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**EXPLANATORY NOTE**

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**FOREWORD**

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**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.

**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 mass**

small localized material object to which can be ascribed properties properties such as volume or mass.

3.1.2 load (*L*)

#### amount of material 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 operatingwithout 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:

1. separate, from the instrument being tested
2. 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

### 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::

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

The tare device may function as:

1. a non-automatic device (load balanced by operator),
2. a semi-automatic device (load balanced automatically following a single manual command),
3. 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]

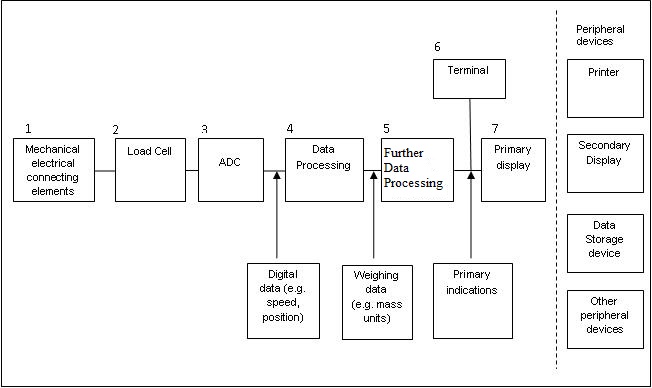
NOTE: The modules of the AGFI may be subject to specified partial error limits.

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**

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:

1. the values corresponding to two consecutive scale marks for analogue indication, or
2. two consecutive indicated values for digital indication.

VIML, 5.01 [2]

### 3.4.2 reference mass of a product

object having a mass equal to the mean of ten of the largest 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:

1. delivery of material to the load receptor,
2. a weighing operation, and
3. 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:

1. 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
2. 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

*I*n *n*th indication

*L* Load

*ΔL* = Additional load to next changeover point

*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

**3.9 Equations**

*P* = *I* + ½ *d* – *ΔL* = Indication prior to rounding (digital indication)

*E* = *I* – *L* or *P* – *L* = Error

**4** **Metrological requirements**

**4.1 Units of measurement**

The units of mass include:

1. milligram (mg),
2. gram (g),
3. kilogram (kg), and
4. tonne (t).

**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 4.3 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.

**4.3**   **Error limits**

**4.3.1**  Maximum permissible deviation (mpd) of each fill

At initial verification the AGFI shall comply with accuracy class X(x) specified by the manufacturer, for which the mpd of each fill from the average of all fills in a test shall be equal to the limits specified in Table 1, multiplied by the class designation factor (x).

The class designation factor (x) shall be ≤ 2 and in the form 1×10k, 2×10k, 5×10k, k being a positive or negative whole number or zero.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 1- Maximum permissible deviation (mpd) of each fill | | | | |
| Value of  the mass of the fills F | | | mpd of each fill from the average of the fills for class X(1)  (as percentage of F or in grams) | |
| (g) | | | Initial verification | In-service |
| 50 <  100 <  200 <  300 <  500 <  1000 <  10000 <  15000 < | F  F  F  F  F  F  F  F  F | ≤ 50  ≤ 100  ≤ 200  ≤ 300  ≤ 500  ≤ 1000  ≤ 10000  ≤ 15000 | 7.2 %  3.6 g  3.6 %  7.2 g  2.4 %  12 g  1.2 %  120 g  0.8 % | 9 %  4.5 g  4.5 %  9 g  3 %  15 g  1.5 %  150 g  1 % |

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

**4.3.2** Maximum permissible error (mpe) 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 for influence factor tests shall be 0.25 mpd in-service for a fill equal to the static test load.

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

**4.3.3 Maximum permissible preset value error (mpse)**

For AGFIs where it is possible to have a preset value the maximum difference between the preset value (see 9.6) and the average mass of all the fills in a test sequence (see 9.7) the maximum difference shall not exceed 0.25 mpd in-service of each fill from the average of the fills (see 4.3.1). These limits will apply for Initial verification and in-service.

**4.4 Reference mass correction (see 3.4.2)**

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

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

**4.5**   Error limits for mutli-load AGFIs

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

**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.

**4.7 Rated Minimum Fill (Minfill)**

The Minfill shall be specified by the manufacturer.

The 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 | 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: | 1. 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 2. The gramme values are rounded to the d values which can be indicated 3. 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 in-service x Minfill, then you have the condition: Minfill ≥ d / mpd in-service (with mpd as relative value).

For calculating the Minfill value for class X(x) AGFIs the 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.

**4.8 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.6.2.4) at the upper limit of the temperature range of the AGFI.

**4.8.1**   Temperature

**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.

**4.8.1.2** 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.

**4.8.1.3** Temperature effect on no load indication

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

**4.8.2 Supply voltage**

An 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:

1. 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
2. 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.
3. Low voltage of internal battery (not connected to the mains power)

The lower limit will be the minimum operating voltage specified by the manufacturer

1. Power from external 12V and 24 V road vehicle batteries

The upper and lower limit are the specified maximum and minimum power supply voltage.

**4.8.3**   Tilting

AGFIs intended to be used outside in open locations (e.g. on roads) or AGFIs without a level indicator shall comply with the appropriate metrological and technical requirements when tilted (longitudinally and transversely) by up to 5 %.

1. Where a levelling device and a level indicator 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.
2. 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
3. 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 evaluation procedure.

**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 1x10n, 2x10n, or 5x10n, 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 [4] 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 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 devices. Tare devices (except preset tare devices) may also be used for zeroing. The devices may be:

1. Non-automatic (tare balancing), or
2. Semi-automatic, or
3. 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 mpd in-service as specified in 4.3.1.

After zero or tare setting the effect of zero deviation on the result of the weighing shall be not more than ± 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 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.5.2.5, or shall be reduced depending on prevailing operating conditions.

The maximum programmable time interval for automatic zero-setting required above and specified in A.5.2.5 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:

1. the indication is at zero, or at a negative net value equivalent to gross zero, and
2. the corrections are not more than 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 3.3.4.3 and 3.3.4.5. Specifically:

1. Automatic zero setting is activated by an event, such as part of every automatic weighing cycle or after a programmed interval.
2. 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/sec.

**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:

1. the requirements for security of software given in 5.10 are applied as appropriate;
2. 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;
3. external storage devices identification and security attributes shall be automatically verified to ensure integrity and authenticity;
4. 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;
5. when storage capacity is exhausted, new data may replace oldest data provided that overwriting the old data has been archived and/or authorized.
6. 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:

1. description of the legally relevant software;
2. description of suitable system configuration and minimal required resources;
3. description of the accuracy of the measuring algorithms;
4. description of the user interface, menus and dialogues;
5. the unambiguous software identification;
6. description of the embedded software;
7. 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;
8. description of the accuracy of the algorithms (e.g. filtering of A/D conversion results, price calculation, rounding algorithms, etc.);
9. description of data sets stored or transmitted;
10. list of commands of each hardware interface of the measuring instrument / electronic device / sub-assembly including a statement of completeness;
11. means of securing software;
12. if fault detection is realized in the software, a list of faults that are detected and a

description of the detecting algorithm;

1. 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:

1. legally relevant software shall be adequately protected against accidental or intentional changes. The requirements for securing given in 5.2.3 apply;
2. 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;
3. 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 [4] or purpose designed 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 4.8.1) 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 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

1. at least Max, Minfill,Ref(x) and d shall be displayed as long as the AGFI is switched on;
2. the other marking may be shown on manual command;
3. it must be described in the type approval certificate; and
4. the markings are considered as device-specific parameters (see 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:

1. type approval sign in accordance with national requirements;
2. name or identification mark of the manufacturer;
3. serial number;
4. temperature range;
5. type approval number;
6. voltage supply;
7. voltage supply frequency, (if applicable)
8. 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:

1. be the part on which the mark is located and it cannot be removed from the AGFI without damaging the marks,
2. allow easy application of the mark without changing the metrological qualities of the AGFI,
3. 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:

* 1. 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 fault limit (3.5.2.7), or
  2. Significant faults are detected and acted upon.

NOTE: A fault equal to or less than the value specified in 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:

1. Each individual cause of significant fault, and/or
2. Each part of the 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 measuring instrument shall comply with the influence factors requirements of 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 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 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:

1. Display unclear data,
2. Falsify displayed, processed or stored weighing results,
3. 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 measuring instruments is intended to verify compliance with the applicable requirements of this Recommendation.

**7.10.1**   Examinations

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

**7.10.2**   Performance tests

An 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 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:

1. type evaluation,
2. initial verification,
3. subsequent verification
4. in-service inspection.

Tests should be applied uniformly by the metrological authority and should form a uniform program. Guidance for the conduct of type evaluation and initial verification is providedinOIML International Documents D 19 [7] and D 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 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 E.

**8.2**   **Type 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 (4.8.3). |
| 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 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:

1. requirements specified for static tests in 4 and 5,
2. technical requirements in 6,
3. requirements in 8 for electronic measuring instruments, where applicable.

The metrological authority shall:

1. Conduct the tests in a manner which prevents an unnecessary commitment of resources,
2. 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:

1. In accordance with the appropriate parts of 6.
2. Under the normal conditions of use for which the AGFI is intended, and
3. 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:

1. 4.8 for all AGFIs,
2. 7 for electronic AGFIs.

**8.2.3.3** Apportioning of errors

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

The error limits applicable to a part which is examined separately are equal to a fraction pi 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:

(p12 + p22 + p32 + ....) ≤ 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 [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 3.3.11) the fractions *pi* 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 [5] valid for SH or CH tested load cells (pLC = 0.7).  NOTE 3: The sign “–” means “not applicable”. | | | |

**8.2.4**   Place of testing for type evaluation

AGFIs submitted for type evaluation may be tested either:

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

**8.2.5**   Type approval certificate and determination of classes (4.2 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 be tested for compliance with 4 and 5 for the intended products and corresponding accuracy classes and when operated under normal conditions of use.

Tests shall be carried out by the metrological authority, in-situ, with the 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:

1. In accordance with the descriptive markings given in 5.12,
2. Under the normal conditions and with the products for which the AGFI is intended.
3. In accordance with the test method in 9 and the material tests procedure given in A.8.2.

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

**8.3.3** Conduct of the tests

The metrological authority:

1. Shall conduct the tests in a manner which prevents an unnecessary commitment of resources,
2. 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:

1. 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 4.3.1 and 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* “determined as above.

1. 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”.

**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 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**  **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

1. 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.
2. 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 3.4.10).
3. 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 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 (FP) as specified in Table 4.

|  |  |  |  |
| --- | --- | --- | --- |
| Table 4 – Number of test fills | | | |
| Preset value of the fills FP (kg) | | | Minimum number of test fills (n) |
| 1 kg < 10 kg <  25 kg < | FP  FP  FP  FP | ≤ 1 kg  ≤10 kg  ≤25 kg | 60 fills  30 fills  20 fills  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 and mpse (as appropriate) for automatic weighing (details as given in 4.3.2 and 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 6 and A.3.6) to find the conventional 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:

1. An appropriately designed indicating device, or
2. 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 of the loads. Error limitation as specified in 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:

1. 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)

1. on the AGFI where the load is weighed in a container on the load receptor

* after tare balancing the empty container (b)
* after filling the container (a)

1. on a subtractive weigher

* after tare balancing the filled load receptor (a)
* after discharge of the fill from the load receptor (b)

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

(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.

(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 mass value of the test fill. The average value of all the test fills 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 4.3.1) 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 4.3.3 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 evaluation**

**A.1.1**   Documentation

Review the documentation that is submitted to determine if it is adequate and correct. For type 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 7.10.

**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.

**A.3**   **General test requirements**

**A.3.1**   Power supply (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 (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 (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.6.2.1 and A.6.2.3.

**A.3.6**   Control instruments (3.2.2.4 and 6)

**A.3.6.1**   Accuracy of test system (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 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 - ΔL

The error prior to rounding is: E = P - L = I + 0.5 d - ΔL - 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, (E0) 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, (Ec) is: Ec = E - E0

For the example in A.3.6.2.1, the error calculated at zero load was: E0 = +0.5 g,

the corrected error is: Ec = + 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 (8.2.2 and 8.2.3)

The following tests shall normally be applied for type evaluation:

Examination for type evaluation in A.1,

1. Static tests in A.5,
2. Influence factor and disturbance tests given in A.6,
3. Span stability test in A.7, and
4. Material tests in A.8.1

**A.4.2**   Non-automatic weighing instruments (2)

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 [6], the tests specified in A.4.1 may be omitted where equivalent test results specified in OIML R 76 [6] prove conformity with the relevant parts of OIML R 61. Use of OIML R 76 [6] test results shall be recorded in the test report checklist and summary in OIML R 61-3.

**A.4.3**   Initial verification (8.3)

The following tests shall normally be applied for initial verification:

1. Examination for initial verification in A.2, and
2. Material tests at initial verification in A.8.2.

Static weighing test method (as detailed in 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 evaluation stage)**

**A.5.1**   General (8.2.2 and 8.2.3.2)

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 4.3, 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**   Zero-setting and tare devices (5.8)

**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:

1. Nonautomatic or semi-automatic,
2. Automatic at switch-on,
3. Automatic at start of automatic operation,
4. Automatic at programmable time intervals,
5. 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.5.2.2** Range of zero-setting

**A.5.2.2.1** Initial zero-setting

(a) Positive range

With the load receptor empty, set the instrument to zero. Place a test load on the load receptor and set the instrument to zero again. Continue this process until it does not reset to zero. The maximum load that can be re-zeroed is the positive portion of the initial zero-setting range.

(b) Negative range

1. Remove any load from the load receptor and set the instrument to zero. Then, if possible, remove any non-essential components of the load receptor. If, at this point, the instrument can be reset to zero with the zero setting device, the mass of the non-essential components is used as the negative portion of the initial zero-setting range.
2. If the instrument cannot be reset to zero with the non-essential components removed, add loads to any live part of the scale until the instrument indicates zero again.
3. Then remove the loads and, after each load is removed, reset to zero. The maximum load that can be removed while the instrument can still be reset to zero 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.5.2.2.2** Automatic zero-setting range

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

1. When the load receptor is empty, zero the AGFI in a mode as determined by A.5.2.1.
2. Add load(s) to the load receptor to determine the additional load at which the indication changes from zero to one scale interval above zero.
3. Calculate the error at zero according to the method described in A.3.6.2.1.
4. Verify that the zero-setting error is within the limit specified in 5.8.2

**A.5.2.4**  Accuracy of taring

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

1. Place the maximum tare load on the load receptor, operate the tare function key immediately in a mode as determined by A.5.2.1 to enable the equilibrium device to release the tare function.
2. Add load(s) to the load receptor to determine the additional load at which the indication changes from zero to one scale interval above zero.
3. Calculate the error according to the method described in A.3.6.2.1.
4. Verify that the zero-setting error is within the limit specified in 5.8.2

**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:

1. The maximum allowable rate of change of a steady ambient temperature is 5 °C per hour as specified in A.3.3.
2. The maximum zero-setting error (5.8.2) is determined as follows:

(Ezsemax) ≤ 0.25 mpd in-service at Minfill x Ref(x) (1)

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

(Ezcmax) ≤ 0.5 mpd in-service at Minfill x Ref(x) (2)

so the maximum zero-variation (Δzmax) is:

(Ezcmax – Ezsemax) = 0.25 mpd in-service at Minfill x Ref(x) (3)

1. In accordance with A.6.2.3, the maximum zero-variation (Δzmax) per 5oC is less than or equal to 0.25 mpd in-service:

Δzmax per 5 °C ≤ 0.25 mpd in-service at Minfill x Ref(x) (4)

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

For Δzmax per 5 °C in equation (4) gives:

Δzmax per hour ≤ 0.25 mpd in-service at Minfill x Ref(x) (5)

Since equations (5) and (4) are identical, an AGFI which needs the maximum allowable variation given in A.6.2.3 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.6.2.3, 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 the maximum programmable time interval of automatic zero setting or taring, which shall be in accordance with 5.8.3.2.

**A.5.3**   Static weighing test method for type evaluation (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.5.4**   Determination of reference accuracy class, Ref(x) (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:

1. Perform static weighing tests for influence factors and loads as specified in this Annex.
2. Determine the mpe for influence factor tests for class X(1), mpe(1) foreach load as follows:

mpe(1) =0.25 mpd(1)  x (pi, if applicable) in-service for the fill value equal to the

load.

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

mpe (1)  = pix (0.25 x 1.5 % x 10,000g)

where

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

mpe(1) is error limit specified in Table 1 for mass of fill.

1. (Calculate [│Error│ / mpe(1)] for each load

Where:

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

1. From (c) determine the maximum value of [│Error│ / mpe(1)] for all the influence factor tests,

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

1. Determine Ref(1) from [│Error│ / mpe(1)]Max such that:

Ref(x) ≥ [│Error│ / mpe(1)]Max and

Ref(x) = 1 x 10k, 2 x 10k, or 5 x 10k,

the index k being a positive or negative whole number or zero. Fault limit values shall then be calculated from the mpd for the reference class.

**A.6**   Influence factor and disturbance tests

**A.6.1**   Test conditions

**A.6.1.1**   General requirements

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

Influence factor and disturbance tests specified in 7.2 and 7.5 are intended to verify that 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.

**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 4.5 are met.

**A.6.1.3.1**   Multi-load AGFIs and fault limit

The examples in Annex C.1 show how to determine the fault 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 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.6.2.2 | | Temperature with static load | | Influence factor | mpe |
| A.6.2.3 | | Temperature effect on no-load indication | Influence factor | mpe |
| A.6.2.4 | | Damp heat | Influence factor | mpe |
| A.6.2.5 | | AC mains voltage variation | Influence factor | mpe |
| A.6.2.6 | | DC mains voltage variation | Influence factor | mpe |
| A.6.2.7 | | Low voltage of internal battery (not connected to the mains supply) | Influence factor | mpe |
| A.6.2.8 | | Power from external 12V and 24V road vehicle batteries | Influence factor | mpe |
| A.6.2.9 | | Tilting | Influence factor | 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.

1. Disconnect instrument from the power supply for a period of at least 8 hours prior to the test.
2. Reconnect instrument and switch on while observing the load indicator.
3. Check that it is not possible to initiate automatic weighing until the indicator has stabilized.
4. As soon as the indication has stabilized, set the instrument to zero if this is not done automatically.
5. Determine the error at zero by the method of A.3.4.2.1, and specify this error as E0I (error of initial zero-setting) at first and as E0  (zero-setting error) when repeating this step.
6. From (e) verify that E0I is not greater than the mpe specified in 5.8.2.
7. Apply a static load close to Max. Determine the error by the method of A.3.4.2.1 and A.3.4.2.2.
8. Repeat steps (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).
9. From (g) and (h) verify that:
10. The error (corrected for zero error) for a static load close to Max is not greater than the mpe specified in 4.3.2,
11. After each time interval the zero-variation error (E0 - E0I) is not greater than the mpe specified in 5.8.2.

**A.6.2.2**   Prescribed temperatures (4.8.1.1)

Prescribed temperatures for static tests are carried out according to according toTable 5.

Supplementary information to the IEC test procedures:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Table 5 Temperature test (d****ry 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 (IH) | 1 | **2** | 3 | 4 | Unit |
| Temperature (TH) | 30 | **40** | 55 | 70 | °C |
|  | The following low temperature test levels may be specified: | | | | |
| Level index low (IL) | -1 | **-2** | -3 | -4 |  |
| Temperature (TL) | 5 | **-10** | -25 | -40 | °C |
| NOTES | *I*Hconcerns the index for TH; *I*Rconcerns the index for TR; *I*Iconcerns the index for TI; *I*Lconcerns the index for TL.  By default: *T*R = 20 °C and *I*R = 0, *I*H = 2, *I*I = 1 and *I*L = -2  *I*R= (IH + IL)/2 (rounded to an integer by deleting the mantissa) and *I*I = (IR -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 | | | | |

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

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| --- | --- | --- | --- | --- | --- |
| **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 (IH) | 1 | **2** | 3 | 4 | Unit |
| Temperature (TH) | 30 | **40** | 55 | 70 | °C |
|  | The following low temperature test levels may be specified: | | | | |
| Level index low (IL) | -1 | **-2** | -3 | -4 |  |
| Temperature (TL) | 5 | **-10** | -25 | -40 | °C |
| NOTES | *I*Hconcerns the index for *TH*; *I*Rconcerns the index for TR; *I*Iconcerns the index for TI; *I*Lconcerns the index for *TL.*  By default: *T*R = 20 °C and *I*R = 0, *I*H = 2, *I*I = 1 and *I*L = -2  *I*R= *(IH + IL)/2* (rounded to an integer by deleting the mantissa) and *I*I = *(IR*-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. | | | | |

**A.6.2.4**   Damp heat test (7.2)

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

A.6.2.4.1 Damp heat, steady state

Damp heat, steady state test are carried out 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 | |

A.6.2.4.2 Damp heat, cyclic test (condensing)

Damp heat, cyclic tests are carried out 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 | | |

**A.6.2.5**   **AC mains voltage variation** (4.8.2)

AC mains voltagevariation tests are carried out 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 | |

**A.6.2.6 DC mains voltage variation (4.8.2)**

AGFIs operating from DC mains power supply shall fulfil the tests in A.6.2, with the exception of A.6.2.6 which is to be replaced by the test to Table 8.

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| **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. | |

**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,  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. |

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

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

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| **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 | | | | |

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| **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 | **Us** 2) | **+ 50** | **+ 50** | V |
| 2b | **Us** 2) | **10** | **20** | V |
| 3a | **Us** 2) | **- 150** | **- 200** | V |
| 3b | **Us** 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,  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. | | | | |

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| **Table 10b Electrical transient conduction via lines other than supply lines** | | | | | |
| Applicable standard | ISO 7637–3 [29], § 3.5.1: fast transient test pulses a and b | | | | |
| Test method | Electrical transient conduction along lines other than supply lines | | | | |
| Applicability | Applicable to analogue I/O cabling of modular measuring instruments installed in vehicles (1) | | | | |
| Object of the test | 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) | | | | |
| 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 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. | | | | |
| Test level | Test pulse | *U*nom1) | 12 | 24 | V |
| pulse a | *U*s 2) | **-60** | **-80** | V |
| pulse b | *U*s 2) | **40** | **80** | V |
| NOTES | 1) *U*nom = nominal battery voltage  2) As specified in ISO 7637-3 | | | | |
| 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) 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. | | | | |

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| **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*nom1) | **12** | | **24** | | V |
| Test levels | Test profile2) | **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. | | | | | |
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| **Table 10d “Load dump” test** | | | | | | |
| Applicable standard | ISO 16750-2 [24] | | | | | |
| Test method | Supply voltage variation due to disconnecting a discharged battery | | | | | |
| 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 shape2) | **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. | | | | | |

**A.6.2.9**   **Tilting (4.8.3)**

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

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

**A.6.2.9.1.1 Tilting at no-load**

The AGFI shall be set to zero in its reference position (not tilted). The 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).

**A.6.2.9.1.2 Tilting when loaded**

The 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).

**A.6.2.9.2 AGFIs not fitted with a level indicator or an automatic tilt sensor (4.8.3 c)**

The test in A.6.2.9.1 only applies for 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.

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| Object of the test: | To verify compliance with the provisions given in 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. 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 4.3.2. |
| 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 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:   1. Date and time 2. Test load 3. Indications at each tilt 4. Errors 5. 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 (7.2)

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| 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 [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 fault . In case of the occurance of a 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 Table 11.

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| **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. | | | |

**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 Tables 12.1 and Table 12.2.

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| **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. | |

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| **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  and 1000 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. | |

**A.6.3.3**   Electrostatic discharge

Electrostatic discharge tests are carried out with test signals and conditions as given in Table 13.

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| **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. | | |

**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 according to Table 14.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | | | |
| **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. | | | |

## A.6.3.4.2 Immunity to conducted electromagnetic fields

Conducted, radio frequency, electromagnetic field immunity tests are carried out 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. | | | |

### 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 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 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. 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. | | | | |

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 |
| 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]

Applicable standard: ISO 7637-3 [26]

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]

|  |  |  |
| --- | --- | --- |
| 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]

|  |  |  |
| --- | --- | --- |
| 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 (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 ≤ t ≤ 10 |
| Test load: | A static test load near Max; the same test weights shall be used throughout the test. |
| Maximum allowable variations: | The variation in the indication of the test load shall not exceed half of the absolute value of the mpe for influence factor tests (4.3.2) for the test load applied on any of the (n) tests conducted. |
| Number of tests (n): | n ≥ 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:   1. Date and time 2. Temperature 3. Barometric pressure 4. Relative humidity 5. Test load 6. Indication 7. Errors 8. Changes in test location   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 (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 (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:

|  |
| --- |
| 1. Types of loads shall be as specified in 9.2.2. 2. Mass of test loads and fills shall be as specified in 9.2.1 a), b) and c). 3. Condition of material tests shall be as specified in 9.2.3 4. 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:

1. Separate verification method: the separate verification method is as defined in 9.5.1.
2. Integral verification method: the integral verification method is as defined in 9.5.2.

**A.8.2.3**   Procedure for metrological material tests

1. Set up the AGFI in accordance with the conditions of test given in 9.2.3.
2. Select a preset value for the fill and set the load value if different from the fill, in accordance with values of the mass of the fills as specified in 9.2.1. Record the indicated preset value.
3. Run the AGFI to produce a number of fills as specified in 9.3 using types of test loads specified in 9.2.2.
4. Weigh all the fills by either:
5. Separate verification method specified in 9.5.1 or
6. 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 instrument shall be considered as the conventional true value of the test fill.

1. In accordance with 9.7 calculate the average value of all the fills in the test as follows:



where:

F is the mass of the fill (conventional true value), in units of mass

n is the number of fills in the test

1. In accordance with 9.8 calculate the deviation of each fill from the average of all the fills in the test as follows:





where:

mdis the deviation from average, in units of mass

1. Repeat stages (b) to (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) (8.2.5)

1. For each preset value of the test fill (FP):
2. Calculate the preset value error specified in 4.3.3 in accordance with 9.9 as follows:



where:

se is the preset value error.

1. Determine the maximum permissible preset value error for class X(1), mpse(1) as follows:

mpse(1) = 0.25 mpd(1) in-service , corresponding to the value of a fill equal to FP

1. Then calculate: [⏐se⏐ / mpse(1)].
2. For each preset value of the test fill (FP):
3. Determine the maximum (largest) of the absolute values of the actual deviation from the average i.e. mdmax
4. Determine the maximum permissible deviation from the average for class X(1), mpd(1) .
5. Then calculate: [mdmax / mpd(1)] .
6. From (a) determine the maximum (largest) value of [⏐se⏐/ mpse(1)],

i.e. [⏐se⏐ / mpse(1)]max from all the preset test fills

1. From (b) determine the maximum (largest) value of [mdmax / mpd(1)],

i.e. [mdmax / mpd(1)]max from all the preset test fills

1. Determine the accuracy class X(x) such that

(x) ≥ [⏐se⏐ / mpse(1)]max

and (x) ≥ [mdmax/ mpd(1)]max

and (x) = 1 × 10k, 2 × 10k, or 5 × 10k,

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 [29].

**B.1 General requirements**

**B.1.1 Software identification**

The legally relevant parts of the software of a AGFI and/or its 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 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.

As an exception, an imprint of the software identification on the AGFI shall be an acceptable solution if it satisfies the following three conditions:

1. 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).
2. The AGFI does not have an interface to communicate the software identification.
3. 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.
4. 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 its 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.

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 its 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 modules of an AGFI

B.2.1.1.a 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 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 results and other legally relevant information belongs to the legally relevant part.

**B.2.3 Storage of data, transmission via communication systems**

If measurement 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 before they are used for legal purposes. In that case the following requirements apply:

B.2.3.1 The measurement result stored 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 results and the accompanying data shall check the time of measurement, authenticity, and integrity of the data after having read them from the storage.

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 that check data after reading or receiving are considered part of the legally relevant software.

B.2.3.3 When transferring measurement 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**

1. Fault limit for selective combination weighers:

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 × (24 / √8) = 2.12 g

1. Fault limit for cumulative weighers:

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 × (120 / √7) = 11.34 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.

1. 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.

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 × (12 g / √4) = 1.5 g

1. 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.

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 × (120 / √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.

**Annex D (Informative)**

**Equipment Under Test**

**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.

**D.2 Other metrological features to be considered**

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 E (Informative)**

**Considerations concerning durability**

**E.1 Type 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 R 61-3 Test Report format.

**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 [30] indicates methods (see clause 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

1. The change of zero

Tests to be considered: accuracy of zero / tare setting, temperature (drift of zero), warm up (drift of zero)

1. 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 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 mpdin service is the worst case and will guarantee that for all fills smaller than 100 g within this range the mpdin 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.

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 influence factors = 0.25 mpd in service

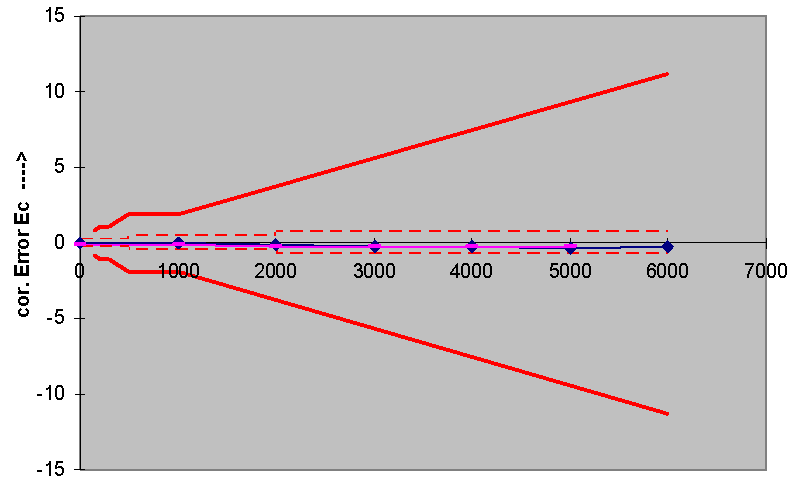
Testing an indicator (module) pi has to be considered: e.g. pi = 0.5

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 pi = 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 in-service x 0.25 (clause 4.3.2 of R 61) x Ref(x) x pi

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 pi = 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) ≤ 0.25 x mpd(X)in service x Min(fill) (5.8.2)

⬄ Min(fill) ≥ mpd(zero) / 0.25 x mpd(X)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.

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 ≥ 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 ≥ 0.25 g / (0.25 x 9 %)  
  
Minfill ≥ 11.1 g and rounded to d  
  
Minfill ≥ 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: Δzmax ≤ 0.25 x mpdin service x Minfill x pi x Ref(X)

* Minfill ≥ Δzmax / (0.25 x mpdin service  x pi x Ref(X))

mpdin service → from Table 1 (4.3.1)

0.25 → 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, pi = 0.5, zero drift 1 e / 5 K, mpdin service = 9 % (assumption that Minfill ≤ 50 g)

from A.6.2.2: Δzmax ≤ 0.25 x mpdin service x Minfill x pi x Ref(X)

* Minfill ≥ Δzmax / (0.25 x mpdin service  x pi x Ref(X))

Assuming that the instrument is not set to zero before 2 h have elapsed:

Minfill ≥ (2 h x 1 e / h) / (0.25 x 9 % x 0.5 x 1)

⇔ Minfill ≥ (2 h x 1 g / h) / (0.25 x 9 % x 0.5 x 1)

⇔ Minfill ≥ 2 g / (0.25 x 9 % x 0.5 x 1)

⇔ Minfill ≥ 177.78 g > 50 g (assumption with regard to Minfill has been wrong)

Next iteration step: Minfill ≤ 200 g and mpdin service = 4.5 % (obviously leading to double the value calculated before)

Minfill ≥ 2 g / (0.25 x 4.5% x 0.5 x 1)

⇔ Minfill ≥ 355.56 g > 200 g (assumption with regard to Minfill has been wrong)

Next iteration step: Minfill ≤ 500 g and mpdin service = 3 %

Minfill ≥ 2 g / (0.25 x 3% x 0.5 x 1)

⇔ Minfill ≥ 533.33 g > 500 g (assumption with regard to Minfill has been wrong)

Next iteration step: Minfill ≤ 1000 g and mpdin service = 15 g, corresponding to   
1.5 % (obviously leading to double the value calculated before)

Minfill ≥ 2 g / (0.25 x 1.5% x 0.5 x 1)

⇔ Minfill ≥ 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 ≥ Δzmax / (0.25 x mpdin service x pi x Ref(X))

Minfill ≥ 1 g x 0.25 / (0.25 x 9% x 0.5 x 1)

⇔ Minfill ≥ 0.25 g / (0.25 x 9 % x 0.5 x 1)

⇔ Minfill ≥ 22.2 g

*C) Warm up time*

from A.6.2.1: E0 - E0 init ≤ 0.25 x mpdin service x Minfill x pi x Ref(X)

* Minfill ≥ (E0 - E0 init ) / (0.25 x mpdin service x pi x Ref(X))

mpdin 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 (E0 - E0 init) < 0 then the absolute value of (E0 - E0 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, pi = 0.5, zero drift due to warm up 3 e,   
mpdin service = 9 % (assumption that Minfill ≤ 50 g)

Minfill ≥ (E0 - E0 init) / (0.25 x mpdin service x pi x 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.   
mpdin 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.   
mpdin 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 ≤ 0.25 x mpdin service x Ref(X) x Minfill

(pi = 1 for disturbance tests; see WELMEC Guide 2.1)

⇔ Minfill ≥ md disturbance / (0.25 x mpdin service x 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 pi, 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 mpdin service = 4.5 %

Then:

Minfill ≥ md disturbance / (0.25 x mpdin service x Ref(X))

⇔ Minfill ≥ 1.5 g / (0.25 x 4.5 % x 1)

⇔ Minfill ≥ 133.3 g

Since mpdin 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 ≤ 0.25 x mpdin service x Ref(X) x Minfill

⇔ md disturbance ≤ 0.25 x 9 % x 1 x 50 g

⇔ md disturbance ≤ 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 pi) 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 pi 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 dWU of the single weighing unit.

d ≥ dWU x 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) ≤ 0.25 x (mpd(X)in service x 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 dWU). 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 dWU ≤ 0.25 x (mpd(X)in service x Min(fill) / sqr (lpf))

⬄ dWU ≥ mpd(X)in service x Min(fill) / sqr (lpf)

⬄ Min(fill) ≥ dWU x sqr (lpf) / mpd(X)in service

Example:  
Nonautomatic weighing instrument with dWU = 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 ≥ dWU x sqr (lpf) / mpd(X)in serviceThe 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 ≥ 1 g x sqr(4) / 9 %  
  
Minfill ≥ 22.2 g and rounded to d  
  
Minfill ≥ 22 g  
  
The Minfill of this instrument (having dWU = 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 dWU 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 dWU, depending on normal accuracy of zero setting of NAWIs:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| dWU | 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 dWU of the weighing unit.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| d/sqr(lpf)  lpf = 4 | calculated  dwu | permissible  dwu | **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:

Δzmax ≤ 0.25 x mpdin service x Minfill x pi x Ref(X) / sqr(lpf)

* Minfill ≥ Δzmax x sqr(lpf) / (0.25 x mpdin service  x pi x Ref(X))

mpdin service → from Table 1 (4.3.2)

0.25 → 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 = dWU = 1 g, Ref(X) = 1, pi = 0.5, zero drift 1 e / 5 K,   
mpdin service = 9 % (assumption that Minfill ≤ 50 g)

from A.6.2.2 and A.6.1.3.2:

Δzmax ≤ 0.25 x mpdin service x Minfill x pi x Ref(X) / sqr(lpf)

* Minfill ≥ Δzmax x sqr(lpf) / (0.25 x mpdin service  x pi x Ref(X))

Assuming that the instrument is not set to zero before 2 h have elapsed:

Minfill ≥ (2 h x 1 e / h) x sqr(4) / (0.25 x 9 % x 0.5 x 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 mpdin 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 mpdin 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: E0 - E0I ≤ 0.25 x mpdin service x Minfill x pi x Ref(X) / sqr(lpf)

* Minfill ≥ (E0 - E0I ) x sqr(lpf) / (0.25 x mpdin service x pi x Ref(X))

mpdin 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 (E0 - E0I) < 0 then the absolute value of (E0 - E0I) 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, pi = 0.5, zero drift due to warm up 3 e, mpdin service = 9 % (assumption that Minfill ≤ 50 g)

Minfill ≥ (E0 - E0 init) x sqr(lpf) / (0.25 x mpdin service x pi x 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.   
mpdin 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 ≥ 3200 g ≥ 1000 g, next iteration step.

Minfill between >1000 g and ≤ 10000 g, mpdin 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 ≤ 0.25 x mpdin service x Ref(X) x Minfill / sqr(lpf)

⇔ Minfill ≥ md disturbance x sqr(lpf) / (0.25 x mpdin service x 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 pi, is again 1. (see R 76-1, C.2.2, Table 12). The expected Minfill is between >100 g and ≤ 200 g, so mpdin service = 4.5 %

Then:

Minfill ≥ md disturbance x sqr(lpf) / (0.25 x mpdin service x 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, mpdin 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 ≤ 0.25 x mpdin service x Ref(X) x Minfill

⇔ md disturbance ≤ 0.25 x 3 % x 1 x 300 g

⇔ md disturbance ≤ 2.25 g

**Annex F -Considerations on MinFill**

**(Informative)**

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 mpd this leads to:

0.25 mpd ≤ 0.25 mpd in-service x Minfill, or Minfill ≥ d / mpd 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 and F values (masses of the fills in Table 1) are applied.

Example 1:

Estimated mass of the fills with 400 g

Class X(0.2) AGFI

d = 20 g and estimated mpd (3 % x 0.2) = 0.6 %

Combining the estimated 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 MPDin-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 are coherent.

Not for each absolute values of the mpd a Minfill can be obtained. Only the relative mpd values can be used for the calculation of the Minfill and the calculated Minfill shall be in the same (F) range as the mpd used in the calculation.

Example 2:

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 = 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 percentage the Minfill would be: 10 g / 0.036 = 280 g:

but for 280 g the 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 = 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 are coherent.

**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, 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 |
| [3] | OIML D 11:2013  *General requirements for electronic measuring instruments -*  *Environmental Conditions* | Contains general requirements for electronic measuring instruments |
| [4] | OIML R 111:2004  *Weights of classes E1, E2, F1, F2, M1, M1–2, M2, M2–3 and M3* | 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 |
| [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 |
| [6] | OIML R 76:2006 *Non-automatic weighing instruments* | Provides the principal physical characteristics and metrological requirements for the verification of non-automatic weighing instruments |
| [7] | OIML D 19:1988  *Type evaluation and type approval* | Provides advice, procedures and influencing factors on type evaluation and type approval |
| [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) |
| [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 |
| [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 |
| [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 |
| [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 |
| [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 |
| [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. |
| [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). |
| [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) |
| [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. |
| [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. |