INTERNATIONAL RECOMMENDATION

OIML R 61-1

Edition 2017 (E)

Automatic gravimetric filling instruments.

Part 1: Metrological and technical requirements

Doseuses pondérales à fonctionnement automatique.

Partie 1: Exigences métrologiques et techniques

ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE

INTERNATIONAL ORGANIZATION OF LEGAL METROLOGY

Contents

Foreword

The International Organization of Legal Metrology (OIML) is a worldwide, intergovernmental organization whose primary aim is to harmonize the regulations and metrological controls applied by the national metrological services, or related organizations, of its Member States. The main categories of OIML publications are:

- **International Recommendations (OIML R),** which are model regulations that establish the metrological characteristics required of certain measuring instruments and which specify methods and equipment for checking their conformity. OIML Member States shall implement these Recommendations to the greatest possible extent;
- **International Documents (OIML D),** which are informative in nature and which are intended to harmonize and improve work in the field of legal metrology;
- **International Guides (OIML G),** which are also informative in nature and which are intended to give guidelines for the application of certain requirements to legal metrology; and
- **International Basic Publications (OIML B),** which define the operating rules of the various OIML structures and systems.

OIML Draft Recommendations, Documents and Guides are developed by Technical Committees or Subcommittees which comprise representatives from the Member States. Certain international and regional institutions also participate on a consultation basis. Cooperative agreements have been established between the OIML and certain institutions, such as ISO and the IEC, with the objective of avoiding contradictory requirements. Consequently, manufacturers and users of measuring instruments, test laboratories, etc. may simultaneously apply OIML publications and those of other institutions.

International Recommendations, Documents, Guides and Basic Publications are published in English (E) and translated into French (F) and are subject to periodic revision.

Additionally, the OIML publishes or participates in the publication of **Vocabularies (OIML V)** and periodically commissions legal metrology experts to write **Expert Reports (OIML E)**. Expert Reports are intended to provide information and advice, and are written solely from the viewpoint of their author, without the involvement of a Technical Committee or Subcommittee, nor that of the International Committee of Legal Metrology. Thus, they do not necessarily represent the views of the OIML.

This publication – reference OIML R 61-1, Edition 2017 – was developed by Technical Subcommittee TC 9/SC 2 *Automatic weighing instruments*. It was approved for final publication by the International Committee of Legal Metrology in October 2017 and will be submitted to the International Conference on Legal Metrology in 2020 for formal sanction. It supersedes the previous edition of R 61 dated 2004.

OIML Publications may be downloaded from the OIML web site in the form of PDF files. Additional information on OIML Publications may be obtained from the Organization's headquarters:

Bureau International de Métrologie Légale
11, rue Turgot - 75009 Paris – France
Telephone: 33 (0)1 48 78 12 82
Fax: 33 (0)1 42 82 17 27
E-mail: biml@oiml.org
Internet: www.oiml.org

Automatic gravimetric filling instruments

Part 1 – Metrological and technical requirements

1 Introduction

This OIML Recommendation consists of three separate parts:

Part 1: Metrological and technical requirements - Tests
Part 2: Test procedures
Part 3: Report format for type evaluation

2 Scope

This Recommendation specifies the metrological and technical requirements, metrological controls and tests for automatic gravimetric filling instruments (hereafter referred to as "AGFIs") which produce a predetermined mass of individual fills of products from one or more loads by automatic weighing.

Note 1: OIML R 61 places no constraint on the maximum or minimum capacities of the AGFIs for which OIML R 61 is applicable.

Note 2: AGFIs may also be required to comply with other OIML Recommendations.

3 Terms and definitions

The terminology used in OIML R 61 conforms to the International Vocabulary of Basic and General Terms in Metrology (VIM) [1], the International Vocabulary of Legal Metrology (VIML) [2], D 11 General requirements for measuring instruments - Environmental conditions [3], R 76 Non-automatic weighing instruments [6], and to D 31 General requirements for software controlled measuring instruments [9]. In addition, for the purposes of R 61, the following definitions apply.

3.1 General definitions

Note: Where the term "mass" is used in this Recommendation, it concerns the "conventional mass" or "conventional value of the result of weighing in air" according to R 111 [4] and D 28 [8].

3.1.1
load, *L*

amount of product that is currently introducing the force on the load receptor

3.1.2
fill

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

3.1.3
weight

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

Note: In OIML R 61 "weight" is preferably used for an embodiment (= material measure) of mass that is regulated in regard to its physical and metrological characteristics.

3.1.4
weighing

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

3.1.5
weighing instrument

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

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

3.1.6
measurement result (VIM 2.9 [1])

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

3.1.7
metrologically relevant device

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

3.1.8
audit trail (OIML D 31 [9])

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

3.2 Categories of instruments

3.2.1
automatic weighing instrument

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

3.2.2
automatic gravimetric filling instrument (AGFI)

automatic weighing instrument intended to fill containers with a predetermined and virtually constant mass of product from bulk (including liquid material) by automatic weighing, and which comprises essentially automatic feeding device(s) associated with weighing module(s) and the appropriate control and discharge devices. Types of AGFI include those described in 3.2.2.1–3.2.2.2

3.2.2.1
multi-load AGFI

cumulative or selective combination AGFI

3.2.2.1.1
selective combination weighing instrument

AGFI comprising more than one weighing module and which computes an appropriate combination of the loads and combines them into one fill

3.2.2.1.2
cumulative weighing instrument

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

3.2.2.2
subtractive weighing instrument

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

3.3 Construction

Note: In OIML R 61 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 realization 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 controls the operation of the feeding process and that 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 mass 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 value of the mass of the fills corresponds to the preset value

Note: The final feed cut-off device may include a correction device for the material feed into the weighing module.

3.3.1.3.4
correction device

device which automatically corrects the setting of the AGFI

3.3.2 Other parts

3.3.2.1
device

identifiable instrument or part of an instrument or of a family of instruments that performs a specific function or functions

Note: A device may be a stand-alone and complete measuring instrument (for example: counter scale, electricity meter) or a part of a measuring instrument (for example: printer, indicator).

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, for example, display the

- differences between the mass of a load and some reference value,
- value of the mass of the fill(s) and/or related quantities,
- 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

3.3.4.1
non-automatic zero-setting device

device for setting the indication to zero by an operator

3.3.4.2
semi-automatic zero-setting device

device for setting the indication to zero automatically following a manual command

3.3.4.3
automatic zero-setting device

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

3.3.4.4
initial zero-setting device

device for setting the indication to zero automatically at the time the instrument is switched on or reset and before it is ready for use

3.3.4.5
zero-tracking device

device for maintaining the zero indication within certain limits automatically

3.3.5 tare

3.3.5.1
tare device

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

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

b) reducing the weighing range for net loads (subtractive tare device)

Note: The tare device functions as

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

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

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

3.3.5.2
preset tare device

device for subtracting a preset tare value from a gross or net weight value and indicating the calculated net weight. The weighing range for net loads is reduced accordingly

3.3.5.3
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

Note: "introduced" includes procedures such as keying in, recalling from a data storage device, or inserting via an interface.

3.3.6 software

3.3.6.1
legally relevant software (VIML, 6.10 [2])

part of the applied software that is subject to legal control

3.3.6.2
legally relevant parameter

parameter of a measuring instrument, (electronic) device, sub-assembly, software or 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 (VIML 4.11 [2])

legally relevant parameter with a value that depends on the type of instrument only

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 (VIML, 4.12 [2])

legally relevant parameter with a value that depends on the individual instrument

3.3.6.5
software identification (VIML, 6.01 [2])

sequence of readable characters (e.g. version number, checksum) that is inextricably linked to the software or software module under consideration

Note: The software identification can be checked on an instrument whilst in use.

3.3.6.6
software separation (VIML, 6.02 [2])

separation of the software in measuring instruments which can be divided into a legally relevant part and a legally non-relevant part

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 (OIML D 31 [9])

shared boundary between two functional units, defined by various characteristics pertaining to the functions, physical interconnections, signal exchanges, and other characteristics of the units, as appropriate

3.3.9
user interface (VIML 6.08 [2])

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

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 (VIML, 4.04 [2])

identifiable part of a measuring instrument or of a family of measuring instruments that performs a specific function or functions and that can be separately evaluated according to prescribed metrological and technical performance requirements as specified in the relevant Recommendation

Example: Typical modules of a weighing instrument are weighing module, load cell, indicator, analog or digital data processing device, terminal, primary display.

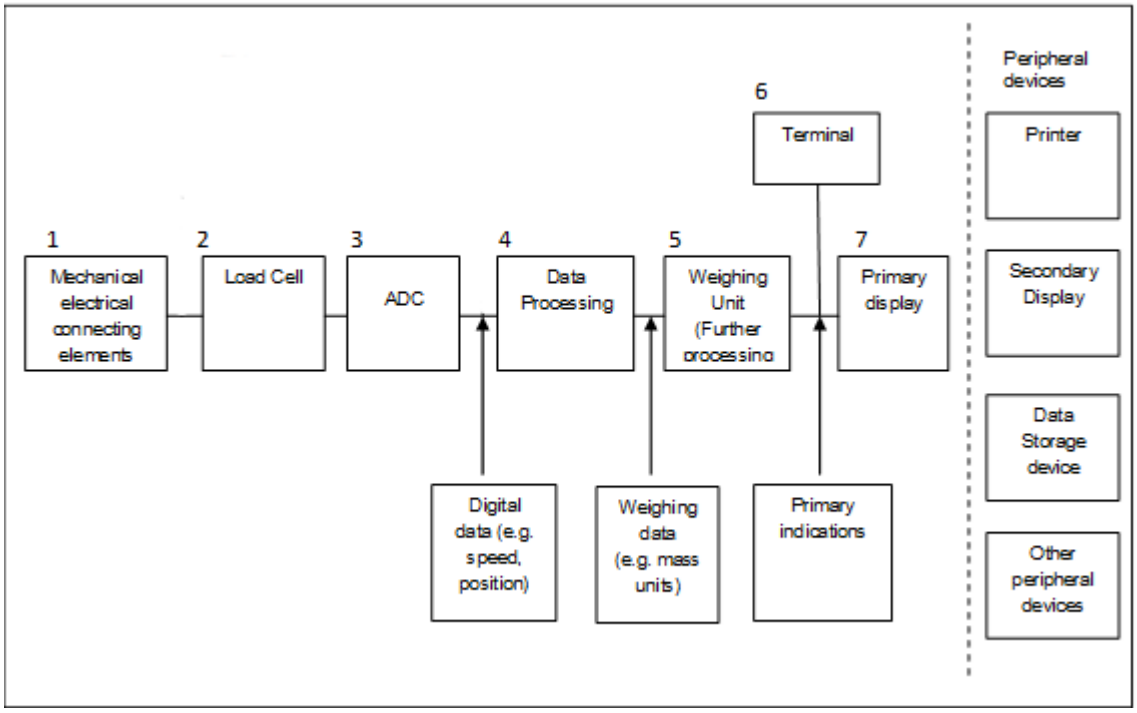

Figure 1 – Typical module combinations according to Table 1 (other combinations are possible)

Table 1 – Definition of typical modules according to 3.3.11 and 8.2.3.3

Modules		Typical combinations
(analogue) load cell	(3.3.11.1)	2
digital load cell	(3.3.11.1.1)	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 (OIML R 60, 3.1.3 [5])

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

3.3.11.2
indicator

electronic device that may perform the analogue-to-digital conversion of the output signal of the load cell, 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, 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, pre-set value, fills per minute, etc. transmitted via the digital interface of a weighing module or an analogue data processing device

3.3.11.7
weighing module

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

3.3.11.8
control instrument (VIML, 5.08 [2])

weighing instrument used to determine the conventional value of the mass of the test load(s)

3.4 Metrological characteristics

3.4.1
scale interval, *d* (VIML, 5.01 [2])

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

a) the values corresponding to two consecutive scale marks for analogue indication, or

b) two consecutive indicated values for digital indication

3.4.2
product reference quantity

calculated quantity value equal to the mean of at least 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 mass 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

combination of operations including

a) the delivery of material to the load receptor(s),

b) a weighing operation, and

c) the discharge of a single discrete load

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

3.4.6
final feed time

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

3.4.7
minimum capacity, Min

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

Note: For AGFIs which accomplish the fill by one weighing cycle the 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 mass of the fill below which the weighing results may be subject to errors exceeding the required limitations specified in this Recommendation

Note: For AGFIs which accomplish the fill by more than one weighing cycle Minfill is larger than the minimum capacity, Min.

3.4.10
maximum fill, Maxfill

maximum possible fill of the instrument related to a specific product

3.4.11
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

3.4.12
load for static test

load that is used in static tests only

3.4.13
minimum discharge

smallest load that can be discharged from a subtractive weighing instrument

3.4.14
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 (VIM, 4.1 [1])

quantity value provided by a measuring instrument or measuring system

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 (device)

output device that allows actual information to be visualized 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" (3.5.1.1 and 3.5.1.2).

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 (VIM, 2.16 [1])

measured quantity value minus a reference quantity value

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

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

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

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

3.5.2.2
intrinsic error (VIML, 0.06 [2])

error of a measuring instrument, determined under reference conditions

3.5.2.3
initial intrinsic error (VIML, 5.11 [2])

intrinsic error of a measuring instrument as determined prior to performance tests and durability evaluations

3.5.2.4
maximum permissible error, mpe (VIM, 4.26 [1])

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'.

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

3.5.2.5
fault (VIML, 5.12 [2])

difference between the error of indication and the intrinsic error of a measuring instrument

Note 1: Principally, a fault is the result of an undesired change of data contained in or flowing through an 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 (VIML, 5.13 [2])

value specified in the applicable Recommendation delimiting non-significant faults

3.5.2.7
significant fault (VIML 5.14 [2])

fault exceeding the applicable fault limit value

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 an 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 Recommendation may specify the nature of these variations.

3.5.2.8
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 the accuracy class specified by the manufacturer for the purpose of static testing of the weighing module during influence quantity testing at the 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 (VIM 2.52 [1])

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

3.6.1.1
influence factor (VIML, 5.18 [2])

influence quantity having a value within the rated operating conditions of a measuring instrument

3.6.1.2
disturbance (VIML, 5.19 [2])

influence quantity having a value within the limits specified in OIML R 61 but outside the rated operating conditions of the measuring instrument

3.6.2
rated operating conditions (VIM, 4.9 [1])

operating condition that must be fulfilled during measurement in order that a measuring instrument or measuring system perform as designed

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

3.6.3
reference conditions (VIM 4.11 [1])

operating condition prescribed for evaluating the performance of a measuring instrument or measuring system or for comparison of measurement results

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 (VIML, 5.21 [2])

test intended to verify whether the equipment under test (EUT) is able to accomplish its intended functions

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

d scale interval

L load

ΔL additional load to next changeover point

F value of the mass of the fill

F_P preset value of the mass of the fill

p_i fraction of the $mpe_{(1)}$ applicable to one part of the instrument which is examined separately

N number of fill stations in the machine

(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)

Min minimum capacity

Minfill rated minimum fill

md_{max} maximum of the actual deviations of each fill from the average of all individual test fills of a test sequence

$mpd_{(1)}$ maximum permissible deviation of each fill from the average for class X(1)

$mp\Delta z_{(1)}$ maximum permissible zero change per 5 °C for class X(1)

AGFI automatic gravimetric filling instrument

3.9 Equations

$P = I + ½\ d - \Delta L$ = Indication prior to rounding (digital indication)

$E = I - L$ = Error

4 Metrological requirements

4.1 Units of measurement

The units of mass include:

a) milligram (mg),

b) gram (g),

c) kilogram (kg), and

d) tonne (t).

4.2 Accuracy classes

The manufacturer 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 mass of the fills, and rated operating conditions.

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

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 2, multiplied by the class designation factor (*x*).

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

Table 2 – Maximum permissible deviation (mpd) of each fill

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

Note: See R 61-2, Table 1 for the number of fills required to find 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 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 error calculation in R 61-2, Annex A.2.

4.3.3 Maximum permissible preset value error, mpse

For AGFIs set with a preset value (R 61-2, 8.6) the maximum difference between the preset value and the average value of the mass of all the fills in a test sequence (R 61-2, 8.7) shall not exceed 0.25 mpd in-service (4.3.1) for the preset value. These limits apply to initial verification and in-service testing.

4.3.4 Fault limit value

a) For each fill, which is equal to the minimum capacity, Min, or rated minimum fill, Minfill, the maximum permissible value of fault is 0.25 mpd in-service (see 4.3.1).

b) Fault limit for selective combination weighing instruments:

   A fault greater than 0.25 mpd in-service of each fill (Table 2) 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.

c) Fault limit for cumulative weighing instruments:

   A fault greater than 0.25 mpd in-service of each fill (Table 2), for a fill equal to the Minfill, divided by the square root of the minimum number of loads per fill.

Note: See R 61-2, Annex A.1 and Annex A.2 for examples showing how to determine the value of a significant fault for multi-loads AGFIs.

4.4 Product reference quantity correction (3.4.2)

For material tests, when the absolute value of the difference between the product reference quantity and the test fill is greater than 10 % of the mpd for the value of the mass of the test fills, an mpd corresponding to a value of 1.5 times the value of the mass of the test fills may be applied.

Note: Product reference quantity correction is not applicable to limits which are derived from Table 2, e.g. influence quantity tests, zero-setting etc.

4.5 Error limits for multi-load AGFIs

4.5.1 General

For multi-load AFGIs, the effect on the fill shall not be greater than the fault limit value in 4.3.4 and the mpe specified in 4.3.2.

4.5.2 Multi-load AGFIs and test limits

For multi-load AGFIs, 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.

4.5.2.1 Multi-load AGFIs and fault limit

The examples in OIML R 61-2, Annex A.1 show how to determine the fault limit on selective combination weighing instruments and cumulative weighing instruments when testing.

4.5.2.2 Multi-load AGFIs and influence factor mpe determination

The examples in OIML R 61-2, Annex A.2 show how to determine the maximum permissible error for influence factor testing for selective combination weighing instruments and cumulative weighing instruments when testing.

4.6 Minimum capacity value, Min

The value of Min shall be specified by the manufacturer.

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

Note: For AGFIs which accomplish the fill by one weighing cycle, the value of Min is equal to the Minfill.

4.7 Rated minimum fill, Minfill

The value of Minfill shall be specified by the manufacturer.

The mpe is applicable to each fill with a mass, F, equal to or greater than the value of Minfill.

Note: As a minimum, the following parameters have an influence on the value of 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 3 below:

Table 3 – 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	1 665	335	110	30
10	3 330	1 330	330	110
20	6 660	2 660	1 340	340
50	25 000	6 650	3 350	1 650
100	50 000	20 000	6 700	3 300
200	100 000	40 000	20 000	6 600
≥500	500 *d*	200 *d*	100 *d*	50 *d*

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 gram values are rounded to the *d* values which can be indicated.

For calculating the Minfill value for class X(x) AGFIs the mpd and F values (value of the mass of the fills) in Table 2 are used. See R 61-2, Annex E for examples.

4.8 Influence factors

4.8.1 General

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

4.8.2 Humidity

The AGFI shall maintain its metrological and technical characteristics at a relative humidity of either 85 % (non-condensing) or 93 % (condensing) at the upper limit of the temperature range of the instrument.

4.8.3 Temperature

4.8.3.1 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

4.8.3.2 Special temperature limits

For special applications the limits of the temperature range may differ from those given above. The range shall not be less than 30 °C and shall be marked on the AGFI in the manner according to 5.12.

4.8.3.3 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 sufficient to disable any zero-tracking for a difference in ambient temperature of 5 °C.

4.8.4 Supply voltage

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

a) AC mains voltage variation:

   1) lower limit = 0.85 U_{nom} or 0.85 U_{min}

   2) upper limit = 1.10 U_{nom} or 1.10 U_{max}

b) DC mains voltage variation:

   1) The upper voltage limit is the DC level at which the EUT has been manufactured to automatically detect high-level conditions.

   2) The lower limit will be the DC level at which the EUT has been manufactured to automatically detect low-level conditions.

c) Low voltage of internal battery (not connected to the mains power). If applicable and only when the internal battery power could be of influence on the result of the measurement. The lower limit will be the minimum operating voltage specified by the manufacturer.

d) Power from external 12 V and 24 V road vehicle batteries:

   1) 12 V lower limit = 9 V upper limit = 16 V

   2) 24 V lower limit = 16 V upper limit = 32 V

4.8.5 Tilting (R 61-2, 10.2.6)

AGFIs intended to be used outside in open locations (e.g. on roads) or AGFIs not permanently installed in a fixed position and without a levelling device and a level indicator shall comply with the appropriate metrological and technical requirements when tilted (longitudinally and transversely) by up to 5 %.

a) Where a levelling device and a level indicator 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 location clearly visible to the user and representative for the tilt sensitive part.

b) If the AGFI is fitted with a tilt sensor the limiting value of tilting is defined by the manufacturer. For AGFI used in vehicles the value of the tilting may be up to 10 % or if higher in accordance with the manufacture's specification. The tilt sensor shall release a display switch-off or other appropriate alarm signal (e.g. error signal) and shall inhibit the printout and data transmission if the limiting value of tilting has been exceeded.

c) Where a tilt sensor is also used to compensate the effect of tilting by correcting 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.

5 Technical requirements

5.1 Suitability for use

AGFIs shall be designed to suit the method of operation and the products for which they are intended. They shall be of adequately robust construction to maintain their metrological characteristics when properly installed and used in an environment for which they are intended.

5.2 Security of operation

5.2.1 Fraudulent use

AGFIs shall have no characteristics likely to facilitate their 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 their correct functioning cannot take place without the 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 unauthorized access is prohibited or is detected and made evident by an audit trail or similar.

National regulations may specify the security or sealing measures.

5.3 Indication of weighing results

5.3.1 Quality of indication

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

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

5.3.2 Form of the indication

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

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

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

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

5.3.3 Use of a printer

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

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

5.3.4 Scale interval, *d*

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

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

5.4 Fill setting device

Where a weighing instrument is used for setting the desired value of the mass of the fill, its indication shall be in units of mass.

Where weights are used to set the desired value of the mass of the fill, these shall be in accordance to OIML R 111 [4] or shall be specifically designed for this purpose and shall as such be distinguishable by shape and identification. The mass of such special weights should be fit for purpose and may be of any value.

5.5 Final feed cut-off device

The final feed cut-off device shall be a clearly distinguishable device on the AGFI.

The final feed cut-off device may include a device which corrects for the residual material feed into the weighing module after cut-off.

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 if 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

5.8.1 General

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

a) non-automatic,

b) semi-automatic, or

c) automatic.

For combined zero-setting and tare devices, the same key operates the semi-automatic zero-setting device and the semi-automatic tare device. In these cases, the accuracy requirements specified in 5.8.3 and in 5.8.5 apply at any load.

5.8.2 Operating range

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

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

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

5.8.3 Accuracy of non-automatic and semi-automatic 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 for a fill equal to the Min.

After zero-setting or taring the residual error at zero shall not affect the result of the weighing by more than 0.25 mpd in-service as defined for a fill equal to the Min.

5.8.4 Control of the zero-setting and tare devices

5.8.4.1 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.

5.8.4.2 Automatic zero-setting devices

An automatic zero-setting device may operate as a part of either

a) every automatic weighing cycle, or

b) a cycle with a programmable time interval.

A description of the operation of the automatic zero-setting device shall be included in the documentation submitted for type evaluation.

The automatic zero-setting device shall operate sufficiently often to ensure that zero is maintained within twice the given mpe in 5.8.3.

Where the automatic zero-setting device operates as a part of every automatic weighing cycle, it shall not be possible to disable this device.

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

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

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

5.8.5 Zero-tracking device

A zero-tracking device shall operate only when the

a) indication is at zero, or at a negative net value equivalent to gross zero, and

b) corrections are not more than 0.5 *d*/s.

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 indicated 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:

a) Automatic zero-setting is activated by an event, such as part of every automatic weighing cycle or after a programmed interval;

b) Zero-tracking may operate continuously when the above conditions are fulfilled and must therefore be subject to a maximum rate of correction of 0.5 *d*/s.

5.8.6 Tare device

5.8.6.1 Accuracy and control of tare devices

Accuracy and operation of the tare device shall be as specified in 5.8.3 and 5.8.4.

5.8.6.2 Subtractive tare device

When subtractive tare is applied it reduces the weighing range and a device shall continue to prevent the use of the AGFI above its maximum capacity or indicate that this capacity has been reached.

5.8.6.3 Automatic tare device

An automatic tare device may operate at the start of automatic operation as a part of

a) every automatic weighing cycle, or

b) a cycle with a programmable time interval.

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

Where the automatic tare device operates as a part of every automatic weighing cycle, it shall not be possible to disable this device.

Where the automatic tare device operates as a part of a cycle with a programmable time interval, the manufacturer shall specify the maximum programmable time interval.

5.8.7 Preset tare device

5.8.7.1 Scale interval

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

5.8.7.2 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

If the instrument has a data storage device, its measurement data shall be stored. The stored data shall be adequately protected against intentional and unintentional changes during the data transmission and/or storage process and shall contain all the relevant information necessary to reconstruct an earlier measurement.

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

To ensure adequate security the following conditions shall apply:

a) the requirements for security of software given in 5.10 are applied as appropriate;

b) if software realizing short or long term data storage can be transmitted to or downloaded into the instrument, these processes shall be secured in accordance with requirements of 5.2.3;

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

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

e) when storage capacity is exhausted, new data may replace the oldest data provided that overwriting the old data is authorized and/or after this data has been archived; and

f) the additional requirements in Annex B apply.

5.10 Software

5.10.1 General

The legally relevant software of the AGFI (i.e. the software that is critical for measurement characteristics, measurement data and metrologically important parameters, stored or transmitted, and software programmed to detect system faults (software and hardware)) shall be identified by the manufacturer. This legally relevant software is considered as an essential part of the AGFI and shall meet the requirements for the security of software specified in 5.10.3. The additional requirements in Annex B apply.

Note: It shall be possible to check the software identification on an installed AGFI.

5.10.2 Software documentation

The software documentation submitted by the manufacturer shall include

- a description of the legally relevant software,
- a description of a suitable system configuration and minimal required resources,
- a description of the accuracy of the measuring algorithms,
- a description of the user interface, menus and dialogues,
- the unambiguous software identification,
- a description of the embedded software,
- an 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,
- a description of the accuracy of the algorithms (e.g. filtering of A/D conversion results, rounding algorithms, etc.),
- a description of data sets stored or transmitted,
- a list of commands of each hardware interface of the AGFI / electronic device / sub-assembly including a statement of completeness,
- a means of securing software,
- if fault detection is realized in the software, a list of faults that are detected and a description of the detecting algorithm, and
- the operating manual.

5.10.3 Security of legally relevant software

There shall be adequate security to ensure that:

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

b) the software shall be assigned with appropriate software identification (Annex B.1.1). This software identification shall be adapted in the case of every software change that may affect the functions and accuracy of the AGFI;

c) functions performed or initiated via connected interfaces, i.e. transmission of legally relevant software, shall comply with the securing requirements for interfaces of 6.10.

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

5.12.1 General markings

The AGFI 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 and where required)
- Year 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, 4.8.2) in the form: ..... °C / ..... °C
- Voltage of electrical power supply in the form: V
- Frequency of electrical power supply in the form: (if applicable): ..... 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 in the form: Minfill .....
- Maximum rate of operation (if applicable) in the form: ..... loads per minute
- Type approval marking
- 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 if applicable) in the form: Min .....
- Maximum additive tare in the form: T = + ...
- Maximum subtractive tare in the form: T = – .....

5.12.2 Supplementary 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 the AGFI 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.

5.12.3 Presentation of descriptive markings

The descriptive markings shall be indelible and shall have 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 location on the AGFI, either on a markings plate or on a permanently fixed sticker on a non-removable part of the AGFI or on the AGFI itself.

Where the markings are placed on a plate or sticker and if the plate or sticker will not be destroyed in case it is removed, a means of securing shall be provided (e.g. a non-removable control mark or a means for sealing the plate bearing the markings). Where the markings are located on the AGFI itself, removing the markings shall not be possible without destroying them.

The descriptive markings may be shown on a programmable display which is controlled by software provided that

a) at least Max, Minfill, Ref(x), X(x) and d will be displayed as long as the AGFI is switched on, and

b) that it is possible to display all the other marking on manual command.

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

- type approval sign in accordance with national requirements;
- name or identification mark of the manufacturer;
- serial number;
- temperature range;
- type approval number;
- voltage of power supply;
- frequency of power supply (if applicable);
- pneumatic/hydraulic pressure (if applicable).

Descriptive markings on a display which is controlled by software shall be described in the type approval (OIML) certificate, and the markings are considered as device-specific parameters, and shall comply with the requirements for securing in 5.2.3 and 5.10.3.

Descriptive markings may be either in the national language or a language which is allowed to be applied in the particular country or in the form of adequate, internationally agreed and published pictograms or signs.

5.13 Verification marks

5.13.1 Position

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

a) be the part on which the mark is located,

b) not be removable from the AGFI without damaging the marks,

c) allow easy application of the mark without changing the metrological qualities of the AGFI, and

d) be visible without moving the AGFI or removing its protective covers.

5.13.2 Mounting

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

5.13.3 Control instruments (3.3.11.8)

The control instrument defined concerns the weighing instrument used during testing, which could be

a) a separate weighing instrument, or

b) the integral weighing module with primary display of the AGFI under test.

6 Requirements for AGFIs with respect to their environment

6.1 General

The type of AGFI is presumed to comply with the requirements if it passes the examinations and tests specified in OIML R 61-2.

6.2 Performance under rated operating conditions

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

6.3 Disturbance tests

AGFIs shall be so designed and manufactured that when exposed to disturbances, either:

a) significant faults do not occur, i.e. the difference between the weight indication due to the disturbance and the indication without the disturbance (intrinsic error, see 3.5.2.2) shall not exceed the significant fault (3.5.2.7); or

b) significant faults are detected and acted upon.

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

6.4 Acting upon a significant fault

When a significant fault has been detected, the AGFI shall either be automatically made inoperative or provide a visual or audible indication of the fault until the user takes action or the fault is resolved.

6.5 Durability

The requirements in 6.2, 6.3 and 6.6 shall be met durably in accordance with the intended use of the instrument. See 8.1 for further information.

6.6 Application

The requirements in 6.3 may be applied separately to

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

b) each part of the AGFI.

The choice of whether AGFIs are designed to

a) withstand disturbances, or

b) detect and act on significant faults is left to the manufacturer of the instrument.

6.7 Influence factors

AGFIs shall comply with the influence factors requirements of 4.8.

6.8 Indicator display test

Upon switch-on (of the indication), a special software procedure shall start that takes care of showing all relevant figure and sign elements of the indicator in their active and non-active state for a time period sufficiently long to be checked by the operator. This required procedure is not applicable for displays on which failure will become evident, e.g. non-segmented displays, screen-displays, matrix-displays, etc.

6.9 Warm-up time

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

6.10 Interfaces

AGFIs may be equipped with interfaces allowing the coupling of the instrument to any peripheral devices or other instruments.

Interfaces concern all mechanical, electrical and software devices at the communication point between instruments, peripheral and software devices.

An interface shall not allow the metrological functions of the AGFI and its measurement data to be inadmissibly influenced by the peripheral devices (for example computers), by other interconnected instruments, 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 5.

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

a) display data that are not clearly defined and which could be mistaken for a weighing result,

b) falsify displayed, processed or stored weighing results,

c) unauthorized adjustment of the AGFI.

Other interfaces shall be secured in accordance with 5.2.3.

Interfaces intended to be connected to a peripheral device to which the requirements of OIML R 61 apply, shall transmit data relating to primary indications in such a manner that the peripheral device can meet the requirements.

7 Examination and tests

7.1 General

Examination and testing of the AGFI is intended to verify compliance with the applicable requirements of OIML R 61.

7.2 Examination

The AGFI shall be examined to obtain a general appraisal of the design and construction.

7.3 Performance tests

The instrument or electronic device, as appropriate, shall be tested as specified in R 61-2, 10, 11 and 12 to determine the correct functioning of the AGFI.

Tests shall be carried out on the whole instrument except when the size and/or configuration of the instrument does not lend itself to testing as a unit. In such cases the electronic devices shall be tested, where possible as a simulated instrument including all electronic elements of a system which can affect the weighing result. In addition, an examination shall be carried out on the fully operational instrument.

This simulation includes the monitoring of the effect on susceptibility caused by connection of (optional) interfaces to other equipment.

When the AGFI is subjected to the span stability test specified in OIML R 61-2, 11, 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.

8 Metrological controls

8.1 General

National legislation may impose controls to ensure that AGFIs used in specific applications comply with the requirements of OIML R 61.

If metrological control is imposed for conformity, this control may comprise

a) type evaluation,

b) initial verification,

c) subsequent verification, and

d) in-service inspection.

The metrological authority involved shall take care that the applicable tests will be executed in a uniform way following a uniform test program. Guidance on the performing of type evaluation and initial verification is provided in OIML D 19 [7].

For the purposes of testing, the metrological authority involved may require from the applicant the product (i.e. the material to be weighed), the handling equipment, the control instrument (as defined in 3.3.11.8) and the personnel assistance for performing the tests.

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

Further information about durability testing is given in OIML R 61-2, Annex C.

8.2 Type evaluation

8.2.1 Documentation

The application for type approval shall include the following information (unless obviously not applicable):

Note: The numbers in parentheses in the list below refer to clauses in OIML R 61-1.

- general description of the AGFI, description of the function, intended purpose of use, kind of instrument;
- general characteristics (manufacturer; Max, Min, X(x), Ref(x), temperature range, voltage, etc.);
- list of descriptions and characteristic data of all devices and modules of the AGFI;
- drawings of general arrangement and details of metrological interest including details of any interlocks, safeguards, restrictions, limits, etc.;
- drawing or photo of the AGFI showing the principle and the location of verification and securing marks to be applied (to be included in the OIML Certificate or Test Report);
- securing components, adjustment devices, controls, etc. (5.2.2), protected access to setup and adjustment operations;
- location for application of control marks, securing elements, descriptive markings, identification, conformity and/or approval marks (5.12, 5.13);
- devices of the AGFI;
- auxiliary, or extended indicating devices (0, 5.3.2);
- multiple use of indicating devices (0, 5.3.2);
- printing devices (only for special purposes) (5.3.2, 5.3.3);
- data storage devices (5.9);
- zero-setting, zero-tracking devices (5.8);
- tare devices and preset tare devices (3.3.5, 5.8);
- leveling device and level indicator, tilt sensor, upper limit of tilting (4.8.5);
- locking devices and auxiliary verification devices;
- load receptors, connection of different load receptors (3.3.1.1, 5.7);
- interfaces (types, intended use, immunity to external influences, instructions (6.10, 5.10.3 c));
- peripheral devices, e.g. printers, secondary displays, for including in the type approval certificate and for connection for the disturbance tests (6.10, 3.5.1.6);
- other devices or functions, e.g. for purposes other than determining the mass (not subject to conformity assessment);
- detailed description of the stable equilibrium function (4.7, 5.9, 5.11) of the AGFI;
- information concerning special cases;
- 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 (8.2.4), reference to evaluation to R 60 for load cells;
- special operating conditions (5.12.2);
- reaction of the AGFI to significant faults (3.5.2.7, 6.3);

- functioning of the display after switch-on (6.8);
- technical description, drawings and plans of devices, sub-assemblies, etc. particularly those in 5.12 and 5.13;
- description of the operation of the automatic tare device (e.g. the maximum programmable time interval);
- load cells, if not presented as modules;
- electrical connection elements, e.g. for connecting load cells to the indicator, including length of signal lines;
- indicator: block diagram, schematic diagrams, internal processing and data exchange via interface, keyboard with function assigned to any key;
- declarations of the manufacturer, e.g. for interfaces (5.10.2, 6.10), for protected access to set-up and adjustment (5.2.2, 5.2.3), for other software based operations;
- samples of all intended printouts;
- results of tests performed by the manufacturer or by other laboratories, on protocols from OIML R 61-3, including proof of competence;
- certificates of other type approvals or separate tests, relating to modules or other parts mentioned in the documentation, together with test protocols;
- for software controlled AGFIs or modules, additional documents according to 5.10 and Annex B.1).

8.2.2 General

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 a selective combination weighing instrument where only one representative weighing module may be included.

The evaluation shall consist of the tests specified in 8.2.3.

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

8.2.3 Type evaluation

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

a) requirement specified for static tests in clause 4,

b) technical requirements in clause 5,

c) requirement in clause 7.

The metrological authority shall

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

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

8.2.3.1 Operational tests for type evaluation

Tests for type evaluation shall be conducted

a) in accordance with the appropriate parts of clause 4,

b) under the normal conditions of use for which the AGFI is intended, and

c) in accordance with the material test methods given in R 61-2, 8 and 12.1, using material that is representative of a product for which the AGFI is designed to assess compliance with the technical requirements in 5.

For software-controlled AGFIs, the additional requirements in 5.10 and in Annex B.1 apply.

8.2.3.2 Influence factor tests

Influence factors shall be applied to the AGFI or 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 4.8 and 7.

8.2.3.3 Modules

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

- testing the instrument as a whole is difficult or impossible,
- modules are manufactured and/or placed on the market as separate units to be incorporated in a complete instrument, or
- the applicant wishes to have a variety of modules included in the approved type.

Where modules are examined separately, the following requirements apply.

8.2.3.3.1 Apportioning of errors

a) The error limits applicable to a part which is examined separately are equal to a fraction p_i of the maximum permissible errors or the allowed variations of the indication of the complete 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 p_i shall satisfy the following equation:

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

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

b) If the metrological characteristics of the load cell or other major component have been evaluated in accordance with the requirements of any OIML 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.

8.2.3.3.2 Compatibility of modules

The compatibility of modules shall be established and declared by the manufacturer. For indicators and load cells this shall be done according to OIML R 76, Annex F. For modules with digital output, compatibility includes the correct communication and data transfer via the digital interface(s); see OIML R 76, Annex F.5.

8.2.4 Type approval certificate and accuracy classes (4.2)

The type approval certificate shall include the reference value for the accuracy class Ref(x), and shall state that the actual class shall be determined at initial verification of the instrument.

8.3 Initial verification

8.3.1 General

AGFIs shall be examined for conformity with the approved type and shall if applicable be tested for compliance with clauses 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.

4.8.5 applies if the AGFI is liable to be tilted, or is not fitted with a levelling device and a level indicator (OIML R 61-2, 10.2.9).

8.3.2 Material tests at initial verification (OIML R 61-2, 8 and 12)

In-situ material tests shall be carried out in accordance with the descriptive markings given in 5.12, and under the normal conditions and with the products for which the AGFI is intended.

The appropriate parts of clause 4 shall apply.

8.3.3 Performance of tests

The metrological authority

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

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

8.3.4 Determination of accuracy class X(*x*) (4.2)

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

a) determine the accuracy class for the materials used in the tests in accordance with 8.2.4 by reference to the material test results (R 61-2, 12) and the limits of error specified in 4.3.1 and 4.3.3 for initial verification,

b) verify that accuracy classes marked in accordance with 5.12 are equal to or greater than the accuracy classes determined as above.

8.4 Subsequent verification

Subsequent verification 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 R 61-2, Annex C.

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.

Annex A: Frequency of automatic zero-setting and taring

(Mandatory)

This requirement is not applicable to 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 the maximum permissible time interval for automatic zero-setting shall be determined as follows:

a) The maximum allowable rate of change of a steady ambient temperature is 5 °C per hour as specified in R 61-2, 7.3.

b) The maximum zero-setting error (5.8.2) is determined as follows:

$$(E\text{zse}_{max}) \leq 0.25 \text{ mpd in-service at Minfill} \times \text{Ref}(x) \quad (1)$$

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

$$(E\text{zc}_{max}) \leq 0.5 \text{ mpd in-service at Minfill} \times \text{Ref}(x) \quad (2)$$

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

$$(E\text{zc}_{max} - E\text{zse}_{max}) = 0.25 \text{ mpd in-service at Minfill} \times \text{Ref}(x) \quad (3)$$

d) In accordance with R 61-2, 10.2.3, the maximum zero-variation (Δz_{max}) per 5 °C shall be less than or equal to 0.25 mpd in-service:

$$\Delta z_{max} \text{ per } 5 \text{ °C} \leq 0.25 \text{ mpd in-service at Minfill} \times \text{Ref}(x) \quad (4)$$

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

$$\Delta z_{max} \text{ per hour} \leq 0.25 \text{ mpd in-service at Minfill} \times \text{Ref}(x) \quad (5)$$

With equations (5) and (4) being identical, and with the maximum allowable rate of change of a steady ambient temperature at 5 °C per hour (4.8.3), the AGFI will have 1 hour maximum programmable time interval of automatic zero-setting or taring.

The maximum programmable time interval may be adjusted proportionally in accordance with the zero-variation in 4.8.3.

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 5.8.4.2.

Annex B: Requirements for software controlled instruments

(Mandatory)

The specific software terminology is defined in OIML D 31 [9].

B.1 General

B.1.1 Software identification

The legally relevant parts of the software of the AGFI and/or its modules shall be clearly identified with the software version or any other token. The identification may consist of 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

a) presented or printed on command, or

b) displayed during operation, or

c) displayed at switch-on for those AGFIs that can be switched on and off.

If a module of the AGFI has neither a display nor a printer, 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.

The software identification and the means of verification provided in the manufacturer's documentation 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)

B.1.3.1 General

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.1.3.2 Support of fault detection

The detection of significant faults by the checking facilities 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 which might result in a significant fault, but which will be detected by the software. The documentation shall include information on the expected reaction and, if needed to understand 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

B.2.1.1 General

Metrologically relevant parts of an AGFI, whether software or hardware, shall not be 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 metrologically critical parts.

B.2.1.2 Separation of modules of the AGFI

B.2.1.2.1 Modules of the 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.2.1.2.2 It shall be demonstrated that the relevant functions and data of these modules cannot be influenced by commands received via an interface.

B.2.1.3 Separation of software parts

B.2.1.4 All software modules (programs, subroutines, objects, etc.) that perform functions which are relevant to legal metrology or that contain legally relevant data domains are considered to be legally relevant software part of an AGFI. This part shall be made identifiable as described in B.1.1.

Note: A data domain is a location in memory that each program needs for processing data. Depending on the kind of programming language used, this location is defined by hardware addresses or by symbolic names (variable names). (OIML D 31:2008)

If the separation of the software is not possible, all software is considered legally relevant.

B.2.1.5 If the legally relevant software part communicates with other software parts, a software interface shall be defined. All communication shall be performed exclusively via this interface. The legally 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.

There shall be technical means (such as sealing) of preventing a program from circumventing the interface and programming hidden commands is not allowed.

B.2.1.6 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.2.1.7 Where legally relevant software has been separated from non-relevant software, the legally relevant software shall have priority using the resources over non-relevant software. The measurement task (realized by the legally 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 legally non-relevant software 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 legally 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

B.2.3.1 General

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.2.3.2 Data storage

The measurement result stored shall be accompanied by all relevant information necessary for the future legally relevant use.

B.2.3.3 Securing measures

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.2.3.4 Data transmission protection

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.2.3.5 Transmission delay

The measurement shall not be inadmissibly influenced by a transmission delay.

B.2.3.6 Transmission interruption

If communication network services become unavailable, no measurement data shall be lost. The measurement process should be stopped to avoid the loss of measurement data unless 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, i.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 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, is it permitted to delete memorized data when both the following conditions are met:

a) 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; and

b) 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 the legally relevant software (3.3.6.1) of an instrument in service shall be considered as a modification of the instrument, when exchanging the software with another approved version and/or a repair of the instrument, or when re-installing the same version.

An instrument which has been modified or repaired while in service may require initial or subsequent verification, dependent on national regulations.

This clause does not concern software which has or will have no influence on the metrologically relevant functions or functioning of the instrument.

Bibliography

Below are references to publications mentioned in OIML R 61

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 E_1, E_2, F_1, F_2, M_1, $M_{1–2}$, M_2, $M_{2–3}$ and M_3	Provides the principal physical characteristics and metrological requirements for weights used with and for the verification of weighing instruments and weights of a lower class
[5]	OIML R 60:2017 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 Pattern evaluation and pattern approval	Provides advice, procedures and influencing factors on type evaluation and type approval
[8]	OIML D 28:2004 (E)	Conventional value of the result of weighing in air
[9]	OIML D 31:2008 General requirements for software controlled measuring instruments	Provides guidance for establishing appropriate requirements for software related functionalities in measuring instruments covered by OIML Recommendations