
Continuous totalizing automatic weighing instruments
(belt weighers).

Part 1: Metrological and technical requirements

Instruments de pesage totalisateurs continus à fonctionnement automatique
(peseuses sur bande).

Partie 1: Exigences métrologiques et techniques



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Foreword

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Continuous totalizing automatic weighing instruments (belt weighers)

Part 1: Metrological and technical requirements

1 General

1.1 Scope

This International Recommendation specifies the metrological and technical requirements for continuous totalizing automatic weighing instruments of the belt conveyor type, hereinafter referred to as “belt weighers”, that are subject to national metrological control.

It is intended to provide standardized requirements and test procedures for evaluating metrological and technical characteristics in a uniform and traceable way.

1.2 Application

This Recommendation applies to

- 1) belt weighers that determine the mass of a product in bulk by using the action of gravity on that product combined with the belt speed, and
- 2) belt weighers that are intended for use with single speed belt conveyors, belt weighers that are intended for use with variable speed belt conveyors and multi-speed belt conveyors.

2 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], OIML B 3 *Basic Certificate System for OIML Type Evaluation of Measuring Instruments* [3], OIML D 11 *General requirements for electronic measuring instruments* [4] and to OIML D 31 *General requirements for software controlled measuring instruments* [23]. In addition, for the purposes of this Recommendation, the following definitions apply.

2.1 General definitions

2.1.1 weighing instrument

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

Note: In this Recommendation “mass” (or “weight value”) is preferably used in the sense of “conventional mass” or “conventional value of the result of weighing in air” according to OIML R 111 [5] and OIML D 28 [6], whereas “weight” is preferably used for an embodiment (or material measure) of mass that is regulated in regard to its physical and metrological characteristics.

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

2.1.2 automatic weighing instrument

weighing instrument that weighs without the intervention of an operator and that follows a predetermined program of automatic processes characteristic of the instrument

2.1.3 continuous totalizing automatic weighing instrument

automatic weighing instrument for continuously weighing a bulk product for example on a conveyor belt, without interrupting the movement of the conveyor belt

Note: In this Recommendation a continuous totalizing automatic weighing instrument of the conveyor belt type is called a “belt weigher”.

2.1.4 true quantity value

quantity value consistent with the definition of a quantity

[VIM, 2.11] [1]

2.1.5 belt speed control

2.1.5.1 single speed belt weigher

belt weigher that is installed with a conveyor belt designed to operate at a single speed

2.1.5.2 variable speed or multiple speed belt weigher

belt weigher that is installed with a conveyor belt designed to operate at a variable speed (within a range) or at more than one set speed

2.1.6 control method

method used to determine the mass of the product used as the test load during product tests

Note: This will generally involve the use of a weighing instrument, referred to as the control instrument (see 2.1.10).

2.1.7 metrologically relevant device

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

2.1.8 legally relevant part

part of a measuring instrument, device or software subject to legal control

2.1.9 audit trail

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

[OIML D 31, 3.1.2] [23]

2.1.10 control instrument

weighing instrument used to determine the true quantity value of the mass of the test loads during product tests

2.1.11 displacement simulation device

device used in simulation tests on the continuously totalizing weigher without its conveyor and intended to simulate displacement of the belt by activating the displacement transducer in a similar manner to how it would operate with the conveyor (e.g. by use of a pulse generator or a motor to simulate rotation of a wheel which incorporates the displacement transducer)

2.2 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 or a key initiating an operation. The device may be a small part or a major portion of an instrument.

2.2.1 load receptor

part of the instrument intended to sense the load on the belt

2.2.1.1 weigh table

load receptor that includes only part of a conveyor

2.2.1.2 load receptor inclusive of conveyor

load receptor that includes an entire conveyor

2.2.2 belt conveyor

equipment for conveying the product by means of a belt (e.g. by resting on rollers or idlers turning about their axis, or by other devices)

2.2.2.1 carrying rollers

arrangements (commonly idlers) by which the conveyor belt is supported as it approaches and departs the load receptor

2.2.2.2 weighing rollers

arrangements (commonly idlers) by which the conveyor belt is supported on the weighing module

Note: An ‘inclusive of conveyor’ type belt weigher will normally have weighing rollers or idlers.

2.2.3 electronic measuring instrument

instrument intended to measure an electrical or non-electrical quantity using electronic means and/or equipped with electronic devices

[OIML D 11] [4]

2.2.3.1 electronic device

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

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

Note 2: An electronic device may be a module in the sense that this term is used in OIML B 3 *OIML Basic Certificate System for Measuring Instruments* [3].

2.2.3.2 electronic sub-assembly

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

2.2.3.3 electronic component

smallest physical entity that uses electron or hole conduction in semiconductors, gases, or in a vacuum

Examples: electronic tubes, transistors, integrated circuits.

2.2.3.4 digital device

electronic device that only performs digital functions and that provides a digitized output or display

Examples: Printer, remote display, terminal, data storage device, personal computer.

2.2.4 belt profile correction device

device capable of correcting for variations in the load applied to the load receptor by an (empty) belt during a belt revolution. The device uses software to maintain a stored profile of the (empty) belt load over a full revolution and to manage the synchronization process of the profile to the belt

2.2.5 totalization device

device that uses information supplied by the weighing module and the displacement transducer, either

- to add partial loads, or
- to integrate the product of the load per unit length and the speed of the belt

2.2.6 zero-setting device

device enabling the indication to be set to zero when there is no load on the load receptor

Note: Usually obtained over a whole number of revolutions of the empty conveyor belt.

2.2.6.1 non automatic zero-setting device

zero-setting device that requires observation and adjustment by the operator

2.2.6.2

semi-automatic zero-setting device

zero-setting device that operates automatically following a manual command or that indicates the value of the adjustment required

2.2.6.3

automatic zero-setting device

zero-setting device that operates automatically without the intervention of the operator after the belt has been operating empty

2.2.7

printing device

device to produce a printout (see 2.4.3) of the weighing results

2.2.8

flowrate regulating device

device intended to ensure a programmed flowrate

2.2.9

pre-selection device

means used to pre-set a weight value for a totalized load

2.2.10

module

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

[OIML B 3, 3.4] [3]

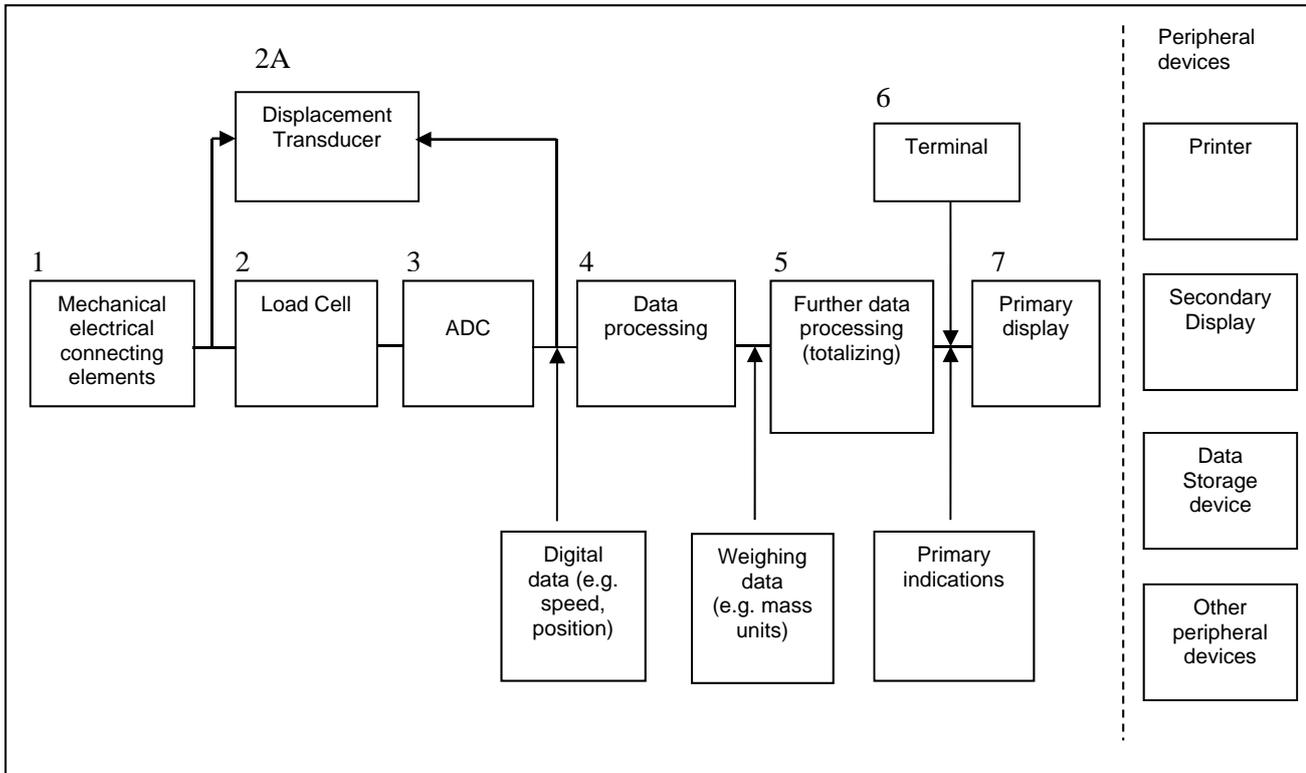
Note 1: The modules of a weighing instrument may be subject to specified partial error limits.

Note 2: Modules may be examined separately (subject to agreement with the metrological authority (see 6.1.6).

Typical modules of an automatic weighing instrument are: load cell, indicator, analogue or digital processors, weighing module, remote display, software.

Figure 1 – Definition of typical modules according to 2.2.10 and 6.1.6

(other combinations are possible)



load cell	(2.2.10.1)	2 + (3) + (4)*
displacement transducer	(2.2.10.2)	2A
indicator	(2.2.10.5)	(3) + 4 + (5) + (6) + 7
analogue data processing device	(2.2.10.3)	3 + 4 + (5) + (6)
digital data processing device	(2.2.10.4)	(4) + 5 + (6)
primary display	(2.2.10.5) (2.2.10.8)	7
weighing module	(2.2.10.7)	1 + 2 + 3 + 4 + (5) + (6)
terminal	(2.2.10.6)	(5) + 6 + 7

* Numbers in brackets indicate options

**2.2.10.1
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] [7]

Note: Load cells equipped with electronics including amplifier, analogue-to-digital converter (ADC), and data processing device (optionally) are called digital load cells (see Figure 1).

**2.2.10.2
displacement transducer**

device on the conveyor providing information either corresponding to the displacement of a defined length of the belt or proportional to the speed of the belt

**2.2.10.3
analogue data processing device**

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

**2.2.10.4
digital data processing device**

electronic device that processes digital data

**2.2.10.5
indicator**

electronic device that may perform the analogue-to-digital conversion of the output signal of the load cell, further processes the data, and displays the weighing result in units of mass

**2.2.10.6
terminal**

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

**2.2.10.7
weighing module**

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

**2.2.10.8
digital display**

output device, the purpose of which is to visualize actual information in volatile digital format

Note 1: A digital display may be a primary display or a secondary display.

Note 2: The terms “primary display” and “secondary display” should not be confused with the terms “primary indication” and “secondary indication” (see 2.4.1.1 and 2.4.1.2).

2.2.10.8.1**primary display**

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

2.2.10.8.2**secondary display**

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

2.2.11**software****2.2.11.1****legally relevant software part**

part of all software modules of a measuring instrument, electronic device, or sub-assembly that is legally relevant

[OIML D 31, 3.1.31] [23]

Note: Examples of legally relevant software are software involved in the determination of the final results of the measurement including the decimal sign and the unit, identification of the weighing range, software identification, and load receptor identification and configuration information.

2.2.11.2**legally relevant parameter**

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

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

[OIML D 31, 3.1.30] [23]

2.2.11.3**type-specific parameter**

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

[VIML, 4.11] [2]

Note: Type-specific parameters are part of the legally relevant software.

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

2.2.11.4**device-specific parameter**

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

[VIML, 4.12] [2]

Note: Device-specific parameters comprise adjustment parameters (e.g. span adjustments or other adjustments or corrections) and configuration parameters (e.g. maximum value, minimum value, units of measurement, etc.).

2.2.11.5
software identification

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

[OIML D 31, 3.1.42] [23]

2.2.11.6
software separation

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

[OIML D 31, 3.1.46] [23]

Note: These parts communicate via a software interface.

2.2.12
data storage device

storage device used for keeping measurement data ready after completion of the measurement for later legally relevant purposes (e.g. the conclusion of a commercial transaction)

2.2.13
interface

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

[OIML D 31, 3.1.27] [23]

2.2.13.1
user interface

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

[VIML, 6.15] [2]

2.2.13.2
protective interface

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

2.3 Metrological characteristics

2.3.1
scale intervals

2.3.1.1
totalization scale interval, d

difference between two consecutive indicated values, expressed in units of mass, with the instrument in its normal weighing mode

2.3.1.2**totalization scale interval for testing, e**

difference between two consecutive indicated values, expressed in units of mass, with the instrument in a special mode for testing purposes. This scale interval for testing, e , is equal to the totalization scale interval, d , if the special mode is not available

2.3.2**weigh length (W_L)**

distance between the two imaginary lines at the half distance between the axes of the end weighing rollers and the axes of the nearest carrying roller. When there is only one weighing roller, the weigh length is equal to half the distance between the axes of the nearest carrying rollers on either side of the weighing roller

Note: The weigh length is not applicable to belt weighers inclusive of conveyor.

2.3.3**complete belt revolution (belt length)**

total length (for one circulation) of the conveyor belt

2.3.4**maximum capacity, Max**

maximum net load (load applied by the bulk product, not including load applied by the belt) that the weighing module is intended to weigh on the portion of the conveyor belt representing the weigh length

2.3.5**minimum capacity, Min**

minimum net load (load applied by the bulk product, not including load applied by the belt) that the weighing module is intended to weigh on the portion of the conveyor belt representing the weigh length

2.3.6**flowrate, Q** **2.3.6.1****maximum flowrate, Q_{max}**

flowrate obtained with the maximum capacity of the weighing module and the maximum speed of the belt

2.3.6.2**minimum flowrate, Q_{min}**

flowrate above which the weighing results comply with the requirements of this Recommendation

2.3.6.3**feeding flowrate**

flowrate of product from a previous device onto the conveyor during the product test procedures

2.3.7**minimum totalized load, Σ_{min}**

totalized quantity, in units of mass, below which a totalization may be subject to excessive relative errors

2.3.8

maximum load per unit length of the belt

quotient of the maximum capacity of the weighing module and the weigh length

2.3.9

control value

value, in units of mass, that is indicated by the totalization indicating device when a known additional mass has been simulated or deposited on the load receptor with the empty belt running for a prescribed number of complete revolutions

2.3.10

warm-up time

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

2.3.11

repeatability

Refer to VIM, 2.21 [1]

2.3.12

durability

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

[OIML D 11, 3.17] [4]

2.3.13

type of a measuring instrument or module

definitive model of a measuring instrument or module (including a family of instruments or modules) of which all of the elements affecting its metrological properties are suitably defined

[OIML B 3, 3.6] [3]

2.3.14

family of measuring instruments

identifiable group of measuring instruments belonging to the same manufactured type within the same category that have the same design features and metrological principles for measurement (for example the same type of indicator, the same type of design of load cell and load transmitting device) but which may differ in some metrological and technical performance characteristics (e.g. Max, Min, *d*, accuracy class, etc.)

[OIML B 3, 3.3] [3]

Note: The concept of family primarily aims at reducing the test effort at type examination. It does not preclude the possibility of listing more than one family in one certificate.

2.4 Indications and errors

2.4.1

indication of a measuring instrument

quantity value provided by a measuring instrument or measuring system

[VIM, 4.1] [1]

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

2.4.1.1**primary indications**

totalized load(s), signals and symbols that are subject to the requirements of this Recommendation

2.4.1.2**secondary indications**

indications, signals and symbols that are not primary indications

2.4.2**types of indicating device****2.4.2.1****instantaneous load indicating device**

device that indicates the percentage of the maximum capacity, Max, or the mass of the load acting on the weighing module at a given time

2.4.2.2**flowrate indicating device**

device that indicates the instantaneous flowrate either as the mass of the product conveyed in unit of time or as a percentage of the maximum flowrate

2.4.2.3**totalization indicating device**

device that receives information from the totalization device and indicates the mass of the loads conveyed

2.4.2.4**general totalization indicating device**

device that indicates the overall total of the mass of all the loads conveyed

2.4.2.5**partial totalization indicating device**

device that indicates the mass of the loads conveyed over a limited period

2.4.2.6**supplementary totalization indicating device**

indicating device with a scale interval greater than that of the general totalization indicating device and intended to indicate the mass of the loads conveyed over a fairly long period of operation

2.4.2.7**whole belt totalization indicating device**

totalization indicating device in which the indication of mass of loads conveyed is updated once in each belt revolution (i.e. at the same point in each belt revolution)

2.4.3**printout**

hard copy of the measurement results produced from a printer

2.4.4 reading

2.4.4.1 reading by simple juxtaposition

reading of the weighing result by simple juxtaposition of consecutive figures giving the result, without the need for calculation

2.4.5 error (of indication)

indication minus a reference quantity value

Note: This reference value is sometimes referred to as a (conventional) true quantity value.

[VIML, 4.06] [2]

2.4.5.1 intrinsic error

error of a measuring instrument determined under reference conditions

[OIML D 11, 3.7] [4]

2.4.5.2 initial intrinsic error

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

[OIML D 11, 3.8] [4]

2.4.5.3 fault

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

[OIML D 11, 3.7] [4]

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

2.4.5.4 significant fault

fault exceeding the absolute value of the appropriate maximum permissible error for a load equal to the minimum totalized load, Σ_{\min} , for the designated class of the belt weigher

Note: A significant fault does not include

- faults arising from simultaneous and mutually independent causes in the belt weigher,
- faults implying the impossibility to perform any weighing,
- transitory faults, momentary variations in the indications which cannot be interpreted, memorized or transmitted as a weighing result,
- faults which are so serious that they will inevitably be noticed by all those interested in the weighing result.

2.4.5.5

maximum permissible error (MPE)

extreme value of an error permitted by specifications, regulations, etc. for a given instrument

[VIM, 4.26] [1]

2.4.5.6

durability error

difference between the intrinsic error after a period of use and the initial intrinsic error of a measuring instrument

[OIML D 11, 3.13] [4]

2.5 Influences and reference conditions

2.5.1

influence quantity

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

[VIM, 2.52] [1]

2.5.1.1

influence factor

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

[OIML D 11, 3.13.1] [4]

Note: The variation of an indication as a consequence of an influence factor is considered an error and not a fault.

2.5.1.2

disturbance

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

[OIML D 11, 3.13.2] [4]

2.5.2

rated operating conditions

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

[VIM, 4.9] [1]

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

2.5.3

reference conditions

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

[VIM, 4.11] [1]

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

2.5.4

typical weighing conditions

usual conditions of use for the instrument including types of product, site and method of operation

2.6 Tests

2.6.1

product test

test carried out on a complete instrument using the type of product that it is intended to weigh

2.6.2

performance test

test intended to verify whether the EUT is able to accomplish its intended functions

[OIML D 11, 3.20.3] [4]

2.6.3

durability test

test intended to verify whether the EUT is able to maintain its performance characteristics over a period of use

[OIML D 11, 3.20.4] [4]

2.6.4

simulation test

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

2.7 Abbreviations and symbols

Symbol	Meaning
I	Indication of the measuring instrument
I_n	n th indication
L	Load
Σ_{\min}	Minimum totalized load
Q	Flowrate
Q_{\max}	Maximum flowrate
Q_{\min}	Minimum flowrate
ΔL	Additional load to next changeover point
P	$I + 1/2 e - \Delta L =$ Indication prior to rounding (digital indication)
E_r	$(I - L) / L$ or $(P - L) / L =$ relative error

Symbol	Meaning
$E\%$	$100 \times (P - L) / L =$ percentage error
E_0	Error at zero load
d	Totalization scale interval
e	Totalization scale interval used for testing
W_L	Weigh length
p_i	Fraction of the MPE applicable to a module of the instrument which is examined separately
MPE	Maximum permissible error
EUT	Equipment under test
sf	Significant fault
Max	Maximum capacity of the weighing instrument
Min	Minimum capacity of the weighing instrument
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
V	Operating speed
v_{min}	Minimum operating speed
v_{max}	Maximum operating speed
e.m.f	Electromotive force
I/O	Input / output ports
RF	Radio frequency
DC	Direct current
AC	Alternating current

2.8 Basic relationships

2.8.1 load per belt displacement = Q / v

e.g. $Q = 1\,440 \text{ t/h} = 400 \text{ kg/s}$, $v = 2 \text{ m/s} \rightarrow$ Load per belt displacement = 200 kg/m

2.8.2 load per weigh length (the load seen by the weighing module) = $W_L \times Q / v$

e.g. $W_L = 3 \text{ m} \rightarrow$ Load per weigh length = $3 \times 200 = 600 \text{ kg}$

So, the load seen by the weighing module when operating at Q_{max} is

$$W_L \times Q_{\text{max}} / v_{\text{max}}, \text{ and hence Max} = W_L \times Q_{\text{max}} / v_{\text{max}}$$

3 Metrological requirements

3.1 Accuracy classes

Belt weighers are divided into four accuracy classes as follows:

0.2 0.5 1 2

3.2 Maximum permissible errors

Maximum permissible errors apply to loads equal to or greater than the minimum totalized load, Σ_{\min} .

3.2.1 Maximum permissible errors for automatic weighing

The maximum permissible errors for each accuracy class, positive or negative, are the applicable values in Table 1 rounded to the nearest totalization scale interval, d .

Table 1 – Maximum permissible errors for automatic weighing

Class	Percentage of the mass of the totalized load for	
	initial verification	in-service
0.2	0.10	0.20
0.5	0.25	0.50
1	0.50	1.0
2	1.0	2.0

3.2.2 Maximum permissible errors for influence factor tests

The maximum permissible errors for each accuracy class, positive or negative, are the applicable values in Table 2 rounded to the nearest totalization scale interval, d .

Table 2 – Maximum permissible errors for influence factor tests

Class	Percentage of the mass of the totalized load
0.2	0.07
0.5	0.175
1	0.35
2	0.70

Where the modules of an instrument are evaluated separately, the maximum permissible error for a device under test shall be the applicable value specified in Table 2 multiplied by the value of the fraction p_i applicable to this device (as described in 6.1.6.7).

However, when testing with influence quantities on a module comprising an analogue component, e.g. a load cell or an electronic device, the maximum permissible error for the device under test shall be 0.7 times the applicable value specified in Table 2.

3.3 Agreement between multiple indicating devices

For the same load, the difference between weighing results provided by any two devices having the same scale interval shall be zero for displaying and printing devices.

3.4 Minimum value of minimum totalized load, Σ_{\min}

The minimum totalized load shall be not less than the largest of the following values:

- 2 % of the load totalized in one hour at maximum flowrate;
- the load obtained at maximum flowrate in one revolution of the belt, (see requirements in 3.8.5);
- the load corresponding to the appropriate number of totalization scale intervals in Table 3.

Table 3 – Minimum value of the minimum totalized load, Σ_{\min}

Class	Number of totalization scale intervals
0.2	2 000
0.5	800
1	400
2	200

3.5 Minimum flowrate, Q_{\min}

- Single speed belt weighers

The minimum flowrate shall be equal to 20 % of the maximum flowrate, unless the characteristics of a particular installation are such that the flowrate variation is less than a ratio of 5 to 1, exclusive of the flowrate gradient at the beginning and the end of the conveyance of the bulk load. In this case, the minimum flowrate shall not exceed 35 % of the maximum flowrate.

- Variable and multi-speed belt weighers

Variable and multi-speed belt weighers may have a minimum flowrate less than 20 % of the maximum flowrate. The minimum instantaneous net load on the weighing module shall be at least 20 % of the maximum capacity.

3.6 Units of measurement

The units of measurement applicable for belt weighers are those that concern mass, mass flowrate, and (belt) speed.

The units to be used

- for mass are: gram (g), kilogram (kg) and tonne (t),
- for mass flowrate are: gram per hour (g/h), kilogram per hour (kg/h), tonne per hour (t/h),
- for belt speed are: metres per second (m/s).

3.7 Simulation requirements applying during type evaluation

3.7.1 Variation of simulation speed

For a variation of ± 10 % of each nominal value of the belt speed, or over the range of belt speeds when continuously variable (with the use of a displacement simulation device), the errors shall not exceed the maximum permissible errors (as specified in 3.2.2 Table 2).

3.7.2 Eccentric loading (R 50-2, 5.4.2)

The totalization errors for different positions of a load shall not exceed the maximum permissible errors (as specified in 3.2.2 Table 2).

3.7.3 Zero-setting

Following any zero-setting within the range of the zero-setting device, the totalization error shall not exceed the maximum permissible errors (as specified in 3.2.2 Table 2).

3.7.4 Influence quantities

3.7.4.1 Temperature (R 50-2, 7.2.1)

Belt weighers shall comply with the appropriate metrological and technical requirements at temperatures from -10 °C to $+40\text{ °C}$ unless special temperature limits are specified in the descriptive markings of the instrument (in a form such as “ $-25\text{ °C} / +55\text{ °C}$ ”).

The minimum range within the temperature limits shall be at least equal to 30 °C .

The temperature limits of a belt weigher shall be selected to be appropriate for the local environmental conditions of its use (this may be subject to national prescription).

3.7.4.2 Temperature effect at zero flowrate (R 50-2, 7.2.2)

The effect of temperature on totalizations at zero flowrate shall not vary by more than

- a) 0.007% for class 0.2,
- b) 0.0175% for class 0.5,
- c) 0.035% for class 1,
- d) 0.07% for class 2

per 5 °C of a load totalized at the maximum flowrate for the duration of the totalization.

3.7.4.3 Voltage variation (R 50-2, 7.2.4)

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

- a) AC mains voltage:
Lower limit is $0.85 \times U_{\text{nom}}$ or $0.85 \times U_{\text{min}}$, upper limit is $1.10 \times U_{\text{nom}}$ or $1.10 \times U_{\text{max}}$,
- b) DC mains voltage:
Lower limit is minimum operating voltage; upper limit is $1.20 \times U_{\text{nom}}$ or $1.20 \times U_{\text{max}}$,
- c) Battery voltage DC (not mains connected):
Lower limit is minimum operating voltage; upper limit is U_{nom} or U_{max} .

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

Battery-powered electronic instruments and instruments with external or plug-in power supply device (AC or DC) 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.

3.7.5 Metrological characteristics (R 50-2, 8)

3.7.5.1 Repeatability (R 50-2, 8.1)

The difference between any two results obtained for the same load placed under the same conditions on the load receptor shall not exceed the absolute value of the maximum permissible errors (as specified in 3.2.2 Table 2).

Note: During in-situ tests, if it is not possible to apply the same load, approximately the same load will be sufficient. In such cases, the difference between the loads shall be corrected.

3.7.5.2 Discrimination of the totalization indicating device (R 50-2, 8.2)

At any flowrate between the minimum and maximum flowrates, the difference between the indications obtained for two totalized loads, differing by a value equal to the maximum permissible error, shall be at least equal to one half of the calculated value corresponding to the difference between these totalized loads.

3.7.5.3 Discrimination of the totalization indicating device used for zero totalization (R 50-2, 8.3)

For tests of a duration of 3 minutes, there shall be a visible difference between the indications of the zero indication at no load and for a load, either deposited on or removed from the load receptor, equal to the following percentages of the maximum capacity, Max:

- a) class 0.2: 0.02 %;
- b) class 0.5 0.05 %;
- c) class 1: 0.1 %;
- d) class 2: 0.2 %.

3.7.5.4 Stability of zero (R 50-2, 8.4)

3.7.5.4.1 Short term stability of zero

For the unloaded belt weigher the difference between zero-indications over a period of 15 minutes of operation at a simulation of maximum belt speed shall not exceed the following percentages of the load totalized in 1 hour at maximum flowrate, Q_{\max} :

- a) class 0.2: 0.000 5 %;
- b) class 0.5: 0.001 25 %;
- c) class 1: 0.002 5 %;
- d) class 2: 0.005 %.

3.7.5.4.2 Long-term stability of zero

For the unloaded belt weigher the difference between zero-indications over a period of 3.5 hours of operation at a simulation of maximum belt speed shall not exceed the following percentages of the load totalized in 1 hour at maximum flowrate, Q_{\max} :

- a) class 0.2: 0.000 7 %;
- b) class 0.5: 0.001 75 %;
- c) class 1: 0.003 5 %;
- d) class 2: 0.007 %.

3.8 In-situ requirements applying during type evaluation and verification (R 50-2, 9)

3.8.1 Repeatability

The difference between the relative errors for several results obtained at practically identical flowrates, for approximately the same quantities of product and under the same conditions, shall not exceed the absolute value of the maximum permissible error for automatic weighing in 3.2.1.

3.8.2 Maximum permissible errors on checking of zero (R 50-2, 9.1)

After a whole number of belt revolutions and a duration as close as possible to, but not less than 3 minutes, the variation of the indication at zero shall not exceed the following percentages of the load totalized at the maximum flowrate, Q_{\max} :

- a) class 0.2: 0.02 %;
- b) class 0.5: 0.05 %;
- c) class 1: 0.1 %;
- d) class 2: 0.2 %.

3.8.3 Discrimination of the totalization indicating device used for zero-setting (R 50-2, 9.1.1)

After a whole number of belt revolutions and a duration as close as possible, but not less than 3 minutes, there shall be a visible difference between the indications of the zero indication at no load and for a load, either deposited on or removed from the load receptor, equal to the following percentages of the maximum capacity, Max:

- a) class 0.2: 0.02 %;
- b) class 0.5: 0.05 %;
- c) class 1: 0.1 %;
- d) class 2: 0.2 %.

3.8.4 Maximum variation during zero-load (R 50-2, 9.1.2)

During a whole number of belt revolutions and of a duration as close as possible, but not less than 3 minutes, the variation of the indication from its initial value shall not exceed the following percentages of the minimum load totalized, Σ_{\min} , at the maximum flowrate, Q_{\max} :

- a) class 0.2: 0.07 %;
- b) class 0.5: 0.175 %;
- c) class 1: 0.35 %;
- d) class 2: 0.7 %.

3.8.5 Indication over whole belt revolution (minimum load)

Belt weighers may include a means of permitting totalized loads to be obtained only over a whole belt revolution (see 2.4.2.7). When such a facility is present it shall meet the requirements in 4.6 b); and when material tests are conducted with this facility the minimum totalized load shall comply with 3.4 a) and c) but need not fulfill the requirement in 3.4 b).

3.9 Durability

The durability error shall not be greater than the absolute value of the maximum permissible error for automatic weighing.

4 Technical requirements

4.1 Suitability for use

A belt weigher shall be designed to suit the method of operation, the product and the accuracy class for which it is intended.

4.2 Rated operating conditions

A belt weigher shall be designed and manufactured so that it does not exceed the maximum permissible errors under rated operating conditions.

4.3 Security of operation

4.3.1 Accidental breakdown and maladjustment

A belt weigher shall be constructed and installed so that an accidental breakdown or maladjustment likely to disturb its correct functioning cannot normally take place without the effect being evident.

Adjustable components (e.g. carrying rollers, idlers, take-up weights, etc. that can disturb the metrological performance of a belt weigher) shall be held securely and the position of the component shall be accurately and permanently defined.

4.3.2 Operational adjustments

It shall not be possible for the general totalization indicating device to be reset to zero.

It shall not be possible to reset legally relevant indicating devices unless the belt is stopped, or the flow rate is zero.

It shall not be possible to make operating adjustments which may affect the measurement result unless the belt is stopped or the flow rate is zero.

4.3.3 Fraudulent use

A belt weigher shall not have characteristics likely to facilitate its fraudulent use.

4.3.4 Operating devices

The operating devices of a belt weigher shall be so designed that it cannot normally come to rest in a position other than that intended, unless all indications and printing procedures are automatically disabled.

4.3.5 Conveyor interlock

If the instrument is switched off or ceases to function, the conveyor belt shall stop, or a visible or audible signal shall be given.

4.3.6 Out-of-range warning or alarm

The instrument shall produce a continuous, clearly audible and/or visible warning or alarm and a record of the warning or alarm with the date, time, duration and totalized value on the applicable partial or general totalized printout, or on any supplementary recording devices (flow rate chart recorder, etc.) if

- a) the instantaneous load is above the maximum capacity of the weighing module,
- b) the flowrate is above the maximum or below the minimum value,
- c) a breakdown, maladjustment or fault has been detected (4.3.1),

- d) a whole belt totalization device, if applicable, provides a totalization over less than a whole number of belt revolutions, or
- e) the MPE on checking of zero (3.8.2) has been exceeded (4.5.1), if applicable.

Note: The indication is intended as a warning indication and its operation shall be obvious (e.g. a continuous beep or flashing warning light would be an acceptable solution). The warning or alarm shall be appropriate for the installation environment and the use of different indications for each cause is acceptable.

4.3.7 Securing and sealing of components and pre-set controls

Components, interfaces and pre-set controls subject to legal requirements that are not intended to be adjusted or removed by the user shall be fitted with a securing means or shall be enclosed. When they are enclosed, it shall be possible to seal the enclosure. The seals shall, in all cases, be easily accessible.

Adequate securing shall be provided on all parts of the measuring system which cannot be materially protected in any other way against operations liable to affect the measurement accuracy.

4.3.7.1 General

Securing and sealing measures on a belt weigher shall ensure that

- a) access to functions liable to affect metrological properties is restricted by means such as: a switch protected by a physical seal, a password with audit trail, hard key or identification tag,
- b) software functions are secured against intentional, unintentional and accidental changes in accordance with the requirements of 5.8,
- c) transmission of metrological data via interfaces is secured against intentional, unintentional and accidental changes in accordance with the requirements of 5.6.1, and
- d) measurement data held on storage devices is secured against intentional, unintentional and accidental changes in accordance with the requirements of 5.7.

4.3.7.2 Components and pre-set controls

Means of securing and sealing components and pre-set controls to which access or adjustment is prohibited shall include the following:

- a) Physical seals which must be broken to access the components or functions, and/or an audit trail system, if available, shall automatically memorize access to components or functions and it shall be possible to access and display this information; the records shall include the date and a means of identifying the authorized person making the intervention (a positive identification of the person may not be possible, however the audit trail should contain sufficient information to identify which password or identification tag was used to make the intervention);
- b) The traceability of the interventions shall be assured (e.g. by means of a counter which is incremented whenever the components or functions are altered, and an associated record of the value of this counter at a particular time) for at least a period of time specified by national prescription (typically the period between periodical verifications if these apply). Records of interventions shall be retained. Records may not be overwritten, with the exception that if the storage capacity for records is exhausted, new records may replace the oldest records provided that the owner of the data has given permission to overwrite the records;
- c) The sealing measures provided shall be easily accessible.

4.4 Totalization indicating and printing devices

The belt weigher shall be equipped with a general totalization indicating device and may additionally be equipped with partial and supplementary totalization indicating devices.

4.4.1 Quality of indication

Totalization indicating and printing devices shall allow reliable, simple, and non-ambiguous reading of the primary indications (see 2.4.1.1) under typical weighing conditions (see 2.5.4):

- the standard uncertainty ($k = 2$) contribution from the reading of an analogue indicating device shall not exceed $0.2 d$;
- the figures forming the primary indications shall be of a size, shape and clarity for reading to be easy, and the height of the figures shall be at least 9.5 mm;
- the scales, numbering and printing shall permit the figures which form the results to be read by simple juxtaposition (see 2.4.4.1).

4.4.2 Format of the indication

4.4.2.1 Unit of mass

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

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

The units of mass shall be indicated in small letters (lower case) as in 3.6.

4.4.2.2 Digital indication

A digital indication shall show at least one figure beginning at the extreme 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 weight values have not more than one non-significant zero to the right. For values with a decimal sign, the non-significant zero is allowed only in the third position after the decimal sign.

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

The decimal sign shall be in line with the bottom of the figures (example: 0.305 kg).

Examples of suitable displays:

Scale interval	Suitable display	Unsuitable display
0.005 t, 5 kg	0.050 t, 50 kg	0.05 t, 0.0500 t
0.01 t, 10 kg	0.10 t, 0.100 t, 100 kg	0.1 t, 0.1000 t
0.02 t	0.20 t, 0.200 t	0.2 t, 0.2000 t
1 t	10 t	10.0 t, 10.00 t

4.4.3 Scale interval

4.4.3.1 Form of the scale interval

The scale intervals of the indicating and printing devices shall be in the form 1×10^k , 2×10^k , or 5×10^k , “ k ” being a positive or negative whole number or zero.

4.4.3.2 Scale interval of a partial totalization indicating device

The scale interval of a partial totalization indicating device shall be equal to the scale interval of the general totalization indicating device, *d*.

4.4.3.3 Scale interval of a supplementary totalization indicating device

The scale interval of a supplementary totalization indicating device shall be at least equal to ten times the totalization scale interval.

Any supplementary totalization devices cannot be used for legal measurements.

4.4.4 Range of indication

At least one totalization indicating device on a belt weigher shall be capable of indicating a value at least equal to the quantity of product weighed in 10 hours of operation at maximum flowrate.

A larger range of indication may be required for installations where larger deliveries are anticipated.

4.4.5 Totalization indicating devices

- a) It shall not be possible to reset the general totalization indicating device to zero.
- b) It shall not be possible to reset the partial totalization indicating device to zero unless the last total indicated before resetting to zero is printed or stored in memory with identification.
- c) In automatic operation it shall not be possible to reset any totalization device to zero.
- d) In the case of a multi-function display, an automatic indication of the total shall be generated if the automatic operation is interrupted or during automatic operation no more than 20 seconds after the previous indication.
- e) Where a device such as a whole belt totalization indicating device (2.4.2.7) is provided, the belt weigher shall provide a valid totalization over a whole number of complete belt revolutions. In this case the requirements of 4.4.6 apply.

4.4.6 Engagement of totalization indicating devices

- a) Totalization indicating and printing devices (when printing devices are present) shall remain engaged at all times except as provided for in 4.4.5 b). In this case the totalization indicating and printing devices shall clearly indicate when they are not engaged.
- b) A device designed to disengage any totalization indicating and printing devices shall only operate when any movement of the belt and product feed has been disabled.

4.4.7 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.

4.5 Zero-setting device

The effective mass of the belt shall be balanced by a zero-setting device of a type appropriate to the principle of operation of the belt weigher. The range of zero-setting shall not be more than 4 % of the maximum capacity.

4.5.1 Semi-automatic and automatic zero-setting devices

Semi-automatic and automatic zero-setting devices shall be constructed in such a manner that

- a) the setting to zero takes place after a whole number of belt revolutions,
- b) the end of the zero-setting operation is indicated,

- c) the zero-setting range shall not exceed 4 % of the maximum capacity, Max, and
- d) a change in zero observed during a zero-load test that exceeds the MPE (3.8.2) shall be corrected by an automatic zero-setting device when present (see also 4.3.6).

For testing purposes, it shall be possible to disengage automatic zero-setting devices.

A belt weigher may include an automatic zero-setting device only if it is provided with an interlock to prevent zero-setting while it is possible for product to feed onto the belt conveyor.

4.6 Belt profile correction device (2.2.4)

Where a belt weigher is fitted with a belt profile correction device, the device shall either

- a) be permanently in operation, or permanently disabled (any ability to enable or disable shall be sealed against user access), and incorporate a mechanism to reliably synchronize the belt position with the stored (empty) belt profile (for example, the use of a sensor to detect the passing of a tag fixed to the belt being one possibility), or
- b) be combined with an automatic or semi-automatic zero-setting device – i.e. operation of the zero-setting device may acquire and store a new profile of the (empty) belt, or operate separately from an automatic or semi-automatic zero-setting device, in which case the automatic or semi-automatic zero-setting device may adjust the average (empty) belt profile value according to the average zero value determined over a whole number of belt revolutions.

4.7 Displacement transducer

The displacement transducer shall be designed so that there is no possibility of slip affecting the results whether the belt is loaded or not.

Displacement transducers shall be driven by the side of the belt not carrying the product.

Measurement signals shall correspond with displacements of the belt equal to or less than the weigh length. It shall be possible to seal adjustable parts.

4.8 Belt weighers inclusive of conveyor

The conveyor shall be constructed in a rigid manner and shall form a rigid assembly.

4.8.1 Installation conditions

Belt weighers shall only be installed where

- a) the frame support of the conveyor is constructed in a rigid manner,
- b) in any straight longitudinal section, the roller track is such that the belt is constantly supported on the weighing rollers or idlers,
- c) belt cleaning devices, if fitted, are positioned and operated so as to have no significant effect on the results, and
- d) the roller track does not cause slippage of the product.

Belt weighers shall be designed so that the installation of the roller track, the construction and mounting of the belt, and the arrangement of the product feed do not cause excessive additional errors.

4.8.1.1 Roller track

Belt weighers shall be protected against corrosion and clogging.

The contact surface of the weighing rollers and the carrying rollers shall be aligned practically in the same plane.

4.8.1.2 Conveyor belt

Variations in the mass per unit length of the belt (including belt joins) shall not have any significant effect on the results (so as to ensure the requirement of 3.8.4 is met). It is recommended that such variations are minimized.

4.8.1.3 Speed control

The belt weigher shall ensure that the speed of the belt is within the following defined speed range:

- a) for single or multiple speed weighers, the speed of the belt during weighing shall not vary by more than 5 % of the nominal speed;
- b) for variable speed belt weighers having a speed setting control, the speed of the belt shall not vary by more than 5 % of the set speed.

4.8.1.4 Weigh length

Belt weighers shall be installed in such a way that the weigh length and vertical alignment remain unchanged while in service.

It shall be possible to seal the weigh length adjusting devices on the belt weigher to prevent adjustments of the weigh length while in service.

4.8.1.5 Belt tension for belt weighers other than belt weighers inclusive of conveyor

The longitudinal tension in the belt shall be maintained independent of the effects of temperature, wear, or load (by some form of automatic mechanism or device, e.g. a gravity tension unit). Tension shall be such that under typical weighing conditions, there is practically no slip between the belt and the driving drum.

4.8.1.6 Belt slope

The belt shall normally be installed in a fixed position. If the slope angle of the load receptor in the running direction of the belt can change, either

- a) the belt weigher shall be fitted with a device to compensate the effect of the change, or
- b) the belt weigher shall not operate, delivery shall not be possible, and totalization shall be disabled during the period when the slope of the conveyor is in transition and when the limits to the slope angle set by the manufacturer are exceeded.

4.9 Descriptive markings

Note: Markings are given here by way of example, but are variable according to national prescription.

Instruments shall bear the following markings.

4.9.1 Markings shown in full

- identification mark of the manufacturer
- serial number and type designation of the instrument
- the inscription: “Zero-setting shall involve at least revolutions” (the number of revolutions in zero-setting shall be decided as a consequence of the type evaluation)
- mains voltage V
- mains frequency Hz (if applicable)
- designation of type(s) of product to be weighed
- weigh length, W_L m
- identification mark on each unit of the instrument consisting of separate but associated units

4.9.2 Markings shown in code

- type approval sign
- maximum capacity, Max g, kg or t
- temperature range °C / °C, (if applicable, see 3.7.4.1)
- accuracy class = 0.2, 0.5, 1 or 2
- totalization scale interval, d = g, kg or t
- as appropriate:
 - nominal speed(s) of the belt v = m/s, or
 - range of speeds of the belt v = / m/s
- maximum flowrate, Q_{\max} = g/h, kg/h or t/h
- minimum flowrate, Q_{\min} = g/h, kg/h or t/h
- minimum totalized load, Σ_{\min} = g, kg or t

4.9.3 Supplementary markings

Depending on the particular use of the instrument, supplementary markings may be required on type approval by the metrological authority issuing the type approval certificate.

4.9.4 Presentation of descriptive markings

Descriptive markings shall be indelible and of a size, shape and clarity to enable legibility under typical weighing conditions.

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

They shall be grouped together in a visible place on the instrument, either

- on a descriptive plate, or
- on a sticker fixed permanently near the general totalization indicating device, or
- on a non-removable part of the indicating device itself.

In the 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, or it shall be possible to seal the plate bearing the markings.

The markings above may also be shown on a software controlled programmable display provided that

- a) at least Max, Q_{\max} , Q_{\min} , Σ_{\min} and d shall be displayed as long as the belt weigher is switched on,
- b) the other marking may be shown on manual command,
- c) it must be described in the type approval certificate, and
- d) the markings are considered as device-specific parameters (see 2.2.11.4) and shall comply with the appropriate requirements for securing in 4.3.7 and 5.8.

The software controlled display markings need not be repeated on the data plate, if they are shown on or indicated near the display of the weighing result, with the exception of the following markings which shall be shown on the data plate:

- Max, Q_{\max} , Q_{\min} , Σ_{\min} and d shall be shown near the display;
- type approval sign in accordance with national prescription;
- name or identification mark of the manufacturer;
- voltage supply;
- voltage supply frequency, (if applicable);
- pneumatic/hydraulic pressure, (if applicable).

4.10 Verification marks

4.10.1 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, and
- c) be visible without the instrument or its protective covers having to be moved when it is in service.

4.10.2 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. When the mark is made with a stamp, the support may consist of a strip of lead or any other material with similar qualities, inserted into a plate fixed to the instrument, or into a cavity in the instrument. When the mark consists of an adhesive transfer, a space shall be prepared for this purpose.

5 Additional requirements for electronic belt weighers

Belt weighers shall comply with the following requirements, in addition to the applicable requirements of all other clauses.

5.1 General requirements

5.1.1 Disturbances

Belt weighers containing electronics shall be designed and manufactured so that when exposed to disturbances, either

- a) significant faults do not occur, or
- b) significant faults are detected and acted upon.

Note: A fault equal to or less than the significant fault specified in 2.4.5.4 is allowed irrespective of the value of the error of measurement.

5.1.2 Durability

The requirements in 3, 4, and 5.1.1 shall be met durably in accordance with the intended use of the instrument.

5.1.3 Evaluation for compliance

The type of an electronic instrument is presumed to comply with the requirements in 5.1.1 and 5.1.2 if it passes the examination and tests specified in R 50-2.

5.2 Application

The requirements in 5.1.1 may be applied separately to

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

The choice as to whether to apply 5.1.1 a) or b) is left to the manufacturer.

5.3 Acting upon a significant fault

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

Means shall be provided to retain any totalized load information contained in the instrument when a significant fault occurs.

5.4 Indicator display test

At switch-on (at switch-on of indication in the case of an electronic instrument permanently connected to the mains), a special procedure shall be performed that indicates all the relevant signs of the indicating devices, 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.

5.5 Functional requirements

5.5.1 Influence factors

Instruments shall comply with the requirements in 3.7.4 and shall in addition maintain their metrological and technical characteristics at a relative humidity of either 85 % (non-condensing) or 93 % (condensing) (see R 50-2, 7.2.3) at the upper limit of the temperature range of the instrument.

5.5.2 Disturbances

Instruments shall comply with the requirements in 5.1.1.

5.5.3 Warm-up time (R 50-2, 3.5, 5.2)

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

5.5.4 Mains electrical power supply failure (R 50-2, 6.5)

An instrument shall, in the event of a mains electrical power supply failure, retain the metrological information contained in the instrument at the time of failure for at least 24 hours, and shall be capable of indicating that information for at least 5 minutes following switch-on during the 24-hour period. A switch-over to an emergency voltage supply shall not cause a significant fault.

5.5.5 Battery power supply failure

An instrument using a battery power supply shall, whenever the voltage drops below the manufacturer's specified minimum value, either continue to function correctly or automatically be put out of service. The instrument shall retain the metrological information contained in the instrument at the time of failure for at least 24 hours, and shall be capable of indicating that information for at least 5 minutes following switch-on during the 24-hour period.

5.6 Interfaces

Instruments may be equipped with interfaces (2.2.13) permitting the coupling of the instrument to external equipment and to user interfaces enabling the exchange of information between a human user and the instrument. When an interface is used, the instrument shall continue to function correctly and its metrological functions (including all metrologically relevant parameters and software) shall not be influenced. Information on instrument interfaces shall be available, for example

- list of all commands (e.g. menu items),
- description of the software interface,
- list of all commands together,
- brief description of their meaning and their effect on the functions and data of the instrument,
- other interface description.

5.6.1 Interface security

Interfaces shall not allow the legally relevant software and functions of the instrument and its measurement data to be inadmissibly influenced by other interconnected instruments, or by disturbances acting on the interface.

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

- a) data are protected e.g. with a protective interface (2.2.13.2), against accidental or intentional intervention;
- b) hardware and software functions shall comply with the appropriate requirements for securing in 4.3.7 and 5.8;
- c) it shall be easily possible to verify the authenticity and integrity of data transmitted to and from the instrument; and
- d) other devices required by national prescription to be connected to the interfaces of the instrument shall be secured to automatically inhibit the operation of the instrument for reasons of the non-presence or improper functioning of the required device.

5.7 Data storage device

If the instrument has a data storage device, its measurement data shall be stored, which may be in internal memory or on external storage for subsequent use (e.g. indication, printing, transfer, totalizing, etc.). In both cases, 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.

5.7.1 Securing measures

To ensure adequate security the following conditions apply:

- a) the appropriate requirements of 4.3.7 for securing are applicable;
- b) external storage devices identification and security attributes shall be automatically verified to ensure integrity and authenticity;
- c) exchangeable storage media for storing measurement data need not be sealed provided that the stored data is secured by a specific checksum or key code;
- d) when storage capacity is exhausted, new data may replace the oldest data provided that overwriting the old data has been archived and/or authorized;
- e) instruments intended to be used in the absence of one trading party shall be equipped with a data storage device which records the measurement result accompanied by information to identify the particular transaction and reconstruct it later.

5.8 Software

The legally relevant software of the instrument shall be identified by the manufacturer, i.e. the software that is critical for measurement characteristics, measurement data and metrologically important parameters, stored or transmitted, and software programmed to detect system faults (software and hardware), is considered as an essential part of an instrument and shall meet the requirements for securing software specified below and shall be examined according to R 50-2, 2. Information on software controlled instruments shall be available, for example

- description of the legally relevant software,
- description of the accuracy of the measuring algorithms,
- description of the user interface, menus and dialogues,
- unambiguous software identification,
- description of the embedded software,
- overview of the system hardware, e.g. topology block diagram, type of computer(s), source code for software functions, etc., if not described in the operating manual,
- means of securing software, and
- operating manual, if appropriate.

Note: It shall be possible to check the software identification whilst the instrument is in use (it is acceptable if this checking can only occur whilst the belt is stopped).

5.8.1 Security of legally relevant software

There shall be adequate security to ensure that

- a) legally relevant software shall be adequately protected against accidental or intentional changes. The appropriate requirements for securing given in 4.3.7 and 5.7 apply,
- b) the software shall be assigned with appropriate software identification (2.2.11.5). This software identification shall be adapted in the case of every software change that may affect the functions and accuracy of the instrument, and
- c) functions performed or initiated via connected interfaces, i.e. transmission of legally relevant software, shall comply with the securing requirements for interfaces in 5.6.

6 Metrological controls

The metrological controls of belt weighers may, in agreement with national prescription, consist of

- a) type evaluation,
- b) initial verification,
- c) subsequent verification, and
- 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 evaluation and initial verification is provided in OIML D 19 [9] and D 20 [10] respectively.

Measures to ensure durability (see 3.9), which shall include assessments under items a) to d) above shall be taken subject to national prescription.

Further information about durability testing is given in R 50-2, Annex C.

6.1 Type evaluation (R 50-2, 4.1)

6.1.1 Documentation (R 50-2, 1)

The application for type evaluation shall include documentation comprising

- a) the metrological characteristics of the belt weigher (3),
- b) a standard set of specifications for the belt weigher,
- c) a functional description of the components and devices,
- d) drawings, diagrams and a photo of the instrument, explaining its construction and operation,
- e) description and application of securing components, interlocks, adjustment devices, controls, etc. (4.3, 4.9, 5.8),
- f) details of fractions p_i (modules tested separately) (6.1.6),
- g) totalization indicating and printing devices (4.4),
- h) data storage device (5.7),
- i) zero-setting devices (4.5),
- j) interfaces (types, intended use, immunity to external influences, instructions, etc.) (5.6),
- k) for software controlled instruments: detailed software information (5.8),
- l) drawing or photo of the instrument showing the principle and the location of control marks, securing marks, descriptive and verification marks (4.9, 4.10),
- m) operating instructions, operating manual, and
- n) any document or other evidence demonstrating that the design and construction of the instrument complies with the requirements of this Recommendation.

6.1.2 General requirements

Type evaluation shall be carried out on at least one and normally not more than three units that represent the definitive type. At least one of the units shall be completely installed at a typical site and at least one of the units shall be submitted in a form suitable for simulation testing of components in a laboratory. The evaluation shall consist of the tests specified in 6.1.3.

6.1.3 Examinations and tests

Belt weighers shall comply with

- a) the metrological requirements in clause 3, particularly with reference to maximum permissible errors, when the instrument is operated in accordance with the manufacturer's specifications for range and product(s),
- b) all the technical requirements in clause 4, and
- c) the requirements in clause 5.

The submitted documents shall be examined and tests carried out to verify that the instruments comply with the above requirements. Tests shall be conducted in a manner that prevents unnecessary commitment of resources, and when the same instrument is involved the result of these tests may be assessed for initial verification.

The metrological characteristics of the instrument in accordance with 4.9 and if applicable the specifications for the modular approach of the modules of the instrument in accordance with 6.1.6 shall be examined.

For software-controlled instruments, the additional requirements in 5.8 and in R 50-2, Annex A shall apply.

6.1.3.1 In-situ product tests

In-situ product tests shall be conducted in accordance with 7.1.

The maximum permissible errors for automatic weighing shall be as specified in 3.2.1, Table 1, for initial verification, as appropriate for the class of the belt weigher.

6.1.3.2 Provision for means of testing

For the purposes of testing, the applicant may be required to furnish the metrological authority with the quantity of product, handling equipment, qualified personnel, and a control instrument (see 7.1).

6.1.3.3 Place of testing

Instruments submitted for type evaluation may be tested at the following locations:

- a) the premises of the metrological authority to which the application was submitted;
- b) any other suitable location mutually agreed upon between the metrological authority and the applicant.

6.1.4 Classes stated in the type approval certificate

The type approval certificate shall state the applicable accuracy classes 0.2, 0.5, 1 or 2, as specified, to which the approved type has been verified to comply during type evaluation.

6.1.5 Influence tests

Tests on the performance of the EUT when exposed to the influence factor tests specified in R 50-2, 7.2 shall be applied to the complete EUT or simulation as specified in 7.3 in a manner that will reveal a corruption of the weighing result of any weighing process for which the instrument could normally be applied, in accordance with

- a) 3.7 for all instruments, and
- b) 5 for electronic instruments.

6.1.6 Testing of a family of instruments or modules

Subject to agreement with the metrological authority, the manufacturer may define and submit a family of instruments or modules to be examined separately. This is particularly relevant in the following cases:

- a) where testing the instrument as a whole is difficult or impossible;
- b) where modules are manufactured and/or placed on the market as separate units to be incorporated in a complete instrument;
- c) where the applicant wants to have a variety of modules included in the approved type; and
- d) when a module is intended to be used for various kinds of instruments (in particular load sensors, indicators, data storage).

Where a family of instruments (2.3.14) or modules of various capacities and characteristics are presented for type examination, the following provisions apply for selecting the equipment under test (EUT).

6.1.6.1 Selection of EUTs

The selection of EUTs to be tested shall be such that their number is minimized but nevertheless sufficiently representative of the type. Further information is provided in R 50-2, Annex B.

6.1.6.2 Accuracy class

If an EUT of a family has been tested completely for one accuracy class, it is sufficient for an EUT of a lower class if only partial tests are carried out that are not yet covered.

6.1.6.3 Other metrological features to be considered

All metrologically relevant features and functions have to be tested at least once in the EUT as far as applicable and as many as possible in the same EUT. Further information is provided in R 50-2, Annex B.2.

6.1.6.4 Summary of relevant metrological characteristics

The characteristics of the EUT must include

- a) lowest input signal (when using analogue strain gauge load cells, see 6.1.6.5),
- b) all accuracy classes,
- c) all temperature ranges,
- d) single speed, variable or multiple speed belt weigher,
- e) maximum size of load receptor, if significant,
- f) displacement transducer,
- g) metrologically relevant features (see 6.1.6.3),
- h) all possible instrument functions,
- i) all possible indications,
- j) all possible implemented digital devices,
- k) all possible interfaces,
- l) weigh idlers,
- m) different types of load receptors, if connectable to the indicator, and
- n) different types of belt conveyors.

6.1.6.5 Minimum input voltage of electronics for maximum capacity

An analogue data processing device or indicator intended for analogue load cell(s) shall be tested at a minimum input voltage signal (specified by the manufacturer) for a load equal to maximum capacity. This is assumed to be the worst case for the performance tests and for the disturbance tests.

A complete instrument shall not be configured in such a way that its input voltage signal for a load equal to maximum capacity is below the value used at type testing.

6.1.6.6 Requirement for the minimum scale interval, v_{\min} , of the load cell(s) used

When analogue strain gauge load cells are used then the minimum scale interval, v_{\min} , of the load cell shall fulfil the following equation:

$$v_{\min} \leq \text{Max} / (S \times R / \sqrt{N})$$

Where

$S = 15\,000$ for class 0.2,

$S = 6\,000$ for class 0.5,

$S = 3\,000$ for class 1,

$S = 1\,500$ for class 2,

R is the reduction ratio of the load receptor,

N is the number of load cells.

When digital load cells are used, the above formula shall also be used, but since $p_i = 1$, the following S values shall be used:

$S = 10\,000$ for class 0.2;

$S = 4\,000$ for class 0.5;

$S = 2\,000$ for class 1;

$S = 1\,000$ for class 2.

6.1.6.7 Apportioning of errors

Where it is necessary to separately test modules of an instrument or system 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 (3.2.2, Table 2) or the allowed variations of the indication of the complete instrument. The fractions for any module have to be taken for the same accuracy class as for the complete instrument incorporating the module.

The fractions p_i shall satisfy the following equation:

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

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 purely 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 sensors) 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.

For mechanical structures evidently designed and manufactured according to sound engineering practice, an overall fraction, $p_i = 0.5$, may be applied without any test, e.g. when levers are made of the same material and when the chain of levers has two planes of symmetry (longitudinal and transversal).

For instruments incorporating the typical modules (see 3.2.10), the fractions p_i may have the values given in Table 4, which takes into account the fact that the modules are affected in a different manner depending on the different performance criteria.

Table 4 – Values of p_i for different performance criteria

Performance criteria	Load cell	Electronic indicator	Connecting elements, etc.
Combined effect ¹	0.7	0.5	0.5
Temperature effect on indication	0.7	0.5	0.5
Power supply variation	-	1	-
Effect of creep	1	-	-
Damp heat	0.7 ²	0.5	0.5
Span stability	-	1	-

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

Note 2: According to OIML R 60 [7] valid for SH tested load cells ($p_{LC} = 0.7$).

Note 3: The sign “-” means “not applicable”.

If the metrological characteristics of the load sensor or other major component have been evaluated in accordance with the requirements of OIML R 60 [7], that evaluation shall be used to aid type evaluation if so requested by the applicant.

6.2 Initial verification and in-service inspection

6.2.1 General requirements

Initial verification shall be carried out by the appropriate metrological authority to establish conformity of the instrument to the approved type and/or the requirements of this Recommendation.

Belt weighers shall comply with the requirements in clause 3, excluding 3.7.1, and clause 4 for a given product or products for which the belt weigher is intended and when operated under typical weighing conditions.

6.2.2 Tests

Tests are carried out by the appropriate metrological authority, in-situ, with the belt weigher fully assembled and fixed in the position in which it is intended to be used.

The installation of a belt weigher shall be designed so that an automatic weighing operation will be virtually the same for testing as it is for a transaction, and tests can be carried out in a reliable and easy manner without disrupting the weighing operation.

Tests shall be conducted in a manner that prevents an unnecessary commitment of resources.

In appropriate situations and to avoid duplicating tests previously performed on the belt weigher for type evaluation under 6.1.3, the metrological authority may use the results of observed tests for initial verification at that site.

6.2.2.1 In-situ product tests

In-situ product tests shall be conducted in accordance with 7.1 and R 50-2, 10.

Before testing, the conveyor shall operate (preferably loaded) for at least 30 minutes at nominal speed. A control instrument meeting the requirements of 7.2 shall be available at all times in the vicinity of the belt weigher(s) submitted for testing. Storage and transport shall be arranged so as to prevent any

loss of the product. Checking of the mass of the product used may take place before or after its passage over the belt weigher.

The maximum permissible errors for automatic weighing shall be as specified in 3.2.1, Table 1, as appropriate for the class of the belt weigher.

6.2.3 Assessment of conformity

Assessment of conformity to the approved type and this Recommendation shall cover

- a) compliance with the appropriate maximum permissible errors in 3.2.1, Table 1,
- b) compliance of the instrument with the technical requirements in clause 4,
- c) correct functioning of all devices, e.g. interlocks, indicating and recording devices, and
- d) construction material and design, as far as they are of metrological relevance.

6.2.4 Visual inspection

Before testing, the instrument shall be visually inspected for

- a) metrological characteristics, i.e. scale interval, minimum capacity,
- b) prescribed inscriptions and positions for verification and control marks, and
- c) visual conformity with the approved type as described in the approval certificate.

6.2.5 Marking and securing

According to national prescription, initial verification may be testified by verification marks as specified in 4.10. National prescription may also require securing of devices whose dismantling or maladjustment might alter the metrological characteristics of the instrument without the alterations being clearly visible. The provisions of 4.3 and 4.10 shall be observed.

6.2.6 Application of accuracy class

Accuracy class requirements shall be applied in accordance with the appropriate parts of 3.2.1 for initial verification.

The accuracy class marking required in accordance with 4.9 shall show the same accuracy class(es) as for which the type was approved and which was laid down in the approval certificate.

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 3.2.1 and 4.9. Marking of a higher accuracy class than was achieved at type approval stage is not permitted.

6.3 Subsequent metrological control

Subsequent metrological control may be performed according to national prescription.

Further information regarding durability testing as part of subsequent control is given in R 50-2, Annex C.

6.3.1 Subsequent verification

Subsequent verification shall be carried out in accordance with the same provisions as in 6.2 for initial verification with the error limits being those on initial verification. Marking and securing may take place according to 6.2.5, the date being that of the subsequent verification.

6.3.2 In-service inspection

In-service inspection shall be carried out in accordance with the same provisions as in 6.2 for initial verification, with the exception that the in-service maximum permissible errors in 3.2.1, Table 1 shall be applied. Marking and securing may remain unchanged, or renewed according to 6.3.1.

7 Test methods

7.1 General test procedure

In-situ product tests shall be done as follows:

- a) in accordance with the descriptive markings;
- b) under the conditions of use for which the belt weigher is intended;
- c) with a quantity of product not less than the minimum totalized load, Σ_{\min} , in 3.4, Table 3 for initial verification and in-service verification;
- d) with a test load(s) that is representative of the range and type of products for which the belt weigher is likely to be used or product(s) for which the instrument is intended;
- e) at flowrates between the maximum and minimum values;
- f) at each belt speed for conveyors with more than one fixed speed, or throughout the speed range for variable speed conveyors;
- g) in accordance with the test methods in clause 7 and the test procedures in R 50-2.

7.2 Verification standards

7.2.1 Control instruments and standard weights

A control instrument and standard weights meeting the appropriate requirements in clause 7 shall be available for determining the true quantity value of the mass of each test load.

The control instrument used for product testing shall enable the determination of the true quantity value of the mass of each test load to an accuracy of at least one-third of the appropriate MPE for automatic weighing in 3.2.1, Table 1.

If necessary, the control instrument shall be checked immediately following completion of the weighing to ascertain whether or not its performance has changed.

The standard weights used as reference for the type examination or verification of an instrument shall meet the metrological requirements of OIML R 111 [5].

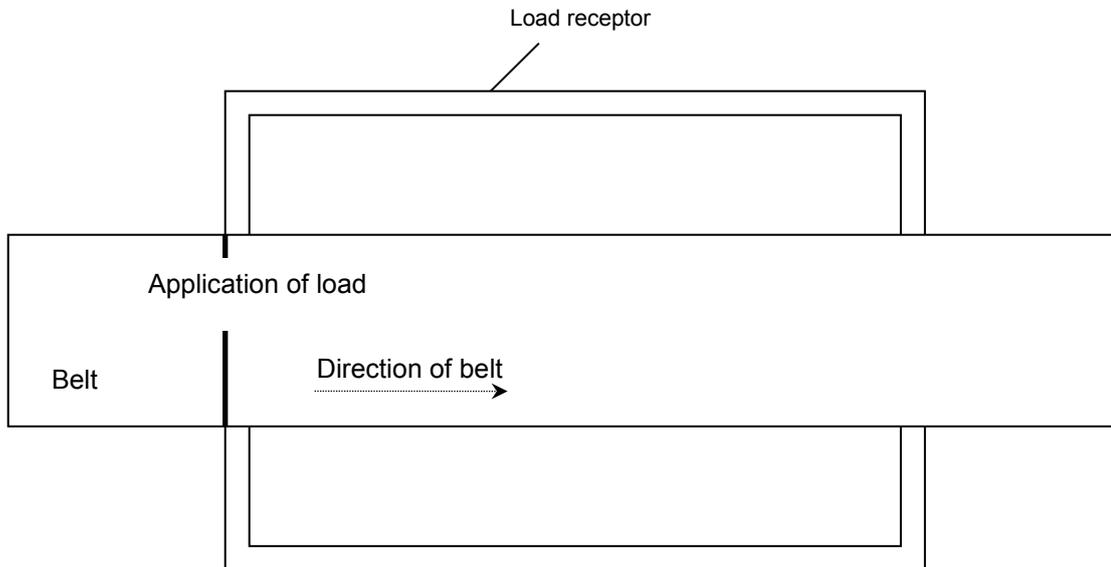
7.3 Simulation tests (test with static load without the belt conveyor)

For testing the metrological characteristics of a belt weigher without its conveyor, standard weights and a displacement simulating device (see 2.1.11) may be used to simulate the displacement of the belt. The EUT shall be fitted with

- a) a complete belt weigher without the belt conveyor,
- b) a representative load receptor (normally the complete weigh table),
- c) a platform (pan) for the standard weights,
- d) a device enabling the comparison of integrations with a constant load over equal complete belt revolutions predetermined by the operator and measured by the displacement transducer,
- e) a displacement simulation device.

The test load, which should be distributed along the load receptor in line with the direction of belt travel as shown in Figure 2, shall be placed at various points across the (simulated) belt width. The duration of each zero totalization shall be equal to the time to weigh the minimum totalized load at minimum flowrate.

Figure 2 – Distribution of the test load



7.4 True quantity value of the mass of the test load

- a) With the in-situ tests control method, the test load shall be weighed on a control instrument and the control instrument indication (after application of any corrections which may be necessary) shall be considered as the true quantity value of the mass of the test load.
- b) With the simulation tests, the true quantity value of the mass of the test load shall be the totalized weight calculated from the product of the static test load and the simulated displacement of the belt as indicated in the individual tests.

7.5 Indicated mass

- a) With the in-situ tests control method, a test load shall be weighed as an automatic bulk weighing operation and the indicated mass on the belt weigher shall be observed and recorded.
- b) With the simulation test, an automatic bulk weighing operation shall be conducted using standard weights distributed on the load receptor in line with the direction of belt travel. The indicated mass shall be observed and recorded, with (simulated) displacement of the belt respectively increased to five times that at totalization of Σ_{\min} . Alternatively, a supplementary totalization indicating device with a scale interval at least 10 times the totalization scale interval (4.4.3.3) may be used to indicate the mass of the test load.

Where possible, the procedures in R 50-2, 3.7 shall be used to eliminate rounding errors included in any digital indication.

7.6 Calculation of relative errors (R 50-2, 3.7)

The relative error, E_r , is given as:

$$E_r(\%) = \frac{I - L}{L} \times 100 = \frac{(\text{Result of measurement} - \text{True quantity value})}{\text{True quantity value}} \times 100$$

For the in-situ tests – control method:

$$E_r(\%) = \frac{(\text{Belt weigher indication} - \text{Control instrument indication})}{\text{Control instrument indication}} \times 100$$

For the simulation tests:

$$E_r(\%) = \frac{(\text{Totalized weight displayed} - \text{Totalized weight calculated})}{\text{Totalized weight calculated}} \times 100$$

The true quantity value is as specified in 7.4 and the indicated (or displayed) mass is as specified in 7.5.

The relative error value expressed as a percentage (%) shall be used for comparison with the appropriate MPEs for automatic weighing in 3.2.1.

7.7 Examination and tests

7.7.1 Examinations

A belt weigher shall be examined to obtain a general appraisal of its design and construction.

7.7.2 Performance tests

An instrument or electronic device, as appropriate, shall be tested as defined in R 50-2 to determine its correct operation. Tests shall be conducted on the whole instrument except when its size and/or configuration does not lend itself to testing as a unit. In such cases, the separate electronic devices shall be subjected to testing. It is not intended that electronic devices be further dismantled for separate testing of components.

In addition, an examination shall be carried out on the fully operational instrument or, if necessary for practical reasons, on the electronic devices in a simulated set-up that sufficiently represents the belt weigher. The instrument shall continue to function correctly as specified in R 50-2.

Modules may be examined separately (subject to agreement with the metrological authority, see 6.1.6).

Annex A

Bibliography

(Informative)

Below are references to publications of the International Electrotechnical Commission (IEC), the International Organization for Standardization (ISO) and the OIML, which are mentioned in this Recommendation.

Ref.	Standards and references	Description
[1]	International Vocabulary of Metrology - Basic and General Concepts and Associated Terms (VIM), Third Edition, 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, 2013	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.
[3]	OIML B 3:2011 OIML Basic Certificate System for OIML Type Evaluation of Measuring Instruments	Provides rules for issuing, registering and using OIML Certificates of conformity.
[4]	OIML D 11:2013 General requirements for measuring instruments - Environmental conditions	Contains general requirements for electronic measuring instruments.
[5]	OIML R 111:2004 Weights of classes E ₁ , E ₂ , F ₁ , F ₂ , M ₁ , M ₁₋₂ , M ₂ , M ₂₋₃ and M ₃	Provides the principal physical characteristics and metrological requirements for weights used with and for the verification of weighing instruments and weights of a lower class.
[6]	OIML D 28:2004 Conventional value of the result of weighing in air (Revision of OIML R 33)	Provides the definition of the quantity “conventional mass” (conventional value of the result of weighing in air) as it is used for the characterization of weights and its relation to the physical quantities mass and density and the evaluation of its uncertainty.
[7]	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.
[8]	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.
[9]	OIML D 19:1988 Pattern evaluation and pattern approval	Provides advice, procedures and influencing factors on pattern evaluation and pattern approval.
[10]	OIML D 20:1988 Initial and subsequent verification of measuring instruments and processes	Provides advice, procedures and influencing factors on the choice between alternative approaches to verification and the procedures to be followed in the course of verification.

Ref.	Standards and references	Description
[11]	IEC 60068-2-1 Ed. 6.0 (2007-03)	Basic environmental testing procedures - Part 2: Tests, Test Ad: Cold, for heat dissipating equipment under test (EUT), with gradual change of temperature.
[12]	IEC 60068-2-2 (2007-07). Environmental testing Part 2: Tests, Test B: Dry heat	Contains test Ba : dry heat for non-heat dissipating specimen with sudden change of temperature; test Bb dry heat for non-heat dissipating specimen with gradual change of temperature; tests Bc: dry heat for heat dissipating specimen with sudden change of temperature; test Bd dry heat for heat dissipating specimen with gradual change of temperature.
[13]	IEC 60068-3-1 (1974-01) + Supplement A (1978-01): Environmental testing Part 3 Background information, Section 1: Cold and dry heat tests	Gives background information for Tests A: Cold (IEC 68-2-1), and Tests B: Dry heat (IEC 68-2-2). Includes appendices on the effect of: chamber size on the surface temperature of a specimen when no forced air circulation is used; airflow on chamber conditions and on surface temperatures of test specimens; wire termination dimensions and material on surface temperature of a component; measurements of temperature, air velocity and emission coefficient. Supplement A - Gives additional information for cases where temperature stability is not achieved during the test.
[14]	IEC 60068-2-78 (2001-08) Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state (IEC 60068-2-78 replaces the following withdrawn standards: IEC 60068-2-3, test Ca and IEC 60068-2-56, test Cb)	Provides a test method for determining the suitability of electro-technical products, components or equipment for transportation, storage and use under conditions of high humidity. The test is primarily intended to permit the observation of the effect of high humidity at constant temperature without condensation on the specimen over a prescribed period. This test provides a number of preferred severities of high temperature, high humidity and test duration. The test can be applied to both heat-dissipating and non-heat dissipating specimens. The test is applicable to small equipment or components as well as large equipment having complex interconnections with test equipment external to the chamber, requiring a set-up time which prevents the use of preheating and the maintenance of specified conditions during the installation period.

Ref.	Standards and references	Description
[15]	IEC 60068-3-4 (2001-08) Environmental testing - Part 3-4: Supporting documentation and guidance - Damp heat tests	Provides the necessary information to assist in preparing relevant specifications, such as standards for components or equipment, in order to select appropriate tests and test severities for specific products and, in some cases, specific types of application. The object of damp heat tests is to determine the ability of products to withstand the stresses occurring in a high relative humidity environment, with or without condensation, and with special regard to variations of electrical and mechanical characteristics. Damp heat tests may also be utilized to check the resistance of a specimen to some forms of corrosion attack.
[16]	IEC 60654-2 (1979-01), with amendment 1 (1992-09). Operating conditions for industrial- process measurement and control equipment - Part 2: Power.	Gives the limiting values for power received by land-based and offshore industrial process measurement and control systems or parts of systems during operation.
[17]	IEC 61000-4-11 (2004-03) Electromagnetic compatibility (EMC). Part 4-11: Testing and measuring techniques - Voltage dips, short interruptions and voltage variations immunity tests	Defines the immunity test methods and range of preferred test levels for electrical and electronic equipment connected to low-voltage power supply networks for voltage dips, short interruptions, and voltage variations. This standard applies to electrical and electronic equipment having a rated input current not exceeding 16 A per phase, for connection to 50 Hz or 60 Hz AC networks. It does not apply to electrical and electronic equipment for connection to 400 Hz AC networks. Tests for these networks will be covered by future IEC standards. The object of this standard is to establish a common reference for evaluating the immunity of electrical and electronic equipment when subjected to voltage dips, short interruptions and voltage variations. It has the status of a Basic EMC Publication in accordance with IEC Guide 107.
[18]	IEC 61000-4-4 (2004-07) Electromagnetic compatibility (EMC). Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test.	Establishes a common and reproducible reference for evaluating the immunity of electrical and electronic equipment when subjected to electrical fast transient/burst on supply, signal, control and earth ports. The test method documented in this part of IEC 61000-4 describes a consistent method to assess the immunity of an equipment or system against a defined phenomenon. The standard defines: <ul style="list-style-type: none"> ▪ test voltage waveform; ▪ range of test levels; ▪ test equipment; ▪ verification procedures of test equipment; ▪ test set-up; and ▪ test procedure. The standard gives specifications for laboratory and post-installation tests.

Ref.	Standards and references	Description
[19]	IEC 61000-4-5 Ed. 2.0 (2008-12) Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test.	Relates to the immunity requirements, test methods, and range of recommended test levels for equipment to unidirectional surges caused by over-voltages from switching and lightning transients. Several test levels are defined which relate to different environment and installation conditions. These requirements are developed for and are applicable to electrical and electronic equipment. Establishes a common reference for evaluating the performance of equipment when subjected to high-energy disturbances on the power and inter-connection lines.
[20]	IEC 61000-4-2 Ed. 2.0 (2009) Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test.	Basic EMC Publication. Electromagnetic Compatibility (EMC) - Part 4: Testing and measurement techniques - Section 2: Electrostatic discharge immunity test. Basic EMC Publication.
[21]	IEC 61000-4-3 (2008-04) Ed. 3.1. Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test.	Electromagnetic Compatibility (EMC) - Part 4: Testing and measurement techniques - Section 3: Radiated, radio-frequency, electromagnetic field immunity test.
[22]	IEC 61000-4-6(2008-10) Ed. 3.0. Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields.	Relates to the conducted immunity requirements of electrical and electronic equipment to electromagnetic disturbances coming from intended radio-frequency (RF) transmitters in the frequency range 9 kHz up to 80 MHz. Equipment not having at least one conducting cable (such as mains supply, signal line or earth connection), which can couple the equipment to the disturbing RF fields is excluded. This standard does not intend to specify the tests to be applied to particular apparatus or systems. Its main aim is to give a general basic reference to all concerned product committees of the IEC. The product committees (or users and manufacturers of equipment) remain responsible for the appropriate choice of the test and the severity level to be applied to their equipment.
[23]	OIML D 31 General requirements for software controlled measuring instruments	Contains general requirements for software controlled measuring instruments.
[24]	OIML R 50-3:2014 Continuous totalizing automatic weighing instruments (belt weighers). Part 3: Test report format	Test report format.
[25]	ILAC-G24/OIML D 10 (2007) Guidelines for the determination of calibration intervals of measuring instruments	

Ref.	Standards and references	Description
[26]	IEC 60068-2-30 (1980-01) with amendment 1 (1985-08) Environmental testing Part 2: Tests Test Db and guidance: Damp heat, cyclic(12 + 12-hour cycle)	Determines the suitability of components, equipment and other articles for use and/or storage under conditions of high humidity when combined with cyclic temperature changes. Amendment 1 replaces the third paragraph of clause 8, Recovery.