001-08) Environmental testing - Part 3-4: Supporting documentation and guidance - Damp heat tests	Provides the necessary information to assist in preparing relevant specifications, such as standards for components or equipment, in order to select appropriate tests and test severities for specific products and, in some cases, specific types of application. The object of damp heat tests is to determine the ability of products to withstand the stresses occurring in a high relative humidity environment, with or without condensation, and with special regard to variations of electrical and mechanical characteristics. Damp heat tests may also be utilized to check the resistance of a specimen to some forms of corrosion attack
~~[15]~~[13]	IEC/TR 61000-2-1 (1990-05) Electromagnetic compatibility (EMC) Part 2: Environment Section 1	Electromagnetic compatibility (EMC) Part 2: Environment Section 1: Description of the environment- Electromagnetic environment for low-frequency conducted disturbances and signalling in public power supply systems
~~[16]~~[14]	IEC 61000-4-1 (2006-10) Ed. 3.0 Basic EMC Publication Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques. Section 1: Overview of IEC 61000-4 series	Gives applicability assistance to the users and manufacturers of electrical and electronic equipment on EMC standards within the IEC 61000-4 series on testing and measurement techniques Provides general recommendations concerning the choice of relevant tests
[15]	IEC 61000-4-2 (2009) with amendment 1 (1998-01) and amendment 2 (2000-11) Consolidated Edition: IEC 61000-4-2 (2001-04) Ed. 1.2	Electromagnetic Compatibility (EMC) - Part 4: Testing and measurement techniques - Section 2: Electrostatic discharge immunity test. Basic EMC Publication
[16]	IEC 61000-4-3 (2008-04) Ed. 3.1	Electromagnetic Compatibility (EMC) - Part 4: Testing and measurement techniques - Section 3: Radiated, radio-frequency, electromagnetic field immunity test

Ref.	Standards and reference documents	Description
[17]	IEC 61000-4-4 (2004-07) Ed 2.0 Electromagnetic compatibility (EMC) Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	Establishes a common and reproducible reference for evaluating the immunity of electrical and electronic equipment when subjected to electrical fast transient/burst on supply, signal, control and earth ports. The test method documented in this part of IEC 61000-4 describes a consistent method to assess the immunity of an equipment or system against a defined phenomenon. The standard defines: ▪ test voltage waveform; ▪ range of test levels; ▪ test equipment; ▪ verification procedures of test equipment; ▪ test set-up; and ▪ test procedure. The standard gives specifications for laboratory and post-installation tests
[18]	IEC 61000-4-5 (2005-11) Ed. 2.0Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test	Relates to the immunity requirements, test methods, and range of recommended test levels for equipment to unidirectional surges caused by over-voltages from switching and lightning transients. Several test levels are defined which relate to different environment and installation conditions. These requirements are developed for and are applicable to electrical and electronic equipment. Establishes a common reference for evaluating the performance of equipment when subjected to high-energy disturbances on the power and inter-connection lines.

Ref.	Standards and reference documents	Description
[19]	IEC 61000-4-6 (2008-10) Ed. 3.0Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques. Section 6: Immunity to conducted disturbances, induced by radio-frequency fields	Relates to the conducted immunity requirements of electrical and electronic equipment to electromagnetic disturbances coming from intended radio-frequency (RF) transmitters in the frequency range 9 kHz up to 80 MHz. Equipment not having at least one conducting cable (such as mains supply, signal line or earth connection), which can couple the equipment to the disturbing RF fields is excluded. This standard does not intend to specify the tests to be applied to particular apparatus or systems. Its main aim is to give a general basic reference to all concerned product committees of the IEC. The product committees (or users and manufacturers of equipment) remain responsible for the appropriate choice of the test and the severity level to be applied to their equipment.
[20]	IEC 61000-4-11 (2004-03) Ed 2.0 Electromagnetic compatibility (EMC) Part 4-11: Testing and measuring techniques - Voltage dips, short interruptions and voltage variations immunity tests	Defines the immunity test methods and range of preferred test levels for electrical and electronic equipment connected to low-voltage power supply networks for voltage dips, short interruptions, and voltage variations. This standard applies to electrical and electronic equipment having a rated input current not exceeding 16 A per phase, for connection to 50 Hz or 60 Hz AC networks. It does not apply to electrical and electronic equipment for connection to 400 Hz AC networks. Tests for these networks will be covered by future IEC standards. The object of this standard is to establish a common reference for evaluating the immunity of electrical and electronic equipment when subjected to voltage dips, short interruptions and voltage variations. It has the status of a Basic EMC Publication in accordance with IEC Guide 107
[21]	IEC 61000-4-20 Ed 2.0 (2010-08) Basic EMC Publication – Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 20: Emission and immunity testing in transverse electromagnetic (TEM) waveguides Stability date: 2014	Provides radiated immunity test methods for electrical and electronic equipment using various types of transverse electromagnetic (TEM) waveguides. These types include open structures (for example, striplines and electromagnetic pulse simulators) and closed structures (for example, TEM cells).

Ref.	Standards and reference documents	Description
	~~OIML R 87~~	~~Quantity of product in prepackages~~
[22]	OIML D 28 Edition 2004 (E)	Conventional value of the result of weighing in air
[23]	IEC 60068-2-30 (1980-01) with amendment 1 (1985-08) Environmental testing Part 2: Tests Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle)	Determines the suitability of components, equipment and other articles for use and/or storage under conditions of high humidity when combined with cyclic temperature changes. Amendment No. 1 replaces the third paragraph of Clause 8, Recovery.
[24]	ISO 16750-2 (2003)	Road vehicles - Environmental conditions and testing for electrical and electronic equipment – Part 2: Electrical loads
[25]	ISO 7637-2 (2004) Road vehicles - electrical disturbance from conducting and coupling – Part 2: Electrical transient conduction along supply lines only	Specifies bench tests for testing the compatibility to conducted electrical transients of equipment installed on passenger cars and light commercial vehicles fitted with a 12 V electrical system or commercial vehicles fitted with a 24 V electrical system. Failure mode severity classification for immunity to transients is also given. It is applicable to these types of road vehicle, independent of the propulsion system (e.g. spark ignition or diesel engine, or electric motor).
[26]	ISO 7637-3 (1995) with correction 1 (1995) Road vehicles - Electrical disturbance by conducting and coupling - Part 3: Passenger cars and light commercial vehicles with nominal 12 V supply voltage and commercial vehicles with 24 V supply voltage - Electrical transient transmission by capacitive and inductive coupling via lines other than supply lines	Establishes a common basis for the evaluation of the EMC of electronic instruments, devices and equipment in vehicles against transient transmission by coupling via lines other than supply lines. The test intention is the demonstration of the immunity of the instrument, device or equipment when subjected to coupled fast transient disturbances, such as those caused by switching (switching of inductive loads, relay contact bounce, etc)

Ref.	Standards and reference documents	Description
[27]	IEC 61000-6-1 Ed. 2.0 (2005-3) Basic EMC Publication – Electromagnetic compatibility (EMC) – Part 6: Generic standards – Section 1: Immunity for residential, commercial and light-industrial environments Stability date: 2013	Defines the immunity test requirements in relation to continuous and transient, conducted and radiated disturbances, including electrostatic discharges, for electrical and electronic apparatus intended for use in residential, commercial and light-industrial environment, and for which no dedicated product or product-family standard exists. Immunity requirements in the frequency range 0 kHz to 400 GHz are covered and are specified for each port considered. This standard applies to apparatus intended to be directly connected to a low-voltage public mains network or connected to a dedicated DC source which is intended to interface between the apparatus and the low-voltage public mains network.
[28]	IEC 61000-6-2 Ed. 2.0 (2005-01) Basic EMC Publication – Electromagnetic compatibility (EMC) – Part 6: Generic standards – Section 2: Immunity for industrial environments Stability date :2013	Defines the immunity performance requirements for electrical and electronic apparatus intended for use in industrial environments, both indoor and outdoor and for which no dedicated product or product-family immunity standard exists. Immunity requirements in the frequency range 0 Hz to 400 GHz are covered, in relation to continuous and transient, conducted and radiated disturbances, including electrostatic discharges, and are specified for each port considered. This standard applies to apparatus intended to be connected to a power network supplied from a high or medium voltage transformer dedicated to the supply of an installation feeding manufacturing or similar plant, and intended to operate in or in proximity to industrial locations, as described below. This standard also applies to apparatus which are battery operated and intended to be used in industrial locations. Industrial locations are in addition characterised by the existence of one or more of the following: - industrial, scientific and medical (ISM) apparatus (as defined in CISPR 11); - heavy inductive or capacitive loads are frequently switched; - currents and associated magnetic fields are high.

Ref.	Standards and reference documents	Description
[29]	OIML D 31: 2008 E General requirements for software controlled measuring instruments	Provides guidance for establishing appropriate requirements for software related functionalities in measuring instruments covered by OIML Recommendations.
[30]	ILAC-G24/OIML D 10: 2007 Guidelines for the determination of recalibration intervals of measuring equipment used in testing laboratories	The purpose of this Document is to give laboratories, particularly while setting up their calibration system, guidance on how to determine calibration intervals. This Document identifies and describes the methods that are available and known for the evaluation of calibration intervals.
[31]	IEC 61000-4-17 Consolidated Ed. 1.2 (2009-01) (incl. Amendment 1 and Amendment 2) Basic EMC Publication – Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 17: Ripple on DC input power port immunity test Stability date: 2015	Provides test methods for immunity to ripple at the DC input power port of electrical or electronic equipment. This standard is applicable to low-voltage DC power ports of equipment supplied by external rectifier systems, or batteries which are being charged. This standard defines: - test voltage waveform, - range of test levels, - test generator, - test setup, - test procedure. This test does not apply to equipment connected to battery charger systems incorporating switch mode converters.