INTERNATIONAL RECOMMENDATION

OIML R 150-1

Edition 2020 (E)

Continuous totalizing automatic weighing instruments of the arched chute type

Part 1: Metrological and technical requirements

Instruments de pesage automatiques totalisateurs continus à goulotte cintrée

Partie 1: Exigences métrologiques et techniques

ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE

INTERNATIONAL ORGANIZATION OF LEGAL METROLOGY

Contents

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Continuous totalising automatic weighing instruments of the arched chute type

Part 1 – Metrological and technical requirements

1 General

1.1 Scope

This International Recommendation specifies the metrological and technical requirements for arched chute weighers, that are subject to national metrological control.

2 Terminology (terms and definitions)

The terminology used in this Recommendation conforms to OIML V 2-200:2012 *International Vocabulary of Basic and General Terms in Metrology* (VIM) [1], OIML V 1:2013 *International Vocabulary of Legal Metrology* (VIML) [2], OIML D 11:2013 *General requirements for measuring instruments - Environmental conditions* [3] and to OIML D 31:2019 *General requirements for software controlled measuring instruments* [4]. 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 111:2004 *Weights of classes E_1, E_2, F_1, F_2, M_1, M_{1-2}, M_2, M_{2-3} and M_3* [5] and OIML D 28:2004 *Conventional value of the result of weighing in air* [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 follows a predetermined program of automatic processes characteristic of the instrument

2.1.3 continuous totalising automatic weighing instrument

automatic weighing instrument for continuously totalising the weight of the particles of a bulk product

2.1.4 arched chute type totalising weighing instrument

weigher designed such that it causes a vertical flow of bulk product to effect a centripetal force proportionally to the mass of the product passing along the circular arched surface of the force receptor (2.2.1)

Note 1: Not all chute weighers meet the definition stated in this Recommendation.

Note 2: Arched chute weighers are designed such that a vertical flow of bulk product uses the action of gravity to effect a centripetal force proportional to the mass of the product.

Note 3: The force receptor of an arched chute weigher is equipped with a circular arched surface.

Note 4: Arched chute weighers that measure horizontal flows, using only centripetal force, are not covered by the definition of a weighing instrument in 2.1.1 and therefore are not covered by this Recommendation.

2.1.5 true quantity value

quantity value consistent with the definition of a quantity

[VIM:2012, 2.11] [1]

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

attribute of any device, instrument, function or software that may influence the measurement result or any other primary indication

[VIML:2013, 4.03] [2]

2.1.8 legally relevant part

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

[VIML:2013, 4.08] [2]

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

[VIML:2013, 6.05] [2]

2.1.10 control instrument

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

[VIML:2013, 5.08] [2]

2.1.11 load, *L*

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

2.1.12 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

[VIML:2013, 6.05] [2]

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 realisation, 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 force receptor

part of the arched chute weigher intended to sense the force induced by the mass flow

2.2.1.1 arched chute

part of the force receptor intended to bend and orient the mass flow

2.2.1.2 force simulation platform

platform designed to be loaded with standard weights for the purpose of simulating a force on the force receptor

2.2.2 conveyor

equipment for transporting the product to and from the chute weigher, (e.g. a conveyor belt, auger (screw type conveyor) or other product feed mechanism)

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 11:2013, 3.1] [3]

2.2.4 digital device

device that provides a digitised output or display

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

2.2.5 totalisation device

device that uses information supplied by the force receptor to integrate over time the mass of the product passing along the force receptor

2.2.6 zero-setting device

device enabling the indication to be set to zero in the absence of any mass passing along the force receptor

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 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

2.2.7 printing device

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

2.2.8 module

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

[VIML:2013, 4.04] [2]

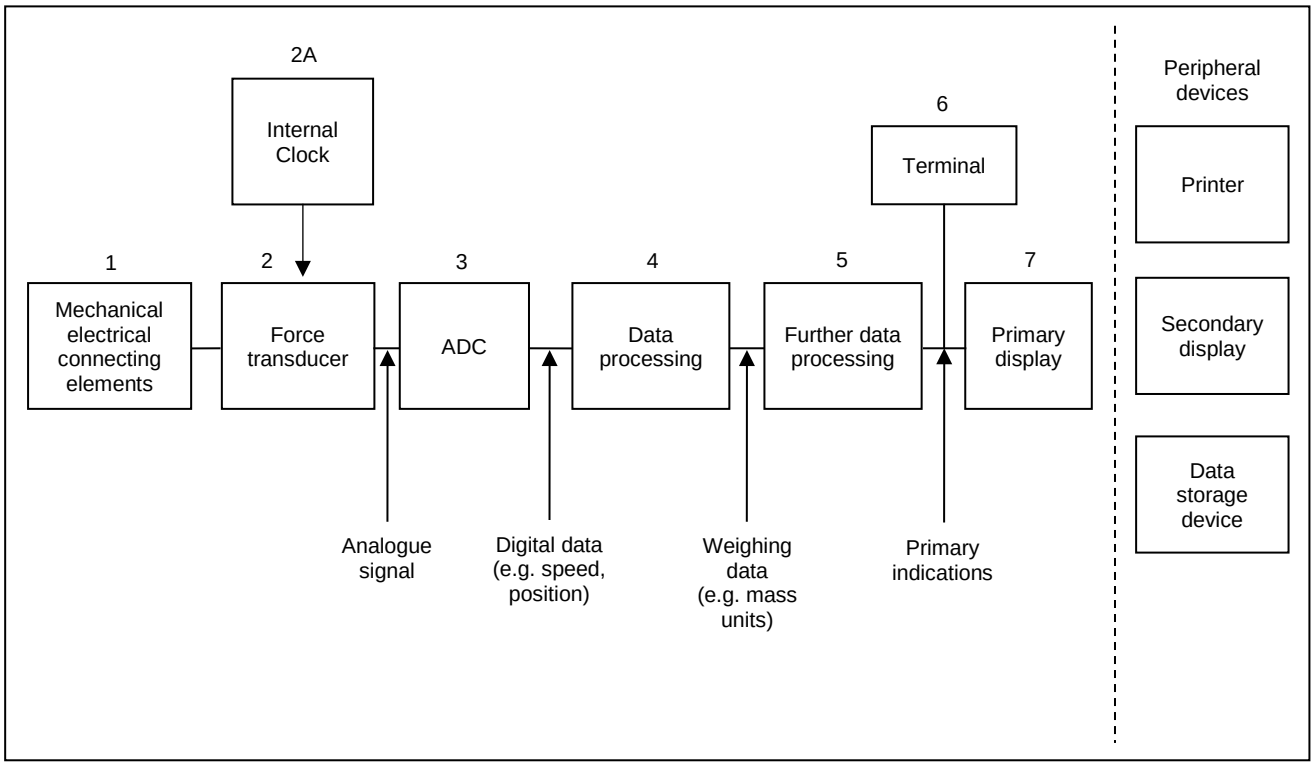
Note 1: The modules of a weighing instrument may be subject to specified partial error limits.

Note 2: Modules may be examined separately (subject to agreement with the metrological authority (see 6.2.6).

Note 3: Typical modules of an automatic weighing instrument are: load cell (force receptor), indicator, analogue or digital processors, weighing module, remote display, software.

Figure 1 – Definition of typical modules according to 2.2.8 and 6.2.6

(other combinations are possible)



Force transducer	(2.2.8.1)	2 + (3) + (4)*
Internal clock	(2.2.8.2)	2A
Analogue data processing device	(2.2.8.3)	3 + 4 + (5) + (6)
Digital data processing device	(2.2.8.4)	(4) + 5 + (6)
Indicator	(2.2.8.5)	(3) + 4 + (5) + (6) + 7
Weighing module	(2.2.8.6)	1 + 2 + 3 + 4 + (5) + (6)
Primary display	(2.2.8.7.1)	7
Terminal	(2.2.8.8)	(5) + 6 + 7

* Numbers in brackets indicate options

2.2.8.1 force transducer

part of the force receptor, that converts the measured induced force into a different measurement quantity (output)

2.2.8.2 internal clock

electronic device that keeps time and is used for the calculation of the measurement result

2.2.8.3 analogue data processing device (ADC)

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

2.2.8.4 digital data processing device

electronic device that processes digital data

2.2.8.5 indicator

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

2.2.8.6 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

2.2.8.7 digital display

output device visualising 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).

2.2.8.7.1 primary display

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

2.2.8.7.2 secondary display

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

2.2.8.8 terminal

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

2.2.9 software

2.2.9.1 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] [4]

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

2.2.9.2 legally relevant parameter

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

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

[VIML:2013, 4.10] [2]

2.2.9.3 type-specific parameter

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

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

[VIML:2013, 4.11] [2]

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

2.2.9.4 device-specific parameter

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

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.).

[VIML:2013, 4.12] [2]

2.2.9.5 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

[VIML:2013, 6.01] [2]

2.2.9.6 software separation

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

Note: These parts communicate via a software interface.

[VIML:2013, 6.02] [2]

2.2.10 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)

2.2.11 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] [4]

2.2.11.1 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:2013, 6.08] [2]

2.2.11.2 protective interface

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

2.2.12 infeed device

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

2.2.13 mass flow rate device

device which regulates the rate of infeed mass flow

2.3 Metrological characteristics

2.3.1 Scale intervals

2.3.1.1 totalisation 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 totalisation 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 totalisation scale interval, *d*, if the special mode is not available

2.3.2 discrimination

ability of an instrument to react to small variations of load

2.3.3 maximum capacity, Max

maximum force that the force receptor is intended to measure

2.3.4 minimum capacity, Min

minimum force that the force receptor is intended to measure

2.3.5 mass flowrate, Qm

mass of a product which passes per unit of time

2.3.5.1 maximum mass flowrate, $Q\mathrm{m}_{\mathrm{max}}$

mass flowrate obtained at the maximum capacity of the force receptor

2.3.5.2 minimum mass flowrate, $Q\mathrm{m}_{\mathrm{min}}$

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

2.3.5.3 infeed mass flowrate

mass flowrate of product from a preceding feeding device onto the force receptor

2.3.6 minimum totalised quantity, Σ_{min}

totalised quantity, in units of mass, below which totalised values may be subject to errors exceeding the applicable maximum permissible errors (mpe)

2.3.7 control value

value, in units of mass, that is indicated by the totalisation indicating device when a known additional force has been actually or by simulation introduced on the (empty) force receptor

2.3.8 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

2.3.9 measurement repeatability

measurement precision under a set of repeatability conditions of measurement

[VIM, 2.21] [1]

2.3.10 durability

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

[VIML:2013, 5.15] [2]

2.3.11 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 force receptor and force transmitting device) but which may differ in some metrological and technical performance characteristics (e.g. Max, Min, *d*, accuracy class, etc.)

[Adapted from VIML:2013, 4.02 – examples added] [2]

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

2.3.12 weighing segment length

length of the weighing part of the arched chute

2.4 Indications and errors

2.4.1 indication of a measuring instrument

quantity value provided by a measuring instrument or measuring system

[VIML:2013, 0.03] [2]

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

2.4.1.1 primary indications

totalised quantity, 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 force indicating device

device that indicates the actual force at a given time effected on the force receptor expressed as its quantity value or as a percentage of the maximum capacity, Max, or alternatively as a quantity converted to mass values

2.4.2.2 mass 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 mass flowrate

2.4.2.3 totalisation indicating device

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

2.4.2.4 general totalisation indicating device

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

2.4.2.5 partial totalisation indicating device

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

2.4.2.6 supplementary totalisation indicating device

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

2.4.3 printout

hard copy of the measurement results produced by a printer

2.4.4 reading by simple juxtaposition

reading of the weighing result by simple juxtaposition of consecutive figures giving the result, without the need of 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:2013, 0.04] [2]

2.4.5.1 intrinsic error

error of a measuring instrument determined under reference conditions

[VIML:2013, 0.06] [2]

2.4.5.2 initial intrinsic error

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

[VIML:2013, 5.11] [2]

2.4.5.3 fault

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

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

Note 2 From the definition it follows that a “fault” is a numerical value which is expressed either in a unit of measurement or as a relative value, for instance as a percentage.

[VIML:2013, 5.12] [2]

2.4.5.4 fault limit

value specified (in this Recommendation) delimiting non-significant faults

[VIML:2013, 5.13] [2]

2.4.5.5 significant fault

fault exceeding the applicable fault limit value

Note: A significant fault does not include

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

[Adapted from VIML:2013, 5.14 – note modified] [2]

2.4.5.6 maximum permissible error (mpe)

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

[VIML:2013, 0.05] [2]

2.4.5.7 durability error

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

[VIML:2013, 5.16] [2]

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 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 which ranges within the specified rated operating conditions of the measuring instrument

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

[Adapted from VIML:2013, 5.18 – part of note omitted] [2]

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

[VIML:2013, 5.19] [2]

2.5.2 rated operating condition

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

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

[VIML:2013, 0.08] [2]

2.5.3 reference condition

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

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

[Adapted from VIML:2013, 0.09 – part of note omitted] [2]

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

[VIML:2013, 5.21] [2]

2.6.3 durability test

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

[VIML:2013, 5.22] [2]

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	nth indication
L	load
Σ_{min}	minimum totalised quantity
Qm	mass flowrate
$Q\text{m}_{max}$	maximum mass flowrate
$Q\text{m}_{min}$	minimum mass flowrate
ΔL	additional load to next changeover point
P	indication prior to rounding (digital indication)
E_r	relative error
E%	relative error in percentage
E_0	error at zero load
d	totalisation scale interval
mpe	maximum permissible error
DC	direct current
AC	alternating current
p_i	fraction of the MPE applicable to a module of the instrument which is examined separately
emf	electromotive force
I/O	input/output
RF	radio frequency
EUT	equipment under test
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
T_{min}	minimum totalising time

2.8 Basic relationships

2.8.1 indication prior to rounding (digital indication)

$$P = I + 1/2\ e - \Delta L$$

2.8.2 relative error

$$E_r = (I - L) / L \text{ or } (P - L) / L$$

2.8.3 relative error prior to rounding

$$E_p = \frac{(P - L)}{L}$$

2.8.4 relative error in percentage

$$E_r\% = 100 \times E$$

3 Metrological requirements

3.1 Accuracy classes

For an arched chute weigher, one of the following four accuracy classes applies:

0.2 0.5 1 2

3.2 Maximum permissible errors

3.2.1 Applicability

Maximum permissible errors apply to totalised quantities equal to or greater than the minimum totalised quantity, Σ_{min}.

3.2.2 Maximum permissible errors during automatic weighing

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

Table 1 – Maximum permissible errors for automatic weighing

Class	Percentage of the mass of the totalised quantity 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

3.2.3 Maximum permissible errors for influence factor tests

Maximum permissible errors for influence factor tests shall not exceed the values in Table 2 rounded to nearest totalisation scale interval, *d*.

Table 2 – Maximum permissible errors for influence factor tests

Class	Percentage of the mass of the totalised quantity
0.2	0.07
0.5	0.175
1	0.35
2	0.70

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 Lower limit for minimum totalised quantity, Σ_{min}

The minimum totalised quantity shall be not less than the largest of the following values:

a) 2 % of the totalised quantity during one hour at maximum mass flowrate;

b) the quantity corresponding to the appropriate number of totalisation scale intervals in Table 3.

Table 3 – Minimum value of the minimum totalised quantity, Σ_{min}

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

For example:

Accuracy class	Σ_{min} shall not be less than the larger value of either:
0.2	$0.02 \times Qm_{max}$ or $2\,000 \times d$
0.5	$0.02 \times Qm_{max}$ or $800 \times d$
1	$0.02 \times Qm_{max}$ or $400 \times d$
2	$0.02 \times Qm_{max}$ or $200 \times d$

Accuracy class = 0.5

Qm_{max} = 2 000 kg/h

d = 0.2 kg

To comply with 3.4 a): $\Sigma_{min} \geq 0.02 \times 2\,000$ kg = 40 kg, and

To comply with 3.4 b): $\Sigma_{min} \geq 800 \times d = 800 \times 0.2$ kg = 160 kg

Therefore, in this example, the value of minimum totalised quantity, Σ_{min} is 160 kg

3.5 Minimum mass flowrate, Qm_{min}

The weighing results shall comply with the requirements of this Recommendation at or above the minimum mass flowrate.

3.6 Units of measurement

The units of measurement applicable for weighing are those that concern mass and mass per unit of time expressed as mass flowrate.

The units to be used

a) for mass are: gram (g), kilogram (kg) and tonne (t),

b) for mass flowrate are: gram per hour (g/h), kilogram per hour (kg/h), tonne per hour (t/h).

3.7 Further metrological requirements

3.7.1 Variation in infeed mass flowrate (R 150-2, 5.4)

A variation of ±10 % in the infeed mass flowrate shall not cause the errors to exceed the maximum permissible error (3.2.3, Table 2).

3.7.2 Eccentric infeed (R 150-2, 5.5)

Eccentric product flow shall not lead to a totalisation error exceeding the maximum permissible error (as specified in 3.2.3, Table 2).

Note: Eccentric product flow may result from:

- non-uniform or eccentric distribution of product mass flowing from the product infeed;
- misaligned product flow, i.e. misalignment between the product infeed and the arched chute.

3.7.3 Influence quantities

3.7.3.1 Temperature

The arched chute weigher shall comply with the appropriate metrological and technical requirements at ambient temperatures from –10 °C to +40 °C unless special temperature limits are specified in the descriptive markings of the instrument (in a form such as "–25 °C / +55 °C").

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

The ambient temperature limits of the arched chute weigher shall be selected to be appropriate for the local environmental conditions of its use (this may be subject to national regulation).

3.7.3.2 Temperature effect at zero mass flowrate

The effect of ambient temperature on totalisations at zero mass flowrate shall not vary by more than

a) class 0.2: 0.007 %
b) class 0.5: 0.017 5 %
c) class 1: 0.035 %
d) class 2: 0.07 %

per 5 °C of a quantity totalised at the maximum mass flowrate for the duration of the totalisation.

3.7.3.3 Voltage variation

The arched chute weigher 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 $0.85 \times U_{nom}$ or $0.85 \times U_{min}$, upper limit is $1.10 \times U_{nom}$ or $1.10 \times U_{max}$,

b) DC mains voltage:

   Lower limit is minimum operating voltage ($0.85 \times U_{min}$), upper limit is $1.20 \times U_{nom}$ or $1.20 \times U_{max}$,

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 instruments and instruments with an external or plug-in power supply device (AC or DC) shall either continue to function correctly or not indicate any weight (load) values if the voltage is below the manufacturer's specified value, the latter being larger than or equal to the minimum operating voltage.

3.7.3.4 Fault limit value

For arched chute weighers the non-significant fault limiting value is the absolute value of the appropriate maximum permissible error for a totalised quantity of mass equal to the minimum totalised quantity, Σ_{min}, for the designated class of the weigher.

3.7.4 Metrological characteristics

3.7.4.1 Repeatability (R 150-2, 8.1)

The difference between any two results obtained for the same force applied under the same conditions to the force receptor shall not result in exceeding the absolute value of the maximum permissible errors (as specified in 3.2.3, Table 2).

3.7.4.2 Discrimination of the totalisation indicating device (R 150-2, 8.2)

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

3.7.4.3 Discrimination of the totalisation indicating device used for zero totalisation (R 150-2, 8.3)

When, for a duration of three minutes, a force equal to the following percentages of the maximum capacity:

a) class 0.2: 0.02 %,

b) class 0.5: 0.05 %,

c) class 1: 0.1 %,

d) class 2: 0.2 %,

is either introduced onto or released from the force receptor, there shall be a visible difference in indication between no force and the situation where a force is applied.

3.7.4.4 Stability of zero (R 150-2, 8.4)

3.7.4.4.1 Short term stability of zero

For an unloaded arched chute weigher the difference between zero indications over a period of 15 minutes of operation simulated at maximum mass flowrate, Qm_{max} shall not exceed the following percentages of the quantity totalised in 1 hour at the maximum mass flowrate:

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 %.

3.7.4.4.2 Long-term stability of zero

For an unloaded arched chute weigher the difference between zero indications over a period of 3.5 hours of operation simulated at maximum mass flowrate, Qm_{max} shall not exceed the following percentages of the quantity totalised in 1 hour at maximum mass flowrate:

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 150-2, 9)

3.8.1 Repeatability (R 150-2, 9.1.1)

The difference between the relative errors for several results obtained at practically identical mass 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 3.2.2.

3.8.2 Zero-setting

Following any zero-setting within the range of the zero-setting device, the totalisation error shall not exceed the maximum permissible errors (3.2.3, Table 2).

3.9 Durability

The durability error shall not be greater than the absolute value of the maximum permissible error for automatic weighing (3.2.2, Table 1).

4 Technical requirements

4.1 Suitability for use

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

4.2 Security of operation

4.2.1 Accidental breakdown and maladjustment

An arched chute weigher shall be constructed and installed such that an accidental breakdown or maladjustment likely to disturb its correct functioning can normally not take place without the effect being evident.

Adjustable components that potentially can disturb the metrological performance of arched chute weighers shall be held securely and the position of the component shall be accurately and permanently defined.

4.2.2 Adjustments during operation

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

It shall not be possible to reset legally relevant indicating devices unless the mass flowrate is zero.

It shall not be possible to make adjustments which may affect the measurement result unless the mass flowrate is zero.

4.2.3 Fraudulent use

An arched chute weigher shall not have characteristics likely to facilitate its fraudulent use.

4.2.4 Operating devices

The design of the operating devices of an arched chute weigher shall ensure that the instrument cannot normally come to rest in a position other than that intended, without automatic disablement of all indications and printing procedures.

4.2.5 Conveyor interlock

If an arched chute weigher is switched off or ceases to function, the product flow shall stop, or a visible or audible signal shall be given.

4.2.6 Out-of-range warning or alarm

An arched chute weigher 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 totalised value on the applicable partial or general totalised printout, or on any supplementary recording devices (mass flowrate chart recorder, etc.) if

a) the instantaneous force is above the maximum capacity of the weighing module,

b) the mass flowrate is above the maximum or below the minimum value,

c) a breakdown, maladjustment or fault has been detected (4.2.1), or

d) the mpe on checking of zero (3.8.2) has been exceeded (4.4.2).

Note: The indication is intended as a warning indication and its operation shall be obvious (e.g. an obvious continuously beeping sound 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.

4.2.7 Securing and sealing of components and preset controls (R 150-2, 6.3)

4.2.7.1 General

Components, interfaces and preset 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 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.

4.2.7.2 Securing and sealing measures

Securing and sealing measures on an arched chute weigher shall ensure that

a) access to functions liable to affect any 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 5.6.2, and

d) measurement data held on storage devices is secured against intentional, unintentional and accidental changes in accordance with the requirements of 5.7.

4.2.7.3 Components and preset controls

Means of securing and sealing components and preset 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 memorise 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 authorised 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 legislation (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 record provided that the owner of the data has given permission to overwrite the records;

c) The sealing measures provided shall be easily accessible.

4.3 Totalisation indicating and printing devices (R 150-2, 6.4)

4.3.1 General

An arched chute weigher shall be equipped with a general totalisation indicating device and may additionally be equipped with partial totalisation indicating devices. Where a totalisation is presented or indicated which is for indicative purposes only, this presentation shall be marked as such and not be applied for any transaction purposes.

4.3.2 Quality of indication

Totalisation indicating and printing devices shall allow reliable, simple, and non-ambiguous reading of the primary indications (see 2.4.1.1) under rated operating conditions (see 2.5.2):

a) 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;

b) The scales, numbering and printing shall permit the figures which form the results to be read by simple juxtaposition (see 2.4.4).

4.3.3 Format of the indication

4.3.3.1 Units 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 only in the case as defined for SI units (lower case letters for the unit symbols “g” and “t” as well for the prefix “k”), as shown in 3.6.

4.3.3.2 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 such that in the values indicated no more than one non-significant zero to the right is presented. For values with a decimal sign, a non-significant zero is allowed only as the third digit to the right of the decimal sign.

A decimal fraction shall be separated from its integer by a decimal sign according to national legislation or convention (i.e. a comma or a 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

4.3.4 Scale interval

4.3.4.1 General

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.

4.3.4.2 Scale interval of a partial totalisation indicating device

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

4.3.5 Range of the indication

At least one totalisation indicating device on an arched chute weigher shall be capable of indicating a value that is at least equal to the quantity of mass of the product totalised during 10 hours of operation at maximum mass flowrate.

Wider indication ranges may be required for installations where larger quantities of product mass are anticipated.

4.3.6 Totalisation indicating devices

a) It shall not be possible to reset the general totalisation indicating device to zero.

b) It shall not be possible to reset the partial totalisation 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 totalisation 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.

4.3.7 Engagement of totalisation indicating devices

a) Totalisation indicating and printing devices (when printing devices are present) shall remain engaged at all times.

b) A means designed to disengage any totalisation indicating and printing devices shall only come into operation when all product feed has stopped.

4.3.8 Printing device

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

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 the column in which the applicable values are presented.

4.3.9 Scale interval of a supplementary totalisation indicating device

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

Any supplementary totalisation devices cannot be used for legal measurements.

4.4 Zero-setting device (R 150-2, 5.6)

4.4.1 General

Any deviation from zero indication during no load condition shall be compensated or corrected for by a zero-setting device of a type appropriate to the principle of operation of the arched chute weigher. The range of zero-setting shall not be more than 4 % of the maximum capacity.

4.4.2 Semi-automatic and automatic zero-setting devices

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

a) the end of the zero-setting operation is indicated,

b) the zero-setting range shall not exceed 4 % of the maximum capacity, Max, and

c) 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 4.2.6).

For testing purposes, it shall be possible to disengage automatic zero-setting devices. Arched chute weighers may include an automatic zero-setting device with an interlock to prevent zero-setting when a mass is fed onto the force receptor.

4.5 Arched chute

4.5.1 Arched chute properties

4.5.1.1 Weighing segment length

The arched chute shall be installed in such a way that the length of the weighing segment and the geometrical alignment remain unchanged while in service.

4.5.1.2 Arched chute shape

The arched chute shall normally be installed in a fixed position.

If the slope angle of the force receptor (normally perpendicular to the mass flow) can change, either

a) the arched chute weigher shall be fitted with a device to compensate the effect of the change, or

b) the arched chute weigher shall not operate, delivery shall not be possible, and totalisation shall be disabled during the period of time that the slope angle of the force receptor is in transition or when the limits to the slope angle set by the manufacturer are exceeded.

4.5.1.3 Arched chute surface

The arched chute surface shall suit the correct weighing of the applicable bulk product. Different bulk products may require different arched chute surfaces. In this case, specific documentation shall accompany each arched chute providing information on the ranges of bulk products for which the arched chute is designed.

4.5.2 Arched chute environmental conditions – draught (air flow) prevention

Adequate measures shall be taken to prevent any disturbance of the flow of the bulk product caused by draughts which may potentially influence the measuring result.

4.5.3 Internal clock

The internal clock shall keep track of the time and is used for the calculation of the measurement result. The following requirements apply:

a) The accuracy of the clock shall be determined in accordance with 6.2.6.8;

b) Time correction shall be secured in accordance with 4.2.7;

c) In the event of a power supply interruption, the internal clock shall continue to function correctly, in accordance with 5.5.5 and 5.5.6.

4.6 Required descriptive markings

4.6.1 Identification markings

Arched chute weighers shall bear the following identification markings:

a) identification mark of the manufacturer;

b) serial number and type designation of the instrument;

c) identification mark on each part of an instrument consisting of separate but associated units;

d) type approval mark.

4.6.2 Marking of specifications

Arched chute weighers shall be marked with the following specifications:

a)	mains power voltage		 V
b)	mains power frequency		..... Hz (if applicable)
c)	designation of type(s) of product to be weighed		
d)	density of the product in kg/L or t/m^3		
e)	particle size of the product in mm or in µm diameter		
f)	maximum capacity	Max	..... N
g)	temperature range (if applicable, see 3.7.3.1)		..... °C / ..... °C
h)	accuracy class		= 0.2, 0.5, 1 or 2
i)	totalisation scale interval	d	= ..... g, kg or t
j)	maximum mass flowrate	$Q\mathrm{m}_{max}$	= ..... g/h, kg/h or t/h
k)	minimum mass flowrate	$Q\mathrm{m}_{min}$	= ..... g/h, kg/h or t/h
l)	minimum totalised quantity	Σ_{min}	= ..... g, kg or t
m)	pneumatic/hydraulic pressure (if applicable)		
n)	designation of the acceptable moisture and temperature range for each product to be weighed		
o)	minimum totalising time	T_{min}	= .....

4.6.3 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.

4.6.4 Presentation of descriptive markings

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

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

The markings shall be grouped together at a visible place on the instrument, either

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

In the case of a plate or sticker which will not be destructed in case it is removed, a means of securing shall be provided (e.g. a non-removable control mark or a means for sealing the plate bearing the markings).

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

a) at least Max, $Q\mathrm{m}_{\mathrm{max}}$, $Q\mathrm{m}_{\mathrm{min}}$, Σ_{min} and d shall be displayed when the arched chute weigher is in switched on mode,

b) other markings will be displayed on manual command,

c) the user manual provides information on the manner in which the specifications can be observed, and

d) the markings are considered as device-specific parameters (see 2.2.9.4) and shall comply with the appropriate requirements for securing in 4.2.7 and 5.8.

The software controlled display markings need not be repeated on the hardware plate, if they are displayed 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:

a) Max, $Q\mathrm{m}_{\mathrm{max}}$, $Q\mathrm{m}_{\mathrm{min}}$, Σ_{min} and d;
b) type approval mark (in accordance with national requirements);
c) name or identification mark of the manufacturer;
d) voltage supply;
e) voltage supply frequency (if applicable);
f) pneumatic/hydraulic pressure (if applicable).

4.7 Verification markings

4.7.1 Position

The hardware exterior of instruments shall comprise an area for applying the verification markings. This area shall

a) be such that the part on which it is located cannot be removed from the instrument without damaging the marks,

b) allow the easy applying of the mark without changing the metrological qualities of the instrument,

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

4.7.2 Mounting

Instruments which are required to bear verification markings shall have a verification mark support, at the location as described in 4.7.1, which shall ensure the conservation of the marks. When such marking is performed using a stamp, the support may consist of an item which is inserted into a plate fixed to the instrument, or into a cavity in the instrument. When the mark consists of an adhesive printed label, a space shall be prepared for this purpose.

5 Requirements for arched chute weighers with respect to their environment

5.1 General requirements

5.1.1 Performance under rated operating conditions

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

5.1.2 Disturbances

Arched chute weighers containing electronics shall be designed and manufactured such that when exposed to disturbances, either

a) significant faults do not occur, or

b) significant faults are detected and acted upon.

5.1.3 Durability

The requirements in 3, 4, and 5.1.2 shall be met durably in accordance with the intended use of the instrument.

5.1.4 Evaluation for compliance

The instrument is presumed to comply with the requirements in 5 if an identical type passes the examinations and tests specified in R 150-2.

5.2 Application

The requirements in 5.1.2 may be applied separately to

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

b) each part of the instrument.

The choice as to whether to apply 5.1.2 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 totalised mass information contained in the instrument when a significant fault occurs.

5.4 Display failure detection

Upon switch-on (at switch-on of indication in the case of an electronic instrument permanently connected to the mains), a special sequence procedure shall be performed subsequently presenting all the relevant individual segments and signs in the display of the indicating devices, in their active and non-active states for a time period sufficient for the operator to easily observe. This requirement is not applicable for non-segmented displays, on which failures will 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 3.7.3.

5.5.2 Disturbances

Instruments shall comply with the requirements in 5.1.2.

5.5.3 Humidity

In addition to 3.7.3, instruments shall maintain their metrological and technical characteristics at a relative humidity of either 85 % (non-condensing) or at 93 % (condensing) at the upper limit of the temperature range of the instrument.

5.5.4 Warm-up time

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.

5.5.5 Mains electrical power supply failure

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

5.5.6 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 it at the time of failure for at least 24 hours, and shall be capable of indicating that information at least for five minutes after power supply recovery during that 24-hour period.

5.6 Interfaces

5.6.1 General

Instruments may be equipped with interfaces (2.2.11) 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:

a) list of all commands (e.g. menu items);

b) description of the software interface;

c) list of all commands together;

d) brief description of their meaning and their effect on the functions and data of the instrument;

e) other interface description.

5.6.2 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 is protected e.g. with a protective interface (2.2.11.2), against accidental or intentional intervention;

b) hardware and software functions shall comply with the appropriate requirements for securing in 4.2.7 and 5.8;

c) it shall be easily possible to verify the authenticity and integrity of data transmitted to and from the instrument;

d) other devices required by national regulations to be connected to the interfaces of the instrument shall be secured to inhibit automatically the operation of the instrument for reasons of the non-presence or improper functioning of the required device.

5.7 Data storage device

5.7.1 General

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, totalising, 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.

5.7.2 Securing measures

To ensure adequate security the following conditions apply:

a) the appropriate requirements of 4.2.7 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 the storage capacity is exhausted, new data may replace the oldest data provided that the old data has been archived and/or overwriting has been authorised;

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

5.8.1 General

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 150-2, A.2. Information on software controlled instruments shall be available, for example:

a) description of the legally relevant software;

b) description of the accuracy of the measuring algorithms;

c) description of the user interface, menus and dialogues;

d) the unambiguous software identification;

e) description of the embedded software;

f) 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;

g) means of securing software;

h) 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 mass flow is stopped).

5.8.2 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 4.2.7 and 5.7 apply;

b) the software shall be assigned with appropriate software identification (see 2.2.9.5). This software identification shall be adapted in the case of every software change that may affect the functions and accuracy of the instrument;

c) functions performed or initiated via connected interfaces, i.e. transmission of legally relevant software, shall comply with the securing requirements for interfaces in 0.

6 Metrological controls

6.1 General

The metrological controls of arched chute weighers may, in agreement with national regulations, consist of

a) type evaluation,

b) initial verification,

c) subsequent verification,

d) in-service inspection.

Tests should be applied uniformly by the legal metrology services and should form a uniform program. Guidance for the conduct of type evaluation and initial verification is provided in OIML D 19:1988 [7] and D 20:1988 [8] respectively.

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

Further information about durability testing is given in R 150-2, Annex C.

6.2 Type evaluation

6.2.1 Documentation

The application for type evaluation shall include documentation comprising

a) metrological characteristics of the arched chute weigher (3),

b) a standard set of specifications for the arched chute weigher,

c) a functional description of the components and devices,

d) drawings, diagrams and photos of the instrument, explaining the construction and operation,

e) description and application of securing components, interlocks, adjustment devices, controls, etc. (4.2.7),

f) details of fractions p_i (modules tested separately) (6.2.6.8),

g) totalisation indicating and printing devices (4.3),

h) data storage devices (5.7),

i) zero-setting devices (4.4),

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 the control marks, securing marks, descriptive and verification marks (4.7),

m) operating instructions, operating manual,

n) information on the applications and ranges of bulk products for which the arched chute weigher is designed (0),

o) any document or other evidence demonstrating that the design and construction of the instrument complies with the requirements of this Recommendation,

p) designation of the acceptable moisture and temperature range for each product to be weighed,

q) description of positioning requirements for product flow presentation and suitable cautions about the effect of improper product infeed on the accuracy of the instrument,

r) instructions on positioning, installation and loading requirements for a force simulation platform that can be loaded with weights for use in simulation testing (R 150-2, 4.3),

s) instructions on adjusting infeed mass flowrate and suitable cautions about limits and securing adjustments during the test the infeed mechanism (R 150-2, 9.3.3).

6.2.2 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 6.2.3.

6.2.3 Examinations and tests

6.2.3.1 General

The arched chute weigher shall comply with the metrological requirements in 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), and the requirements in 4, and 5.

The submitted documents shall be examined and tests carried out to verify that the instrument complies 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 3.7 and, if applicable, the specifications for the modular approach of the modules of the instrument in accordance with 6.2.6 shall be examined.

For software-controlled instruments, the additional requirements in 5.8 and in R 150-2, Annex A shall apply.

6.2.3.2 In situ product tests

In-situ product tests shall be conducted in accordance with R 150-2, 4.1.

6.2.3.3 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 R 150-2, 4.1).

6.2.3.4 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 has been submitted,

b) Any other suitable location mutually agreed upon between the metrological authority and the applicant.

6.2.4 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.

6.2.5 Influence tests

Test on the performance of the EUT when exposed to the influence factor tests specified in R 150-2, 7.2 shall be applied to the complete EUT or simulation as specified in R 150-2, 4.3 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 3.7 and 5.

6.2.6 Testing of a family of instruments or modules

6.2.6.1 General

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 wishes to have a variety of modules included in the approved type;

d) where a module is intended to be used for various kinds of instruments (in particular force transducers, indicators, data storage).

Where a family of instruments (2.3.11) or modules of various capacities and characteristics is presented for type examination, the following provisions apply for selecting the equipment under test (EUT).

6.2.6.2 Selection of EUTs

The selection of EUTs to be tested shall be such that their number is minimised but nevertheless sufficiently representative of the type. Further information is provided in R 150-2, Annex B.

6.2.6.3 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.

6.2.6.4 Other metrological features to be considered

All metrologically relevant features and functions shall 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 150-2, Annex B.2.

6.2.6.5 Summary of relevant metrological characteristics

The specification of characteristics of the EUT shall include

a) lowest input signal (6.2.6.6),

b) all accuracy classes,

c) all temperature ranges,

d) dimensions of the force receptor, where relevant,

e) dimensions and geometrical position (angles) of the arched chute,

f) metrologically relevant features (see 6.2.6.4),

g) all possible instrument functions,

h) all possible indications,

i) all possible implemented digital devices,

j) all possible interfaces,

k) different types of force receptors, if connectable to the indicator,

l) the internal clock.

6.2.6.6 Minimum input voltage of electronics for maximum capacity

An analogue data processing device or indicator intended for force transducer(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.

6.2.6.7 Requirements for force transducers

Force transducers shall satisfy the following requirements:

a) the accuracy class of the load cells must be better than or equal to the accuracy class of the weighing instrument;

b) the total capacity of the load cells must be greater than the capacity of the weighing instrument, including the dead load;

c) a safety margin of at least 20 % must be applied when determining the measuring range of load cells because the force is never perfectly distributed due to eccentric loading or an uneven load receptor.

6.2.6.8 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 (3.2.3 Table 2) or the allowed variations of the indication of the complete instrument. The fractions for any module shall be taken for the same accuracy class as for the complete instrument incorporating the module.

The fractions p_i shall satisfy the following equation:

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

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 force transducers) 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 2.2.8), 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	Force transducer	Electronic indicator	Connecting elements and other modules
Combined effect [1]	0.7	0.5	0.5
Temperature effect on no load indication	0.7	0.5	0.5
Power supply variation	N/A	1	N/A
Effect of creep	1	N/A	N/A
Damp heat	0.7 [2]	0.5	0.5
Span stability	N/A	1	N/A

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 60:2017 [9] valid for SH tested load cells ($p_{LC} = 0.7$).

If the metrological characteristics of the force sensor or other major component have been evaluated in accordance with the requirements of OIML R 60:2017 [9], that evaluation shall be used to aid type evaluation if so requested by the applicant.

6.3 Initial verification and in-service inspection

6.3.1 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.

Arched chute weighers shall comply with the requirements in 3 and 4, excluding 3.7.1, for a given product or products for which the arched chute weigher is intended and when operated under rated operating conditions.

6.3.2 Tests

6.3.2.1 General

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

The installation of arched chute weighers 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 arched chute weigher for type evaluation under 6.2.3, the metrological authority may use the results of observed tests for initial verification at that site.

6.3.2.2 In-situ product tests

In-situ product tests shall be conducted in accordance with R 150-2, 4.1 and R 150-2, 9.

Before testing, the arched chute weigher shall operate (preferably loaded) for at least 30 minutes at nominal mass flowrate. A control instrument meeting the requirements of R 150-2, 4.2.1 shall be available at all times in the vicinity of the arched chute weigher 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.

The maximum permissible errors for automatic weighing shall be as specified in 3.2.2, Table 1, for initial verification, as appropriate for the class of the arched chute weigher.

6.3.3 Assessment of conformity

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

a) compliance with the appropriate maximum permissible errors in 3.2.2, Table 1,

b) compliance of the instrument with the technical requirements in 4,

c) correct functioning of all devices, e.g. interlocks, indicating and recording devices,

d) construction material and design, as far as they are of metrological relevance.

6.3.4 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,

c) visual conformity with the approved type as described in the approval certificate.

6.3.5 Marking and securing

According to national legislation, initial verification may be testified by verification marks as specified in 4.7. National regulations 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 4.2 and 4.6 shall be observed.

6.3.6 Application of accuracy class

Accuracy class requirements shall be applied in accordance with the appropriate parts of 3.2.2 for initial verification.

The accuracy class marking required in accordance with 3.1 shall show the same accuracy class(es) as those for which the type was approved and which was laid down in the approval certificate.

6.4 Subsequent metrological control

6.4.1 General

Subsequent metrological control may be performed according to national regulations.

Further information regarding durability testing as part of subsequent control is given in R 150-2, Annex C.

6.4.2 Subsequent verification

Subsequent verification shall be carried out in accordance with the same provisions as in 6.3 for initial verification with the error limits being those on initial verification. Marking and securing may take place according to 6.3.5, the date being that of the subsequent verification.

6.4.3 In-service inspection

In-service inspection shall be carried out in accordance with the same provisions as in 6.3 for initial verification, with the exception that the in-service maximum permissible errors in 3.2.2, Table 1 shall be applied. Marking and securing may remain unchanged, or renewed according to 6.4.2.

7 Examination and tests

7.1 Examinations

An arched chute weigher shall be examined to obtain a general appraisal of its design and construction.

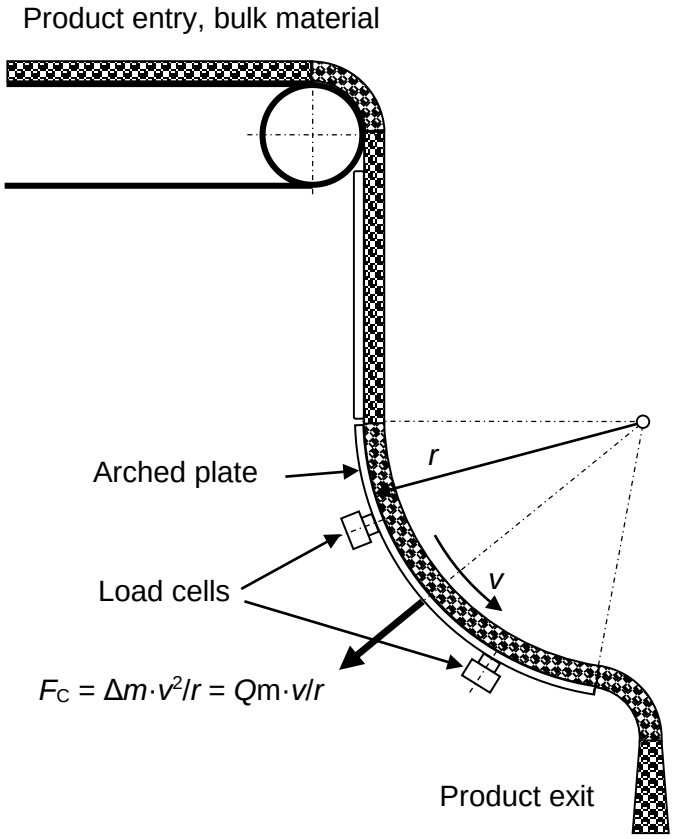
7.2 Performance tests

An arched chute weigher shall be tested as defined in R 150-2 to determine its correct operation. Tests shall be conducted on the whole instrument except when its size and/or configuration does not allow for testing the complete instrument. In such cases, the separate devices shall be subjected to testing. It is not intended that devices be further dismantled for separate testing of individual 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 setup sufficiently representing the arched chute weigher. The instrument shall continue to function correctly as specified in R 150-2.

Modules may be examined separately (subject to agreement with the metrological authority, see 6.2.6).

Annex A
Typical weighing instrument of the arched chute type
(Informative)



The essential components are:

- product infeed, guiding the bulk material;
- arched chute, causing the flow of bulk material to be subject to a centripetal force;
- force transducers supporting the arched chute weigher and converting the centripetal force into an electrical signal;
- product exit.

Optimum arrangement of the force receptor will result in a linear relationship with the throughput as a result of determining the mass of the load and velocity at the same time in free fall as the particles slide, rather than impact across the arched chute reducing or eliminating the influence of product properties such as density, particle size, or friction.

Annex B
Bibliography
(Informative)

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

Ref.	Standards and references	Description
[1]	OIML V 2-200:2012 *International Vocabulary of Basic and General Terms in Metrology* (VIM)	Vocabulary, prepared by a joint working group consisting of experts appointed by BIPM, IEC, IFCC, ISO, IUPAC, IUPAP and OIML.
[2]	VIML:2013 *International vocabulary of terms in legal metrology* (VIML)	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 D 11:2013 *General requirements for measuring instruments - Environmental conditions*	Contains general requirements for electronic measuring instruments.
[4]	OIML D 31:2019 *General requirements for software-controlled measuring instruments*	Specifies the general requirements applicable to legally relevant software-related functionality and security in measuring instruments and gives guidance for verifying the compliance of an instrument with these requirements.
[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*	Provides the definition of the quantity "conventional mass" (conventional value of the result of weighing in air) as it is used for the characterisation of weights and its relation to the physical quantities mass and density and the evaluation of its uncertainty.
[7]	OIML D 19:1988 *Pattern evaluation and pattern approval*	Provides advice, procedures and influencing factors on pattern evaluation and pattern approval.
[8]	OIML D 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.
[9]	OIML R 60:2017 *Metrological regulation for load cells*	Provides the principal static characteristics and static evaluation procedures for load cells used in the evaluation of mass.