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Project: Review of R51:2006 Automatic catchweighing instruments

Title: **OIML R51-1 Automatic catchweighing instruments**
Part 1: Metrological and technical requirements

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EXPLANATORY NOTE

The 53rd CIML approved as a new project, under the responsibility of TC 9/SC / p10 and under the joint convenorship of the UK (Morayo Awosola), and India (B.N Dixit.) the revision of OIML R51 “Automatic Catchweighing Instruments 2009 E”. This working draft has been restructured from two parts into three separate parts:
Part 1: Metrological and Technical Requirements;
Part 2: Testing procedures;
Part 3: Report Format for Type Evaluation.

To align with other D11, some additional tests for disturbance:
1) Battery voltage variations during starting up a vehicle engine
2) “Load dump” test
3) Ripple on DC mains power

No other changes/comments have been implanted in this first working draft.

TC 9/SC 2/p 10 Revision of R51:2006 Automatic catchweighing instruments
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FOREWORD

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PART 1 – METROLOGICAL AND TECHNICAL REQUIREMENTS

1 INTRODUCTION

This OIML Recommendation consists of 3 separate parts:

Part 1: Metrological and Technical Requirements;
Part 2: Testing procedures;
Part 3: Report Format for Type Evaluation.

2 Scope

This International Recommendation specifies the metrological and technical requirements and test procedures for automatic catchweighing instruments (catchweighers), hereinafter called «instruments», that are subject to national metrological control.

It is intended to provide standardized requirements and testing procedures to evaluate the metrological and technical characteristics in a uniform and traceable way. A standardized test report format is given as part 3 of this Recommendation (R 51-3).

3 Application

This Recommendation applies to instruments that automatically weigh discrete loads or single loads of loose material.

4 TERMINOLOGY (Terms and definitions)

The terminology used in this Recommendation conforms to the *International Vocabulary of Basic and General Terms in Metrology* (VIM) [1], the *International Vocabulary of Legal Metrology* (VIML) [2], the *OIML Certificate System for Measuring* Instruments [3], and to the *OIML International Document for General requirements for Electronic Measuring Instruments* [4]. In addition, for the purposes of this Recommendation, the following definitions apply.

4.1 General definitions

4.1.1 Mass

physical quantity, which can be ascribed to any material object and which gives a measure of its quantity of matter. OIML D 28 [8]

4.1.2 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 [8], whereas “weight” is preferably used for an embodiment (= material measure) of mass that is regulated in regard to its physical and metrological characteristics.

4.1.2.1 Test weights

The material measure of mass that is regulated in regard to its physical and metrological characteristics and maximum permissible error. It is used (as standard weights or mass) for the type examination or verification of an instrument.

4.1.3 Load

The quantity representing the material measure of mass due only to the vertically-downward force of gravity as applied on the weighing instrument.

4.1.4 Weighing

The process of determining the mass of an amount of material from the effects of gravity on this material.

4.1.5 Weighing instrument

Measuring instrument that serves to determine the mass of an amount of material by using the action of gravity on this material.

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

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

4.1.6 Automatic weighing instrument

Instrument that weighs and follows a pre-determined program of automatic processes characteristic of the instrument.

4.1.7 Automatic catchweighing instrument (catchweigher)

Automatic weighing instrument that weighs pre-assembled discrete loads or single loads of loose material.

4.1.7.1 Checkweigher

Catchweigher that sub-divides prepackages of different mass into two or more sub-groups according to the value of the difference between their mass and the nominal set point.

4.1.7.2 Weigh labeller

Catchweigher that labels individual pre-assembled discrete loads (e.g. prepackages) with the weight value.

4.1.7.3 Weigh-price labeller

Catchweigher that calculates the price to pay on the basis of the indicated mass and the unit price and labels individual pre-assembled discrete loads (e.g. prepackages with the weight value, unit price and price to pay).

4.1.7.4 Vehicle mounted instrument

A complete instrument that is firmly mounted on a vehicle, and that is designed for that special purpose.

Note: For example, a garbage weigher (waste collecting vehicle) that determines the quantity of loose material emptied from a container (supported by the load receptor) into the body of the vehicle.

4.1.7.5 Vehicle incorporated instrument

An instrument where components of the vehicle are also components of the weighing instrument, i.e. parts of the vehicle (levers, joints and/or force transmission) are used for the instrument.

Note: For example, a front-end loader (front-end loading vehicle) that determines the quantity of loose material held in the bucket (load receptor).

4.1.8 Loose material

Material which is not packaged during and/or after the weighing process. The material may be collected for weighing in the load receptor of the instrument (e.g. front-end loader) or in a separate container (garbage weigher).

4.1.9 Grading instrument

Instrument which assigns a weighing result to a predetermined range of mass to determine a tariff or toll.

Examples: postal scales, garbage weighers

4.1.10 Electronic instrument

Instrument equipped with electronic devices.

4.1.11 Control instrument

Weighing instrument used to determine the conventional true value of the mass of the test load(s).

Control instruments used for testing may be:

- separate from the instrument being tested, or
- integral, when a static weighing mode is provided by the instrument being tested.

4.1.12 Conventional true value (of a quantity)

A value attributed to a particular quantity (mass of a body) and accepted, by convention, as having an uncertainty appropriate for a given purpose. [VIM 1.20]

4.1.13 Metrological authority

A legal entity (i.e. the verification, and/or issuing authority) designated or formally accepted by the government to be responsible for ascertaining that the automatic weighing instrument satisfies all or some specific requirements of this Recommendation.

4.1.14 Indications of an instrument

Value of a quantity provided by a measuring instrument.

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

4.1.14.1 Primary indications

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

4.1.14.2 Secondary indications

Indications, signals and symbols that are not primary indications.

4.1.15 Metrologically relevant

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

4.2 CONSTRUCTION

Note: In this Recommendation the term «device» is used for any means by which a specific function is performed irrespective of the physical realization e.g. by a mechanism, a key or software initiating an operation; the device may be a small part or a major portion of an instrument.

4.2.1 Load receptor

Part of the instrument intended to receive the load.

4.2.2 Load-transmitting device

Part of the instrument for transmitting the force produced by the load acting on the load receptor to the load-measuring device.

4.2.3 Load-measuring device

Part of the instrument for measuring the mass of the load, and an indicating device.

4.2.4 Load conveyor

Device to move the loads on to and off the load receptor.

4.2.5 Load transport system

The system used to transport the load over the load receptor.

4.2.6 Displaying device (of a weighing instrument)

Device providing the weighing result in visual form.

4.2.7 Module

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

Note: Typical modules of an automatic weighing instrument are: load cell, indicator, analogue or digital data processing device, computer terminal (4.2.7.6), weighing module, digital display.

4.2.7.1 Load cell

Force transducer which, after taking into account the effects of the acceleration of gravity and air buoyancy at the location of its use, measures mass by converting the measured quantity (mass) into another measured quantity (output). OIML R 60 [5]

4.2.7.2 Indicator

Electronic device of an instrument that processes the measurement data and displays the weighing result in units of mass.

4.2.7.3 Analogue data processing device

Electronic device of an instrument 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. It may optionally have one or more keys to operate the instrument.

4.2.7.4 Digital data processing device

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

4.2.7.5 Weighing module

That 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) but not having the means to display the weighing result. It may optionally have devices for further processing (digital) data and operating the instrument.

4.2.7.6 Computer terminal

Digital device that has one or more keys to operate the instrument, and a display to indicate the weighing results transmitted via the digital interface of a weighing module or an analogue data processing device.

4.2.7.7 Digital display

Either incorporated in the indicator housing or in the computer terminal housing or realised as a display in a separate housing (i.e. terminal without keys), e.g. for use in combination

with a weighing module.

4.2.7.8 Software

4.2.7.8.1 Legally relevant parameter

Parameters that belong to the measuring instrument or device, and define or fulfil functions which are subject to legal control.

The following types of legally relevant parameter can be distinguished: type-specific and device-specific.

4.2.7.8.2 Type-specific parameter

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

Examples of type-specific parameters are: parameters used for mass calculation, stability analysis or price calculation and rounding, software identification.

4.2.7.8.3 Device-specific parameter

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

4.2.7.8.4 Software identification

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

4.2.7.8.5 Data storage device

The internal memory storage of the instrument or external (removable) storage device used for keeping measurement data (4.3.2.4.4) ready after completion of the measurement.

4.2.7.8.6 Software separation

The unambiguous separation of software into legally relevant software and non-legally relevant software. If no software separation exists, the whole software is to be considered as legally relevant.

4.2.8 Electronic parts

4.2.8.1 Electronic device

Device employing electronic sub-assemblies and performing a specific function. An electronic device is usually manufactured as a separate unit and is capable of being independently tested.

4.2.8.2 Electronic sub-assembly

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

4.2.8.3 Electronic component

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

4.2.8.4 Indicating device (of a weighing instrument)

The 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 the mass of an article and a reference value,
- the mean value and/or the standard deviation of a number of consecutive weighings.

4.2.8.5 Indicating device with a differentiated scale division

Digital indicating device of which the last figure after the decimal sign is clearly differentiated from other figures.

4.2.8.6 Extended indicating device

A device temporarily changing the actual scale interval (*d*) to a value less than the verification interval (e) following a manual command.

4.2.9 Supplementary devices

4.2.9.1 Setting device

Device for fixing the limits of mass of the sub-groups.

4.2.9.2 Nominal set point

Value expressed in units of mass preset by the operator by means of the setting device in order to establish the limit between consecutive sub-groups.

4.2.9.3 Adjustment range

The range of weight values close to a set point outside which the weighing results may be subject to excessive relative error.

4.2.9.4 Counter

Device counting the number of loads which have moved on to the load receptor (movement counter) or indicating the number of the loads in each of the sub-groups (division counter).

4.2.9.5 Sorting device

Device which automatically divide the loads into separate sub-groups.

4.2.9.6 Levelling device

Device for setting an instrument to its reference position.

4.2.9.7 Tilt limiting device

Device which prevents the instrument from operating above a predetermined value of tilt.

4.2.9.8 Zero-setting device

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

4.2.9.8.1 Nonautomatic zero-setting device

Device for setting the indication to zero by an operator.

4.2.9.8.2 Semi-automatic zero-setting device

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

4.2.9.8.3 Automatic zero-setting device

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

4.2.9.8.4 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.

4.2.9.9 Zero-tracking device

Device for maintaining the zero indication within certain limits automatically.

4.2.9.10 Tare device

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

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

It may function as:

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

4.2.9.10.1 Tare balancing device

Tare device without indication of the tare value (4.3.2.3) when the instrument is loaded.

4.2.9.10.2 Tare-weighing device

Tare device that stores the tare value (4.3.2.3) and is capable of indicating or printing it whether or not the instrument is loaded.

4.2.9.10.3 Preset tare device

Device for subtracting a preset tare value (4.3.2.4.1) from a gross (4.3.2.1) or net (4.3.2.2) weight value and indicating the result of the calculation. The weighing range for net loads is reduced accordingly.

4.2.10 Dynamic setting

Adjustment intended to eliminate the difference between the static load value and the dynamic load value.

4.3 Metrological characteristics

4.3.1 Weighing capacity

4.3.1.1 Maximum capacity (Max)

Maximum weighing capacity, not taking into account the additive tare capacity.

4.3.1.2 Minimum capacity (Min)

Value of the load below which the weighing results may be subject to an excessive relative error.

4.3.1.3 Weighing range

Range between the minimum and maximum capacities.

4.3.1.4 Maximum tare effect (T+, T–)

Maximum capacity of the additive tare device or the subtractive tare device.

4.3.2 Weighing results

Note: The following definitions apply only for instruments that weigh pre-assembled discrete loads (see 2.1.7) and when the indication has been zero before the load has been applied to the instrument.

4.3.2.1 Gross value (G or B)

Indication of the weight value of a load on an instrument, with no tare or preset tare device in operation.

4.3.2.2 Net value (NET, N)

Indication of the weight value of a load placed on an instrument after operation of a tare device.

4.3.2.3 Tare value (T)

The weight value of a load, determined by a tare weighing device.

4.3.2.4 Other weighing values

4.3.2.4.1 Preset tare value (P_T)

Numerical value, representing a weight value, that is introduced into the instrument. It is a predetermined tare value that is used for one or several weighings.

Notes:

1) "Introduced" includes procedures such as: keying in, recalling from data storage, or inserting via an interface.

2) “Predetermined” means that a tare value is determined once and is applied to other weighings without determining the individual tare values.

4.3.2.4.2 Calculated net value

Value of the difference between a gross or net weight value and a preset tare value.

4.3.2.4.3 Final weight value

The weight value that is achieved when the instrument is completely at rest and balanced, with no disturbances affecting the indication.

4.3.2.4.4 Measurement data

Value attributed to a measurand, obtained by measurement and subject to national regulation [Adapted from VIM 3.1].

4.3.2.5 Stable equilibrium

The condition of the instrument such that the printed or stored weighing values show no more than two adjacent values with one of them being the final weight value.

4.3.2.6 Critical points

Test load values at which the maximum permissible error changes.

4.3.3 Scale divisions

4.3.3.1 Actual scale interval (d)

Value expressed in units of mass of:

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

4.3.3.2 Verification scale interval (e)

Value, expressed in units of mass, used for the classification and verification of an instrument.

4.3.3.3 Number of verification scale intervals (single-interval instrument)

Quotient of the maximum capacity and the verification scale interval:

$$n = Max/e$$

4.3.3.4 Multi-interval instrument

Instrument having one weighing range which is divided into partial weighing ranges each with different scale intervals, with the weighing range determined automatically according to the load applied, both on increasing and decreasing loads.

4.3.3.5 Multiple range instrument

Instrument having two or more weighing ranges with different maximum capacities and different scale intervals for the same load receptor, each range extending from zero to its maximum capacity.

4.3.4 Operational characteristics

4.3.4.1 Rate of operation

Number of loads weighed automatically per unit of time.

4.3.4.2 Warm-up time

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

4.3.4.3 Nonautomatic (static) operation

A static weighing mode for test purposes.

4.3.4.4 Automatic operation

The instrument weighs without the intervention of the operator and follows a pre-determined program of automatic processes characteristic of the instrument. The instrument may either weigh statically or dynamically in automatic operation.

4.3.4.5 Instrument that weighs statically

An instrument that operates with a stable equilibrium (4.3.2.5) based measuring system during the mass determining process, when the load transport system has stopped or, in the case of vehicle mounted or incorporated catchweighers, the load receptor is stationary.

4.3.4.6 Instrument that weighs dynamically

An instrument that operates with a non-stable equilibrium based measuring system during the mass determining process while the load transport system is in motion (i.e. the load transport system is moving, or checkweighers fitted with load receptor on which the load slides, or in the case of vehicle mounted or incorporated catchweighers, the load receptor is in motion).

4.3.5 Sensitivity

For a given value of the measured mass, the quotient of the change of the observed variable *I* and the corresponding change of the measured mass M:

$$k = \Delta I / \Delta M$$

4.3.6 Repeatability

Ability of an instrument to provide results that agree one with the other when the same load is deposited several times and in a practically identical way on the load receptor under reasonably constant test conditions.

4.3.7 Durability

Ability of an instrument to maintain its performance characteristics over a period of use.

4.4 Indications and errors

4.4.1 Methods of indication

4.4.1.1 Analogue indication

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

4.4.1.2 Digital indication

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

4.4.2 Reading

4.4.2.1 Reading by simple juxtaposition

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

4.4.2.2 Overall inaccuracy of reading

The overall inaccuracy of reading of an instrument with analogue indication is equal to the standard deviation of the same indication, the reading of which is carried out under normal conditions of use by several observers.

4.4.3 Errors

4.4.3.1 Error (of indication)

The indication of an instrument minus the (conventional) true value of the mass. [VIM 5.20]

4.4.3.2 Rounding error of digital indication

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

4.4.3.3 Intrinsic error

The error of an instrument, determined under reference conditions. [VIM 5.24]

4.4.3.4 Initial intrinsic error

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

4.4.3.5 Mean (systematic) error ($\bar{x}$)

The mean value of the error (of indication) for a number of consecutive automatic weighings of a load, or similar loads, passed over the load receptor, expressed mathematically as:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

where:

x represents the error of a load indication,
$\bar{x}$ is the mean of the errors, and
n is the number of weighings.

4.4.3.6 Standard deviation of the error (s)

The standard deviation of the error (of indication) for a number of consecutive automatic weighings of a load, or similar loads, passed over the load receptor, expressed mathematically as:

$$s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}$$

4.4.3.7 Maximum permissible errors (MPE)

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

4.4.3.8 Fault

The difference between the error of indication of an instrument and the intrinsic error.

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

4.4.3.9 Significant fault

A fault greater than the verification scale interval e.

A significant fault does not include:

- faults arising from simultaneous and mutually independent causes in the instrument or in its checking facility, or
- faults that imply it is impossible to perform a measurement, or
- faults that are so serious they will inevitably be noticed by all those interested in the measurement, or
- transitory faults that are momentary variations in the indications that cannot be interpreted, memorized or transmitted as a measurement result.

4.4.3.10 Span

The modulus of the difference between the two limits of a nominal range [VIM 5.2]

4.4.3.11 Span stability

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

4.5 Influences and reference conditions

4.5.1 Influence quantity

A quantity that is not the measurand but that affects the result of the measurement. [VIM 2.7]

4.5.1.1 Influence factor

An influence quantity having a value within the specified rated operating conditions of the instrument.

4.5.1.2 Disturbance

An influence quantity having a value within the limits specified in this International Recommendation but outside the rated operating conditions of the instrument.

4.5.2 Rated operating conditions

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

4.5.3 Reference conditions

A set of specified values of influence factors fixed to ensure valid inter-comparison of the results of measurements. [VIM 5.7]

4.6 Tests

4.6.1 Operational test

A test carried out on a complete instrument using a test load or loads of the type that it is intended to weigh, and using the load conveyor or load transport system to move it on to and off the load receptor.

4.6.2 Simulation test

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

4.6.3 Performance test

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

4.6.4 Span stability test

A test to verify that the EUT is capable of maintaining its performance characteristic over a period of use.

4.7 Abbreviations and symbols

Symbols	Meaning
I	Indication
I_n	n^{th} indication
L	Load
ΔL	Additional load to next changeover point
P	I + 0.5 e – ΔL = Indication prior to rounding (digital indication)
E	I – L or P – L = Error
E_0	Error at zero load
d	Actual scale interval
e	Verification scale interval
d_T	Preset tare Scale interval
n, n_i	Number of verification scale intervals
p_i	Fraction of the MPE applicable to a module of the instrument which is examined separately.
MPE	Maximum permissible error
MPME	Maximum permissible mean (systematic) error for automatic operation
MPSD	Maximum permissible standard deviation of the error for automatic operation
EUT	Equipment under test
sf	Significant fault
Max	Maximum capacity of the weighing instrument
Min	Minimum capacity of the weighing instrument
Max_1, Max_i, Max_r	Maximum capacity of the weighing instrument, rules for indices
U_{nom}	Nominal voltage value marked on the instrument
U_{max}	Highest value of a voltage range marked on the instrument
U_{min}	Lowest value of a voltage range marked on the instrument
DC	Direct current
AC	Alternating current
T	Tare value
T+	Maximum capacity of the additive tare device
T–	Maximum capacity of the subtractive tare device
G or B	Gross value
N or Net	Net value

PT Preset tare value

5 METROLOGICAL REQUIREMENTS

5.1 Accuracy classes

Instruments are divided according to their use into two primary categories designated by:

X or Y

Category X applies only to checkweighers used to check prepacked products that are subject to the requirements of OIML R 87 [7].

Category Y applies to all other automatic catchweighing instruments such as weigh-price labellers, postal and shipping scales, and instruments that weigh single loads of loose material.

Note: An instrument can be classified as both category X and category Y, e.g. where an instrument is configured with two separate modes of operation which enable it to operate either as a checkweigher or as a weigh-price labeller.

5.1.1 Category X

The primary category is further divided into four accuracy classes:

XI, XII, XIII and XIIII

The accuracy classes are supplemented by a factor (x) which is specified by the manufacturer. The value of (x) shall be 1×10^k, 2×10^k, or 5×10^k, k being a positive or negative whole number or zero.

The use of a class for a particular application may be determined by national requirements.

5.1.2 Category Y

The primary category is further divided into four accuracy classes:

Y(I), Y(II), Y(a), and Y(b)

The use of a class for a particular application may be determined by national requirements.

5.2 Classification of instruments

5.2.1 Verification scale interval

The verification scale interval and number of verification scale intervals, in relation to the accuracy class, are given in Table 1.

Table 1

Accuracy class		Verification scale interval (e)	Number of verification scale intervals n = Max/e	
			Minimum	Maximum

XI	Y(I)	0.001 g ≤ e[1]	50 000	-
XII	Y(II)	0.001 g ≤ e ≤ 0.05 g	100	100 000
		0.1 g ≤ e	5 000	100 000
XIII	Y(a)	0.1 g ≤ e ≤ 2 g	100	10 000
		5 g ≤ e	500	10 000
XIIII	Y(b)	5 g ≤ e	100	1 000

On multiple range instruments the verification scale intervals are e_1, e_2, …, e_r with $e_1 < e_2 < ... < e_r$. Min, n and Max are indexed accordingly.

On multiple range instruments, each range is treated basically as an instrument with one range.

5.2.2 Minimum capacity (Min)

Min shall be specified by the manufacturer.

For category Y instruments Min shall not be less than:

class Y(I):	100 e		
class Y(II):	20 e	For	0.001 g ≤ e ≤ 0.05 g and
	50 e	For	0.1 g ≤ e
class Y(a):	20 e		
class Y(b):	10 e		
Scales used for grading, postal scales and garbage weighers:	5 e		

5.3 Additional requirements for a multi-interval instrument[2]

5.3.1 Partial weighing range

Each partial weighing range (index i = 1, 2 ...) is defined by:

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[1] It is normally not feasible to test and verify an instrument to e < 1 mg due to the uncertainty of the test loads.

[2] Example for a multi-interval instrument:

Maximum capacity Max = 2 / 5 / 15 kg class Y(a)
Verification scale interval e = 1 / 2 / 10g

This instrument has one Max and one weighing range from Min = 20 g to Max = 15 kg. The partial weighing ranges are:
Min_1 = 20 g, Max_1 = 2 kg, e_1 = 1 g, n_1 = 2000
Min_2 = 2 kg, Max_2 = 5 kg, e_2 = 2 g, n_2 = 2500
Min_3 = 5 kg, Max_3 = Max = 15 kg, e_3 = 10 g, n_3 = 1500

For automatic operation the maximum permissible errors on initial verification (MPE) (see 5.5.1.2) are:
For m = 400 g = 400e_1 MPE= ± 1.0 g
For m = 1 600 g = 1 600e_1 MPE= ± 1.5 g
For m = 2 100 g = 1 050e_2 MPE= ± 3.0 g
For m = 4 250 g = 2 125e_2 MPE= ± 4.0 g
For m = 5 100 g = 510e_3 MPE= ± 15.0 g
For m = 15 000 g = 1 500e_3 MPE= ± 15.0 g

Whenever the variation of the indication due to certain influence factors is limited to a fraction or multiple of e, this means, in a multi-interval instrument, that e is to be taken according to the load applied; in particular, at or near zero load e = e_1.

- its verification scale interval e_i, $e_{i+1} > e_i$,
- its maximum capacity Max_i,
- its minimum capacity $Min_i = Max_{i-1}$ (for i = 1 the minimum capacity is Min_1 = Min).

The number of verification scale intervals n_i for each partial range is:

$$n_i = Max_i/e_i$$

5.3.2 Accuracy class

e_i and n_i in each partial weighing range shall comply with the requirements given in Table 1 according to the accuracy class of the instrument. Min_1 shall comply with the requirements given in 5.2.2 according to the accuracy class of the instrument.

5.3.3 Maximum capacity of partial weighing ranges

With the exception of the last partial weighing range, the requirements in Table 2 shall be complied with, according to the accuracy class of the instrument.

Table 2

Category X	XI	XII	XIII	XIIII
Category Y	Y(I)	Y(II)	Y(a)	Y(b)
Max_i/e_{i+1}	≥ 50 000	≥ 5 000	≥ 500	≥ 50

5.3.4 Instrument with a tare device

Requirements concerning the ranges of a multi-interval instrument apply to the net load, for every possible value of the tare.

5.4 Auxiliary indicating device

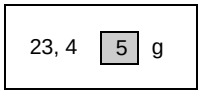
For instruments fitted with an auxiliary indicating device such as an indicating device with a differentiated scale division[3], the device is permitted only to the right of the decimal sign.

For category Y(a) and Y(b) instruments the use of auxiliary indicating devices shall be limited to testing applications only.

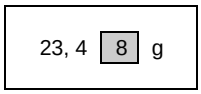
A multi-interval instrument shall not be fitted with an auxiliary indicating device.

Note: Extended indicating devices (see 4.2.8.6 and 6.4.2) are not regarded as auxiliary indicating devices.

[3] Figure 1: examples of indicating devices each with a differentiated scale division



Last differentiated figure: 5
d = 0.01 g or 0.05 g
e = 0.1 g



Last differentiated figure: 8
d = 0.01 g or 0.02 g
e = 0.1 g

5.5 Maximum permissible errors

5.5.1 Automatic operation

5.5.1.1 Category X instruments

For a number of consecutive weighings of a net load, greater than or equal to the Min and less than or equal to the maximum capacity (Max), the maximum permissible mean (systematic) error shall be as specified in Table 3.

Table 3

Net load (m) expressed in verification Scale intervals (e)				Maximum permissible mean error for category X instruments	
XI	XII	XIII	XIIII	Initial verification	In-service inspection
0 < m ≤ 50 000	0 < m ≤ 5 000	0 < m ≤ 500	0 < m ≤ 50	± 0.5 e	± 1 e
50 000 < m ≤ 200 000	5 000 < m ≤ 20 000	500 < m ≤ 2 000	50 < m ≤ 200	± 1 e	± 2 e
200 000 < m	20 000 < m ≤ 100 000	2 000 < m ≤ 10 000	200 < m ≤ 1 000	± 1.5 e	± 3 e

The maximum permissible standard deviation of the error (random error) shall be as specified in Table 4, multiplied by the class designation factor (x).

Table 4

Value of the mass of the net load m (g)	Maximum permissible standard deviation (as percentage of m or in grams) for class designation factor x = 1	
	Initial verification	In-service inspection
m ≤ 50	0.48 %	0.6 %
50 < m ≤ 100	0.24 g	0.3 g
100 < m ≤ 200	0.24 %	0.3 %
200 < m ≤ 300	0.48 g	0.6 g
300 < m ≤ 500	0.16 %	0.2 %
500 < m ≤ 1 000	0.8 g	1.0 g
1 000 < m ≤ 10 000	0.08 %	0.1 %
10 000 < m ≤ 15 000	8 g	10 g
15 000 < m	0.053 %	0.067 %

For classes XI and XII, (x) shall be less than 1
For classes XIII, (x) shall be not greater than 1
For classes XIIII, (x) shall be greater than 1

5.5.1.2 Category Y instruments

The maximum permissible error for any load greater than or equal to the Min and less than or equal to the Max in automatic operation shall be as specified in Table 5.

Table 5

Load (m) expressed in verification scale intervals (e)				Maximum permissible error for category Y instruments[4]	
Y(I)	Y(II)	Y(a)	Y(b)	Initial verification	In-service inspection
0 < m ≤ 50 000	0 < m ≤ 5 000	0 < m ≤ 500	0 < m ≤ 50	± 1 e	±1.5 e
50 000 < m ≤ 200 000	5 000 < m ≤ 20 000	500 < m ≤ 2 000	50 < m ≤ 200	± 1.5 e	± 2.5 e
200 000 < m	20 000 < m ≤ 100 000	2 000 < m ≤ 10 000	200 < m ≤ 1 000	± 2 e	± 3.5 e

5.5.2 **Nonautomatic (static) operation[5]**

For category X and category Y instruments, the maximum permissible error for any load greater than or equal to the Min and less than or equal to the Max in nonautomatic (static) operation shall be as specified in Table 6.

Table 6

Load (m) expressed in verification Scale intervals (e)				Maximum permissible error for category X and category Y instruments	
XI and Y(I)	XII and Y(II)	XIII and Y(a)	XIIII and Y(b)	Initial verification	In-service inspection
0 < m ≤ 50 000	0 < m ≤ 5 000	0 < m ≤ 500	0 < m ≤ 50	± 0.5 e	± 1 e
50 000 < m ≤ 200 000	5 000 < m ≤ 20 000	500 < m ≤ 2 000	50 < m ≤ 200	± 1 e	± 2 e
200 000 < m	20 000 < m ≤ 100 000	2 000 < m ≤ 10 000	200 < m ≤ 1 000	± 1.5 e	± 3 e

5.5.3 **Maximum permissible errors for influence factor tests**

5.5.3.1 Category X instruments

For automatic operation:

- the maximum permissible mean error shall be as specified in Table 3 for initial verification, and
- the maximum permissible standard deviation of the error shall be as specified in Table 4 for initial verification multiplied by the class designation factor (x).

[4]This MPE is applicable for instruments with a device for displaying the digital indication with d ≤ 0.2 e. (see R51-2, 3.9.2.1). For instruments without a device for displaying the indication with d ≤ 0.2 e the procedure in R51-2, 3.9.2.2 shall be applied.

In case the net weight value is calculated by subtraction of 2 individual weighings, the MPEs only apply:
- either to these individual weighings. if they are printed or recorded separately.
- or to net weight value if only the net weight value is printed

[5]As defined in 2.3.4.3, therefore 5.5.2 is not applicable for the automatic (static) weighing mode.

For nonautomatic (static) operation the maximum permissible errors shall be as specified in Table 6 for initial verification.

5.5.3.2 Category Y instruments

For automatic operation the maximum permissible errors for each load shall be as specified in Table 5, for initial verification.

For nonautomatic (static) operation the maximum permissible errors shall be as specified in Table 6 for initial verification.

5.6 Units of measurement

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

- metric carat (ct)[6]
- milligram (mg),
- gram (g),
- kilogram (kg)
- tonne (t).

5.7 Permissible differences between results

5.7.1 Effect of eccentric loading

If it is possible to pass loads eccentrically, the maximum permissible errors given in the appropriate part or parts of 5.5 shall not be exceeded at any eccentric setting (see 9.4.4).

5.7.2 Agreement between indicating and printing devices

For the same load, the difference between the weighing results (4.3.2) provided by any two devices having the same scale interval shall be as follows:

1) zero for digital displaying and printing devices;
2) not greater than the absolute value of the maximum permissible error for automatic weighing for analogue devices.

5.8 Influence factors

Refer to Annex A for test conditions.

5.8.1 Temperature

5.8.1.1 Temperature limits

If no particular working temperature is stated in the descriptive markings of an instrument, this instrument shall maintain its metrological properties within the following temperature limits:

- 10 °C to + 40 °C

5.8.1.2 Special temperature limits

[6] For special applications, e.g. trade with precious stones, the metric carat (1 carat = 0.2 g) may be used as unit of measurement. The symbol for the carat is ct.

An instrument for which particular limits of working temperature are stated in the descriptive markings shall comply with the metrological requirements within those limits. The limits may be chosen according to the application of the instrument.

The ranges within those limits shall be at least equal to:

5 °C for instruments of classes XI and Y(I),
15 °C for instruments of classes XII and Y(II),
30 °C for instruments of all other classes.

5.8.1.3 Temperature effect on no-load indication

The indication at zero or near zero shall not vary by more than one verification scale interval for a difference in ambient temperature of 1 °C for instruments of classes XI and Y(I), and 5 °C for other classes.

5.8.2 Voltage supply

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

1) AC mains voltage: lower limit is 85 % of U_{min}, upper limit is 110% of U_{max};
2) DC mains voltage, including rechargeable battery if battery can be fully (re)charged during the operation of the instrument: lower limit is the minimum operating voltage, upper limit is 120% of U_{max} (U_{max} is the voltage of a new or fully charged rechargeable battery of the type specified by the manufacturer);
3) Battery voltage supply (DC), including non-rechargeable battery voltage, and also including rechargeable battery voltage supply if (re)charge of batteries during the operation of the instrument is not possible: lower limit is the minimum operating voltage, upper limit is U_{max};
4) 12 V or 24 V road vehicle battery voltage supply: lower limit is 9 V (for 12 V battery) or 16 V (for 24 V battery), upper limit is 16 V (for 12 V battery) or 32 V (for 24 V battery).

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

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

5.8.3 Tilting

Instruments which are not intended for installation in a fixed position and which do not have a levelling device and a level indicator shall comply with the appropriate metrological and technical requirements when tilted (longitudinally and transversely) by 5%, or when tilted to a predetermined value selected by the manufacturer if the instrument is provided with a tilt limiting device which prevents the instrument from operating when tilted above this value.

Where a levelling device and a level indicator is present it shall enable the instrument to be set to a tilt of 1 % or to the limiting value of tilting as defined by an obvious marking on the level indicator, (e.g. a ring, or a legible notice provided on the instrument in a clearly visible

place that points the user to the level indicator). The level indicator shall be fixed firmly on the instrument in a place clearly visible to the user and representative for the tilt sensitive part.

Instruments mounted on or incorporated in vehicles shall comply with the appropriate metrological and technical requirements when tilted (longitudinally and transversely) by 10 %, or when tilted to a lower predetermined value selected by the manufacturer, e.g. 3 %, if the instrument is provided with an automatic tilt limiting device which prevents the instrument from operating when tilted above this value.

5.9 Indication or printout for test purposes (automatic operation)

For category X instruments, practical means shall be provided in accordance with 9.1.8 for determining the mean error and the standard deviation of the error to demonstrate compliance with Tables 3 and 4, e.g. indications and/or print-outs of the mass (or the difference between the mass and a nominal set-point).

Note: In normal operation, the sorting device of category X instruments shall work with the same or smaller scale interval d which is used for determining the mean error and standard deviation of the error during type approval and initial verification testing.

For category Y instruments, practical means for determining the individual errors of weighings shall be provided in accordance with 9.1.7.2 to demonstrate compliance with Table 5.

5.10 Span stability

For the span stability, the absolute value of the difference between the errors obtained for any two measurements shall not exceed the maximum span error.

The maximum span error is equal to one half the maximum permissible error for influence factor tests for a near maximum capacity load.

6 TECHNICAL REQUIREMENTS

6.1 Suitability for use

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

6.2 Security of operation

6.2.1 Fraudulent use

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

6.2.2 Accidental breakdown and maladjustment

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

6.2.3 Dynamic setting

An instrument may be fitted with a dynamic setting facility to compensate for the dynamic effects of the load in motion. This facility may operate over a weighing range relative to a setting weight value provided that when the facility is used for that weighing range and in accordance with the manufacturer's instructions, the maximum permissible errors are not exceeded.

Once dynamic setting has taken place to give a weighing range over which the permissible errors are not exceeded, the instrument shall automatically take appropriate action for loads falling outside that range; for these loads printout of weight shall also be inhibited.

Instruments with dynamic setting available to the user (not secured in accordance with 6.2.6) shall have a facility to automatically and non-erasably record any adjustment of the dynamic setting, e.g. an event logger. The instrument shall be capable of presenting the recorded data.

6.2.4 Controls

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

6.2.5 Tilt limiting device

An instrument mounted on a vehicle may be provided with a tilt limiting device which prevents the instrument from operating if the vehicle is tilted (longitudinally and transversely) above a predetermined value set by the manufacturer.

6.2.6 Securing

Means shall be provided for securing components, interfaces, device-specific parameters and pre-set controls to which access or adjustment is prohibited. National regulation may specify the securing that is required. On classes XI and Y(I) instruments, devices to adjust sensitivity (or span) may remain unsecured.

The introduction into the instrument of data that can influence the instruments metrological properties or measurement results shall be prevented, e.g. by a protective interface (5.2.4).

Components and pre-set controls may be secured by passwords or similar software means provided that any access to the secured controls or functions becomes automatically evident, e.g. by automatically updating a device-specific parameter the value of which at the time of the last verified set-up had been durably marked on the instrument in accordance with the requirements of 6.11.4.

An instrument may be fitted with a span adjustment device. External influence upon this device shall be practically impossible after securing.

6.2.7 Sorting device

The sorting device of a category X instrument shall automatically divide loads into separate sub-groups depending on their mass.

6.3 Indication of weighing results

6.3.1 Quality of reading

Reading of the primary indications (4.1.14.1) shall be reliable, easy and unambiguous under conditions of normal use:

- the overall inaccuracy of reading of an analogue indicating device shall not exceed 0.2 e,
- the figures, units and designations forming the primary indications shall be of a size, shape and clarity for reading to be easy.

The scales, numbering and printing shall permit the figures which form the results to be read by simple juxtaposition (see 4.4.2.1).

6.3.2 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 value, only one unit of mass may be used.

The scale interval for weighing results (4.3.2) shall be in the form 1×10^k, 2×10^k or 5×10^k units in which the result is expressed, k being a positive or negative whole number or zero.

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

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

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

Zero may be indicated by one zero to the extreme right, without a decimal sign.

The unit of mass shall be chosen so that the weight values have not more than one non-significant zero to the right. For values with decimal sign, the non-significant zero is allowed only in the third position after the decimal sign. The units of mass shall be written in small letters (lower case) as indicated in 5.6.

6.3.3 Limits of indication

Category Y: There shall be no indication, printing, storing or transmission of weight values above Max + 9 e.

Category X: There shall be no indication, printing, storing or transmission of weight values above Max + 9 e or Max + three times the maximum permissible standard deviation value as specified in Table 4, whichever is the greater.

6.3.4 Indication or printout for normal operation

For normal operation the scale interval of indications or printouts of individual article weights shall be the verification scale interval e.

The scale interval of indications or printouts of the mean (systematic) error and the standard deviation of the error (or indication), for a number of consecutive automatic weighings of a load, may be to a higher resolution than the verification scale interval e.

6.4 Digital indicating, printing and memory storage devices

The following requirements apply in addition to those in 6.3.1 through 6.4.4.

6.4.1 Stable equilibrium (4.3.2.5)

For instruments that weigh statically, equilibrium is deemed to be stable when:

a) in case of printing and/or data storage, the printed or stored weighing values show no more than two adjacent values; with one of them being the final weight value (4.3.2.4.3),
b) in case of zero or tare operations, a correct operation according to 6.4.3 (printing), 6.5.3 (control of zero-setting), 6.5.4 (stability of automatic zero-setting), 6.5.5 (zero-tracking) and 6.6.7 (tare-weighing) of the device within relevant accuracy requirements is achieved.

Both conditions shall also be met under continuous or temporary disturbance of the equilibrium

For instruments that weigh dynamically no separate criteria for stable equilibrium are given.

6.4.2 Extended indicating device

An extended indicating device shall not be used on an instrument with an auxiliary indicating device.

When an instrument is fitted with an extended indicating device, displaying the indication with a scale interval smaller than e shall be possible only:

a) during pressing a key, or
b) for a period not exceeding 5 seconds after a manual command.

In any case printing shall not be possible.

6.4.3 Printing device

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.

Printing shall be inhibited if the stability criteria (6.4.1) are not fulfilled.

6.4.4 Data storage device (4.2.7.8.5)

The primary indications may be stored in a memory of the instrument or on external storage for subsequent use (e.g. indication, printing, data 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 shall be inhibited if the stability criteria (6.4.1) are not fulfilled.

6.4.5 Software

The legally relevant software used in the instrument must be present in such a form in the instrument that alteration of the software is not possible without breaking a seal, or any change in the software can be signalled automatically by means of an identification code.

The legally relevant software shall be adequately protected against accidental or intentional changes. Evidence of an intervention such as changing, uploading or circumventing the legally relevant software shall be available until the next verification or comparable official inspection.

The software shall be assigned with a fixed software identification (4.2.7.8.4). This fixed software identification shall be adapted in the case of every software change that may affect the metrological functions of the instrument.

Software documentation provided with the instrument shall include the following:

- A description of the system hardware, e.g. topology block diagram, type of computer(s), source code for software functions, etc, and legally relevant software environment;
- A description of the fixed software version number and/or software identification) that is assigned to the metrologically relevant functions;
- A description of the relevant menus and dialogues;
- The securing measures foreseen (e.g. checksum, signature, audit trail);
- A description of the data storage device(s);
- The operating manual.

6.5 Zero-setting and zero-tracking devices

An instrument shall have one or more zero-setting devices and shall not have more than one zero-tracking device. These devices may be:

a) non-automatic, or
b) semi-automatic, or
c) automatic

6.5.1 Maximum effect

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

The overall effect of zero-setting and zero-tracking devices shall not be more than 4 %, and of the initial zero-setting device not more than 20 %, of the maximum capacity.

A wider range is possible for the initial zero-setting device if tests show that the instrument complies with the maximum permissible errors in 5.5 and 5.6, the permissible differences in errors in 5.7, and the influence factors in 5.8, for any load compensated by this device within the specified range.

6.5.2 Accuracy

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

6.5.3 Control of the zero-setting devices

An instrument whether or not equipped with an initial zero-setting device, may have a combined semi-automatic zero-setting and semi-automatic tare-balancing device operated by the same key.

If an instrument has a zero-setting device and a tare-weighing device the control of the zero-setting device shall be separate from that of the tare-weighing device.

A semi-automatic zero-setting device shall function only:

a) when the instrument is in stable equilibrium (6.4.1),
b) if it cancels any previous tare operation.

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

6.5.4 Stability of automatic zero-setting device

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

The automatic zero-setting device shall operate:

a) only when the stability criteria (6.4.1) are fulfilled, and
b) sufficiently often to ensure that zero is maintained within 0.5 e.

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 time interval. The maximum programmable time interval shall not be greater than the value necessary to ensure that the zero error is not greater than 0.5 e (see R51-2, 5.5).

The maximum programmable time interval for automatic zero-setting required above may start again after tare weighing or zero tracking has taken place.

The actual maximum programmable time interval for automatic zero-setting shall be specified taking into account the actual operating conditions of the instrument. The automatic zero-setting device shall either automatically set to zero after the allocated time or should stop

the instrument so that a zero-setting operation can occur or be capable of generating information to draw attention to overdue zero setting.

6.5.5 Zero-tracking device

A zero-tracking device shall operate only when:

a) the indication is at zero, or at a negative net value (4.3.2.2) equivalent to gross zero, and
b) the stability criteria (6.4.1) are fulfilled, and
c) the corrections are not more than 0.5 e/second.

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

Note: Zero-tracking is functionally similar to automatic zero-setting. The differences are important in applying the requirements of 6.5. Refer to 4.2.9.8.3 and 4.2.9.9. For many types of catchweigher, which have automatic zero-setting, zero-tracking will not be appropriate. The maximum rate of correction applicable to zero-tracking does not apply to zero-setting.

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 conditions of 6.5.5 are fulfilled) and must therefore be subject to a maximum rate of correction (0.5 e / second) to prevent interaction with the normal weighing process.

6.6 Tare device

6.6.1 Scale interval

The scale interval of the tare device shall be equal to the scale interval of the instrument for any given load.

6.6.2 Accuracy

A tare device shall permit setting the indication to zero with a deviation of not more than 0.25 e.

On a multi-interval instrument e shall be replaced by e_1.

6.6.3 Operating range

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

6.6.4 Visibility of operation

Operation of the tare device shall be visibly indicated on the instrument. In the case of instruments with digital indication this shall be done by marking the indicated net value

(4.3.2.2) with the sign “NET”[7] or “N”, and, if applicable, the indicated tare value (4.3.2.3) with the sign “T”.

Note: If an instrument is equipped with a device that allows the gross value (4.3.2.1) to be displayed temporarily while a tare device is in operation, the “NET” symbol shall disappear while the gross value is displayed.

This is not required for an instrument with a combined semi-automatic zero-setting device and a semi-automatic tare-balancing device operated by the same key.

It is permitted to replace the symbols NET and T by complete words in an official language of the country where the instrument is used.

6.6.5 Subtractive tare device

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

6.6.6 Multiple range instrument

On a multiple range instrument the tare operation shall be effective also in the greater weighing ranges, if switching to a greater weighing range is possible while the instrument is loaded.

6.6.7 Operation of tare devices

Semi-automatic or automatic tare devices shall operate only when the stability criteria (6.4.1) are fulfilled.

A nonautomatic or semi-automatic tare device shall not be operable during automatic operation.

6.6.8 Combined zero-setting and tare-balancing devices

If the semi-automatic zero-setting device and the semi-automatic tare-balancing device are operated by the same key, 6.5.2 (zero-setting accuracy) and if appropriate 6.6.2 (tare-setting accuracy), apply at any load.
``

6.6.9 Consecutive tare operations

Repeated operation of a tare device is permitted.

If more than one tare device is operative at the same time, tare weight values shall be clearly designated when indicated or printed.

6.6.10 Printing of weighing results

Gross weight values (4.3.2.1) may be printed without any designation. For a designation by a symbol, only “G” or “B”, are permitted.

If only net values (4.3.2.2) are printed without corresponding gross or tare values, they may be printed without any designation. A symbol for designation shall be “N”. These conditions

[7] NET may be displayed as “NET”, “Net” or “net”.

apply also where semi-automatic zero setting and semi-automatic tare balancing are initiated by the same key.

Gross, net, or tare values determined by a multiple range instrument or a multi-interval instrument need not be marked by a special designation referring to the (partial) weighing range.

If net values are printed together with the corresponding gross and/or tare values, the net and tare values shall at least be identified by the corresponding symbols “N” and “T”.

However, it is permitted to replace the symbols G, B, N and T by complete words in an official language of the country where the instrument is used.

If net values and tare values determined by different tare devices are printed separately, they shall be suitably identified.

6.7 Preset tare device

6.7.1 Scale interval

For Category X instruments the scale interval (d_T) shall be equal to or smaller than the verification scale interval (e) of the instrument.

For Category Y instruments the scale interval (d_T) shall be equal or automatically rounded to the scale interval (d) of the instrument.

On a multiple range instrument a preset tare value (4.3.2.4.1) may only be transferred from one weighing range to another one with a larger verification scale interval but shall then be rounded to the latter. For a multi-interval instrument, the preset tare value shall be entered with the smallest verification scale interval (e_1) of the instrument, and the maximum preset tare value shall not be greater than Max_1. The indicated or printed calculated net value (4.3.2.4.2) shall be rounded to the scale interval of the instrument for the same net weight value.

6.7.2 Modes of operation

A preset tare device may be operated together with one or more tare devices provided that:

a) 6.6.9 (consecutive tare operations) is respected, and
b) 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).

6.7.3 Indication of operation

For the indicating device 6.6.4 (visibility of operation) applies. It shall be possible to indicate the preset tare value at least temporarily.

6.6.10 applies accordingly provided that:

a) if the calculated net value is printed at least the preset tare value is printed as well.

b) preset tare values are designated by the symbol “PT”; however, it is permitted to replace the symbol “PT” by complete words in an official language of the country where the instrument is used.

6.8 Selection of weighing ranges on a multiple range instrument

The range that is actually in operation shall be clearly indicated.

6.8.1 Manual selection

Manual selection of the weighing range is allowed:

a) from a smaller to a greater weighing range, at any load,
b) from a greater to a smaller weighing range, when there is no load on the load receptor, and the indication is zero or at a negative net value; the tare operation shall be cancelled, and zero shall be set to $\pm$ 0.25 e_1, both automatically.

Manual selection of the weighing range shall be inhibited during automatic operation.

6.8.2 Automatic selection

Automatic change over is allowed:

a) From a smaller to the following greater weighing range when the load exceeds the maximum gross weight value of the range being operative,
b) Only from a greater to the smallest weighing range when there is no load on the load receptor, and the indication is zero or at a negative net value; the tare operation shall be cancelled and zero shall be set to $\pm$ 0.25 e_1, both automatically.

6.9 Devices for selection (or switching) between various load receptors, load-transmitting devices and various load-measuring devices

6.9.1 Compensation of no-load effect

The selection device shall ensure compensation for the unequal no-load effect of the various load receptors - load-transmitting devices in use.

6.9.2 Zero-setting

Zero-setting of an instrument with any multiple combination of various load-measuring devices and various load receptors shall be possible without ambiguity and in accordance with the provisions of 6.5.

6.9.3 Impossibility of weighing

Weighing shall not be possible while selection devices are being used.

6.9.4 Identification of the combinations used

Combinations of load receptors and load-measuring devices used shall be readily identifiable.

6.10 Weigh or weigh-price labelling instrument

A weigh or weigh-price labelling instrument shall have at least one displaying device for the weight value. It may be used temporarily for set-up purposes such as supervision of weight value setting limits, unit prices, preset tare values and commodity names.

It shall be possible to verify the actual values of unit price and preset tare during automatic operation.

6.10.1 Price computing

The price to pay shall be calculated and rounded to the nearest interval of price to pay by multiplication of weight value and unit price, both as indicated or printed by the instrument. The device which performs the calculation is considered a part of the instrument.

The interval of price to pay, and the monetary symbols and location shall comply with national regulations applicable to trade.

The unit price shall be in the form of: Price/100 g or Price/kg, or specified in accordance with national regulations applicable to trade.

6.10.2 Totalisation

An instrument may totalize weight values and price data on one or more tickets or labels provided that the total values are identified by a special word or symbol. All totals shall be the algebraic sums of all the values printed.

6.10.3 Printing

When price computing transactions performed by the instrument are printed, the weight value, unit price and price to pay shall all be printed.

The data may be stored in a memory of the instrument before printing. The same data shall not be printed twice on the ticket or label.

Printing below minimum capacity shall not be possible.

6.11 Descriptive markings

Instruments and associated modules shall bear the following markings, variable according to national regulation, at each location having a mass indicating and/or printing device.

6.11.1 Markings shown in full

- name or identification mark of the manufacturer
- name or identification mark of the importer (if applicable)
- serial number and type designation of the instrument
- maximum rate of operation (if applicable) in the form: .....loads/min or units/min
- maximum speed of load transport system (if applicable) in the form: ...m/s or m/min
- electrical supply voltage in the form: ...V
- electrical supply frequency in the form: ...Hz
- pneumatic/hydraulic pressure (if applicable) in the form: ..... kPa

- adjustment range referred to set point (if applicable) in the form: ± ...g or % (of set point value)
- temperature range (when not -10^0 C to 40^0 C)
- software identification (if applicable)

6.11.2 Markings shown in code

- type approval sign
- indication of the accuracy class, e.g. XI(0.5) or Y(a)
- verification scale interval in the form: e = ...
- actual scale interval in the form: d = ...
- maximum capacity in the form: Max .....
- minimum capacity in the form: Min .....
- maximum tare additive in the form: T = +
- maximum tare subtractive in the form: T = –

6.11.3 Supplementary markings

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

Additional markings (for example, products) may be required on initial verification to specify types of packs and related weighing conditions.

6.11.4 Presentation of descriptive markings

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

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

They shall be grouped together in a clearly visible place on the instrument, either on a descriptive plate or sticker fixed permanently to the instrument, or on a non removable part of the instrument itself. In case of a plate or sticker which is not destroyed when removed, a means of securing shall be provided, e.g. a non removable control mark that can be applied

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

Alternatively, the descriptive markings may be simultaneously shown on a display which is controlled by software either permanently or on manual command provided that:

a) the markings: Max…, Min…, e, d if $d \neq e$, and X(x) and/or Y(y) shall be shown at least in one place and permanently either on the display or near to the display in a clearly visible position, and are permanently and simultaneously shown (or alternating one after each other) on the display of the weighing result as long as the instrument is switched on;
b) the other markings may be shown on manual commend;
c) the markings are considered as device-specific parameters (see 4.2.7.8.3) and shall comply with the requirements for securing in 6.2.6.

When a software controlled display is used, the plate of the instrument shall bear at least the following markings:

- max, min and d shall be shown near the display if not already located there;
- type approval sign in accordance with national requirements;
- name or identification mark of the manufacturer/ type/ serial number;
- electrical supply voltage;
- electrical supply frequency;
- pneumatic / hydraulic pressure.

6.12 Verification marks

6.12.1 Position

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

a) be such that the part on which it is located cannot be removed from the instrument without damaging the marks,
b) allow easy application of the mark without changing the metrological qualities of the instrument,
c) normally be visible without the instrument having to be moved when it is in service.

6.12.2 Mounting

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

7 REQUIREMENTS FOR ELECTRONIC INSTRUMENTS

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

7.1 General requirements

7.1.1 Rated operated conditions

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

7.1.2 Influence factors

An electronic instrument shall comply with the requirements of 5.8 .

7.1.3 Disturbances

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

a) significant faults do not occur, i.e. the difference between the weight value indication due to the disturbance and the indication without the disturbance (intrinsic error) does not exceed 1 e, or
b) significant faults are detected and acted upon. The indication of significant faults in the display should not be confusing with other messages that appear in the display

Note: A fault equal to or less than the value specified in 4.4.3.9 (1 e) is allowed irrespective of the value of the error of indication.

7.1.4 Durability

The requirements in 7.1.1, 7.1.2 and 7.1.3 shall be met durably in accordance with the intended use of the instrument.

7.1.5 Evaluation for compliance

A type of an electronic instrument is presumed to comply with the requirements of 7.1.1, 7.1.2 and 7.1.3 if it passes the examination and tests specified in Annex A.

7.1.6 Application

The requirements for disturbances in 7.1.3 may be applied separately to:

a) each individual cause of significant fault, and/or
b) each part of the electronic instrument.

The choice of whether 7.1.3 (a) or (b) is applied is left to the manufacturer.

7.1.7 Humidity

In addition to 7.1.2, instruments shall maintain their metrological and technical characteristics at a relative humidity of either 85 % (non-condensing) or at 93 % (condensing) at the upper limit of the temperature range of the instrument.

Note: This is not applicable to an electronic instrument of classes XI and Y(I), and of classes XII and Y(II) if e is less than 1 g.

7.2 Functional requirements

7.2.1 Indications test

If the failure of an indicator can cause a false weight value indication then the instrument shall have a display test facility which is automatically initiated at switch-on of indication, e.g. display 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. This is not applicable for non-segmented displays, on which failures become evident, for example screen-displays, matrix-displays, etc.

7.2.2 Acting upon a significant fault

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

7.2.3 Warm-up time

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

7.2.4 Interfaces

An electronic instrument may be equipped with interfaces permitting the coupling of the instrument to any peripheral devices or other instruments.

An interface shall not allow the metrological functions of the instrument 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 6.

Note: An “interface” comprises all mechanical, electrical and software devices at the data interchange point between an instrument and peripheral devices or other instruments.

It shall not be possible to introduce into an instrument, through an interface, instructions, software programs or data intended or suitable to:

a) Display data that are not clearly defined and could be mistaken for a weighing result,
b) Falsify displayed, processed or stored weighing results,
c) Adjust the instrument or change any adjustment factor.

An interface through which the functions mentioned above cannot be performed or initiated, need not be secured. Other interfaces shall be secured as per 6.2.6.

An interface intended to be connected to a peripheral device to which the requirements of this Recommendation apply, shall transmit data relating to primary indications in such a manner that the peripheral device can meet the requirements.

8 METROLOGICAL CONTROLS

8.1 General

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

a) type approval;
b) initial verification;
c) subsequent verification;
d) in-service inspection.

Tests should be applied uniformly by the legal metrology services and should form a uniform program. Guidance for the conduct of type approval and initial verification is provided in OIML International Document D 19 [7].

8.2 Type approval

8.2.1 Documentation

The application for type approval shall include documentation comprising:

- metrological characteristics of the instrument,
- a set of specifications for the instrument,
- a functional description of the components and devices,
- drawings, diagrams and general software information (if applicable), explaining the construction and operation, and
- any document or other evidence that the design and construction of the instrument complies with the requirements of this Recommendation.

Note: Adherence to requirements for which no test is available, such as software-based operations, may be demonstrated by a specific declaration of the manufacturer (e.g. for interfaces as per 7.2.4, and for password protected access to device-specific parameters, and set-up and adjustment operations as per 6.2.6).

8.2.2 General requirements

Type evaluation shall be carried out on one or more and not normally more than three instruments that represent the definitive type. If the performance of an instrument could be affected by a particular manner of operation or a particular manner of use for which conditions cannot be duplicated other than in an in-situ operation then at least one of the instruments shall be completely installed at a typical site. At least one of the instruments shall be submitted in a form suitable for laboratory simulation tests. The evaluation shall consist of tests specified in 8.2.3.

8.2.3 Type evaluation

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

a) the metrological requirements in clause 5, particularly with reference to maximum permissible errors on initial verification referred to in 5.5 using test loads described in 9.1.3 or test loads specified by the manufacturer,
b) the technical requirements in clause 6,
c) the requirements in Clause 7 for electronic instruments, where applicable.

The metrological authority shall:

a) conduct the tests in a manner that prevents an unnecessary commitment of resources,
b) permit the results of these tests to be assessed for initial verification when the same instrument is involved.
c) check that an instrument used in nonautomatic (static) operation in accordance with 5.5.2, meets the weighing performance test requirements in OIML R 76-1 [6].

8.2.3.1 Operational tests

Tests shall be done as follows:

a) in accordance with the descriptive markings (6.11),
b) under the normal conditions of use for which the instrument is intended, and
c) in accordance with the test methods in clause 9.

The metrological authority may require the applicant to supply test loads, equipment and personnel to perform the tests.

The metrological authority may accept, with the consent of the applicant, test data obtained from other metrological authorities without repeating the tests.

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

8.2.3.2 Tests and checks for compliance with technical requirements

Tests and checks shall be done on a complete instrument to assess compliance with the requirements for security of operation in 6.2.

8.2.3.3 Influence factor tests

Influence factors shall be applied to the complete instrument or simulator as specified in 9.4.5 and in Annex A, in accordance with:

a) 5.8 for all instruments,
b) Clause 7 for electronic instruments.

8.2.3.4 Apportioning of errors

Where modules of an instrument or system are tested separately the following requirements apply.

The error limits applicable to a module which is examined separately are equal to a fraction p_i of the maximum permissible errors or the allowed variations of the indication of the complete instrument as specified in 5.5. The fractions for any module have to be taken for at least the same accuracy class as for the complete instrument incorporating the module.

The fractions p_i shall satisfy the following equation:

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

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

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

If the metrological characteristics of the load cell or other modules have been evaluated in accordance with the requirements of OIML R 60 [5], or any other applicable OIML

Recommendation, that evaluation shall be used to aid type evaluation if so requested by the applicant.

8.2.4 Place of testing

Instruments submitted for type approval may be tested either:

a) on the premises of the metrological authority to which the application has been submitted, or
b) in any other suitable place agreed between the metrological authority concerned and the applicant.

8.2.5 Type approval certificate and determination of classes

The type approval certificate shall state the appropriate accuracy class(es), X(x) and / or Y(y), as specified at type approval stage and be determined by compliance with the metrological requirements at initial verification of each instrument.

8.3 Initial verification

8.3.1 General requirements

Instruments shall be tested to verify that they comply with the metrological requirements in clause 5 (including 5.8.3, but excluding the rest of 5.8) and the technical requirements in clause 6 for the type of article(s) for which they are intended and when operated under the normal conditions of use. (Instruments mounted on or incorporated in vehicles shall be tested as specified in 5.8.3. Otherwise, only the functional test of the tilt limiting device shall be performed).

Instruments that weigh statically may be tested in nonautomatic mode provided the conditions of 9.4.5 are met.

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

8.3.2 Tests

Instruments shall be tested in their normal mode of automatic operation.

Tests shall be done:

a) in accordance with the descriptive markings (6.11),
b) under the rated conditions for which the instrument is intended,
c) in accordance with the test methods given in clause 9 using test loads described in 9.1.3.2.

The metrological authority may require the applicant to supply test loads, equipment and personnel to perform the tests.

Accuracy requirements shall be applied in accordance with the appropriate part or part(s) of 5.5.

8.3.3 Conduct of the tests

The metrological authority:

a) shall conduct the tests in a manner that prevents an unnecessary commitment of resources,
b) may, where appropriate and to avoid duplicating tests previously done on the instrument for type evaluation under 8.2.3.1, use the test results from type evaluation for initial verification.

8.3.4 Determination of accuracy class

8.3.4.1 Category X instruments

For category X instruments the metrological authority shall:

a) apply the accuracy class requirements for the product(s) used in the tests in accordance with the appropriate parts in 5.5.1.1 for initial verification.
b) verify that the:
   1) accuracy classes marked in accordance with 6.11 are equal to the accuracy class determined as above and
   2) designated accuracy class factor (x) marked in accordance with 6.11 is equal to or larger than the factor (x) determined as above under (a).

Note: The accuracy class that was achieved at type approval stage may not be achieved at initial verification if the loads used are significantly less stable or of different dimensions. In this case a lower accuracy class shall be marked in accordance with 5.5.1.1 or 5.5.1.2 and 6.11.2. Marking of a higher accuracy class than was achieved at type approval stage is not permitted.

8.3.4.2 Category Y instruments

For category Y instruments the metrological authority shall apply the requirements for the accuracy class marked in accordance with the appropriate parts specified in 5.5.1.2.

8.4 Subsequent metrological control

8.4.1 Subsequent verification

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

8.4.2 In-service inspection

In-service inspection shall be carried out in accordance with the same provisions as in 8.3 for initial verification, with the exception that the in-service maximum permissible errors shall be applied.

9 TEST METHODS

9.1 Automatic operation

9.1.1 Values of the mass of test loads

Test loads shall be applied as follows:

a) test load values close to Min and Max,
b) test load values close to, but not above, two critical points (4.3.2.6) in between Min and Max.

Note: To achieve the maximum rate of operation specified for the instrument it may be necessary to use more than one test load at each of the four nominal values above.

9.1.2 Number of test weighings

The minimum number of consecutive test weighings taken and used to determine the mean error and the standard deviation of the error for category X instruments, or the individual errors for category Y instruments, shall be as specified in Table 7.

Table 7

Category	Load	Number of test weighings
X	$m \leq 1$ kg	60
	1 kg < $m \leq 10$ kg	30
	10 kg < $m \leq 20$ kg	20
	20 kg < m	10
Y	Minimum of 10 for any load	

Note: For category Y instruments the number of test weighings shall be at least 10 unless within the type approval certificate a special test procedure is required.

9.1.3 Types of test load

9.1.3.1 Type approval

Test loads shall be used which comply with the following conditions:

a) appropriate dimensions,
b) constant mass,
c) solid, non-hygroscopic, non-electrostatic, non-magnetic material,
d) metal-to-metal contact to be avoided.

9.1.3.2 Initial verification, subsequent verification and in-service inspection

Test loads shall be the type of article(s) which are intended to be used.

9.1.4 Conditions of tests

The load transport system shall be set to its maximum speed, and if adjustable by the operator, also at a speed approximately midway through the operating range. If the speed is related to a particular product, set the speed to the preset speed for that product.

Zero shall be set at the start of each test sequence at a given load value.

9.1.5 Control instrument

A control instrument (meeting the requirements in 9.1.5.1) for determining the conventional true value of the mass of each test load shall be available for testing. The control instrument may either be separate or integral.

9.1.5.1 Accuracy of control instruments

When the instrument under test is used to determine the conventional true value of the mass of the test load (as an integral control instrument), or when instrument other than the instrument being verified is used to determine the conventional true value of the mass of the test load (as a separate control instrument), the control instrument shall ensure the determination of the conventional true value of the mass of each test load to an accuracy of at least one-third of whichever is the smaller of the appropriate maximum permissible errors for automatic weighing in Tables 3 and 4, for category X instruments, and one third of the appropriate maximum permissible errors in Table 5 for category Y instruments.

9.1.6 Conventional true value of the mass of the test load

The conventional true value of the mass of each test load shall be determined using either the separate or the integral control instrument described in 9.1.5.1 as appropriate.

9.1.7 Individual errors of weighings

9.1.7.1 Category X

The individual errors of weighings shall be the difference between the conventional true value of the mass of the test load as described in 9.1.6 and the indicated or printed weight value observed and recorded (see 9.1.8).

9.1.7.2 Category Y

The individual errors of weighings shall be the difference between the conventional true value of the mass of the test load as described in 9.1.6 and the indicated or printed weight value observed and recorded.

To eliminate the effect of rounding error during testing, one of the following shall be used:

a) the scale interval d shall be $\leq$ 0.2 e (see R51-2, 3.9.2.1)
b) the mass of the test load shall be selected using the procedure at R51-2, 3.9.2.2

Note: Where the procedure at R51-2, 3.9.2.2 is used it will not be possible to record the individual errors. It will suffice, however, to note whether or not the instrument is within the maximum permissible errors in Table 5.

9.1.8 Indicated weight for category X instruments

For category X instruments, indications and/or printouts of the weight values (or the difference between the weight value and a nominal set-point) shall be provided for each load for determining the mean error and the standard deviation of the error for each test. For this purpose the scale interval d shall not be greater than the appropriate limit for Table 4 multiplied by the class designation factor (x).

Alternatively, other practical means for demonstrating compliance with Tables 3 and 4 shall be provided by agreement with the metrological authority. For example, where suitable facilities, for directly performing these calculations, exist within the instrument under test these may be used provided that they are checked for accuracy before use. In this situation it is not mandatory that the individual weight values are recorded. No specific method of verifying that the instrument meets the calculation requirements is given as the method used will depend on the particular design being tested. However, any methods used shall demonstrate that the correct errors are being calculated as specified in 9.1.7.1, the correct formulae as specified in 4.4.3.5 and 4.4.3.6 are being used for the calculations in the instrument, and shall include at least some checks with loads. Details of the method used shall be recorded in the appropriate place in the type evaluation report.

9.2 Nonautomatic (static) operation

9.2.1 Verification standards

The error of the standard test weights or masses used shall not be greater than one-third of the maximum permissible error for the load as specified in Table 6.

9.2.2 Values of the mass of the test load

Test loads shall be applied as specified for each individual test in Annex A.

9.2.3 Number of weighings

The number of test weighings at each test load may be one.

9.2.4 Test weights indication

For nonautomatic (static) operation the instrument shall be provided with:

a) a static ‘live’ weight indication, or
b) a continually updated weight indication by simulation of the weighing cycle.

For determining the individual errors, the scale interval d shall be $\leq$ 0.2 e or, alternatively, the procedure described in R51-2, 3.10.2 shall be used.

9.3 Status of automatic correction facilities

Status of dynamic adjustment and automatic zeroing facilities shall be as specified for each individual test in Annex A.

9.4 Mode of operation for testing

9.4.1 Span stability testing (R 51-2, 7)

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

9.4.2 Disturbance testing (R 51-2, 6)

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

9.4.3 Warm-up test (R51-2, 5.2)

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

9.4.4 Eccentricity (R51-2, 5.7)

For instruments that weigh dynamically in automatic operation, the effect of eccentric loading shall be determined in automatic operation using a test load of 1/3 Max (plus the additive tare capacity, if applicable) using the portion of the load transport system that is halfway between the centre and the back, and repeated with the same test load using the portion of the load transport system that is halfway between the centre and the front.

For instruments that weigh statically in automatic operation, the effect of eccentric loading shall be determined in nonautomatic (static) operation with a test load of 1/3 Max (plus the additive tare capacity, if applicable) located in the centre (R51-2, 5.7.2) and in each of the four quarter segments of the stationary load transport system.

On an instrument with a load transport system having n points of support, with n > 4, the fraction 1/(n–1) of Max (plus the additive tare capacity, if applicable) shall be applied to each point of support.

9.4.5 Influence factor tests

The mode of operation required for influence factor tests shall be decided as follows.

All instruments designed to weigh loose material may be tested in non-automatic (static) operation.

All tests with loads greater than or equal to 20 kg may be done in non-automatic (static) operation.

For instruments that weigh pre-assembled discrete loads dynamically, the mode of operation for influence factor tests shall be as specified for each individual test in Annex A.

For instruments that weigh pre-assembled discrete loads statically, the mode of operation for influence factor tests may be as specified for each individual test in Annex A or may be decided on by the procedure of 9.4.5.1.

9.4.5.1 Option for nonautomatic (static) testing

As an alternative to automatic operation during influence factor testing, static test loads may be applied in a nonautomatic (static) operation provided that:

a) the instrument weighs statically in normal operation and,
b) the test of 9.4.5.2 has demonstrated that random errors are not significant in normal operation and,
c) where a decision is made to test in nonautomatic (static) operation this shall be applied to all the influence factor tests and recorded in the test report.

9.4.5.2 Determination of random errors for instruments that weigh statically

To determine whether static loads may be used for influence factor testing, the following test shall be applied before approval testing takes place: automatic test weighings, as specified in 9.1, shall be applied to the instrument under normal conditions of use for Min and Max

load values and for the load transport system set to its maximum speed of operation and also approximately midway through the operating speed range.

Static loads may be used for influence factor testing where the results of these tests demonstrate that, for the test loads, the differences between the results of several weighings of the same load are not greater than the absolute value of the maximum permissible error of the instrument for that load given in Table 6 for initial verification.

9.5 Examination and tests of electronic instruments

The examination and testing of an electronic weighing instrument is intended to verify compliance with the applicable requirements of this Recommendation and especially with the requirements of clause 7.

9.5.1 Examination

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

9.5.2 Performance test

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

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

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

9.5.3 Span stability test (4.6.4, 5.10, 9.4.1)

The span stability test specified in R 51-2, 7, shall verify that the EUT is capable of maintaining its performance characteristic over a period of use.

Annex B - BIBLIOGRAPHY

Below are references to Publications of the International Electrotechnical Commission (IEC), the International Organisation for Standardization (ISO) and the OIML, where mention is made in R 51-1.

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

Ref.	Standards and reference documents	Description
[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 60:2000 *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 76-1:2006 *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 pattern evaluation and pattern approval
[8]	OIML D 28 Edition 2004 (E)	Conventional value of the result of weighing in air