National Institute of Metrology

APLMF Seminars and Training Courses

Type evaluation of non-automatic weighing instruments

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1 Brief Introduction of weighing instruments

2 Overview of OIML R 76

3 Type Evaluation Tests according R 76

Forward

- Important Comments:
  - All the texts are coming from the (OIML) international recommendation -- R76 & R111.

What is legal metrology?

- **Legal metrology is the application of legal requirements to measurements and measuring instruments "**

Weighing instrument in legal metrology

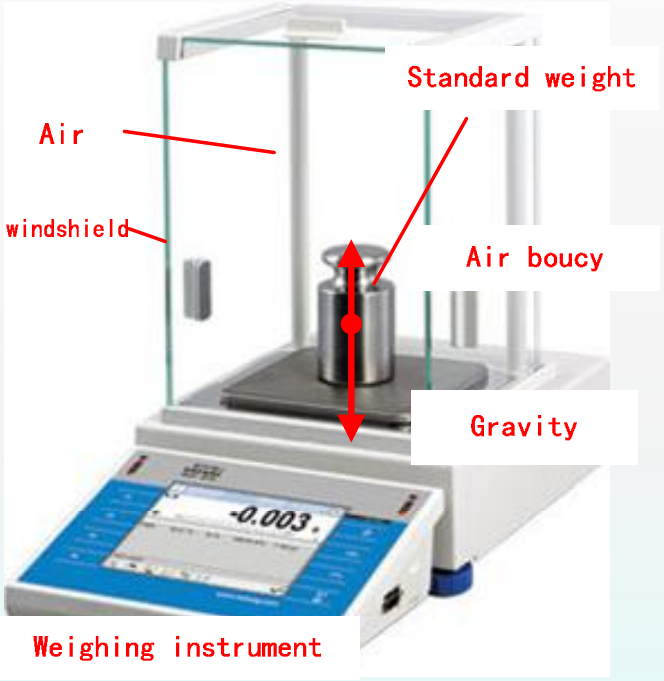
Measuring instrument that serves to determine the mass of a body by using the action of gravity on this body.

Where to find the legal requirements?

OIML Recommendations **give the general** **Legal requirements**

Weighing instrument in legal metrology

Measuring instrument that serves to determine the mass of a body by using the action of gravity on this body.



- “mass” is preferably used in the sense of “conventioanl mass” or “conventialnal value of the result of weighing in air”.

2013 year, weighing instruments in OIML Certificate System

OIML Certificate System

Number of Applicants per country

GERMANY	97
P.R. CHINA	73
UNITED KINGDOM	55
UNITED STATES	46
ITALY	41
NETHERLANDS	38
JAPAN	28
FRANCE	28
KOREA (R.)	23
SPAIN	23
TURKEY	15
SWITZERLAND	14
SWEDEN	13
CHINESE TAIPEI	12
DENMARK	12
ISRAEL	10
RUSSIAN FEDERATION	10
INDIA	9
CANADA	7
FINLAND	6

OIML Certificate System

Number of Applicants per category

Non automatic weighing instruments	220
Load cells	166
Automatic catchweighing instruments	98
Automatic gravimetric filling instruments	53
Fuel dispensers for motor vehicles (R 117 + R 118)	49
Water meters	30
Diaphragm gas meters	25
Automatic level gauges for fixed storage tanks	19
Indicators for non automatic weighing instruments	18
Discontinuous totalizing automatic weighing instruments	18
Multi-dimensional measuring instruments	11
Continuous totalizing automatic weighing instruments	10
Automatic rail weighbridges	7
In motion road weighing instruments	6
Evidential breath analysers	5
Load receptors for non automatic weighing instruments	2
Taximeters	2
Direct mass flow measuring systems	1
Clinical electrical thermometers with maximum device	1
Measurement of area of leathers	1
Exhaust gas analysers	1
All categories	**607**

Type of Metrological controls

- Type approval
  - Application for type approval
  - Process of Type evaluation
- Initial verification
- Subsequent metrological control
  - Subsequent verification
  - Service inspection

Type evaluation and initial verification

- Type evaluation
  - EUT
    - Newly designed by manufacture, type not approved
  - Target
    - To determine whether the weighing instrument meet the legal requirements or not.
- Initial verification
  - Person:
    - May be performed by authorized personnel according to national regulations.
  - EUT:
    - not be performed unless conformity of the instrument to the approved type and/or the requirements of R76 is established.

Type evaluation and initial verification

- Initial verification
  - Where to carry out:
    - Initial verification may be carried out at the manufacturer's facility or at any other location:
      - a) if transport to the location of use does not require dismantling of the instrument;
      - b) if putting the instrument into service at its location of use does not require assembly of the instrument or other technical installation work likely to affect the instrument's performance; and
      - c) if the gravity value at the location at which the instrument will be put into service is taken into consideration or if the instrument's performance is insensitive to gravity variations.

Type evaluation and initial verification

8.4 Subsequent metrological control **(defined in OIML 76)**

may be performed by authorized personnel according to national regulations.

8.4.1 Subsequent verification **(defined in OIML 76)**

Upon subsequent verification, normally only inspection and tests according to 8.3.2 and 8.3.3 shall be performed, the error limits being those on initial verification. Stamping and securing may take place according to 8.3.4, the date being that of the subsequent verification.

8.4.2 Service inspection **(defined in OIML 76)**

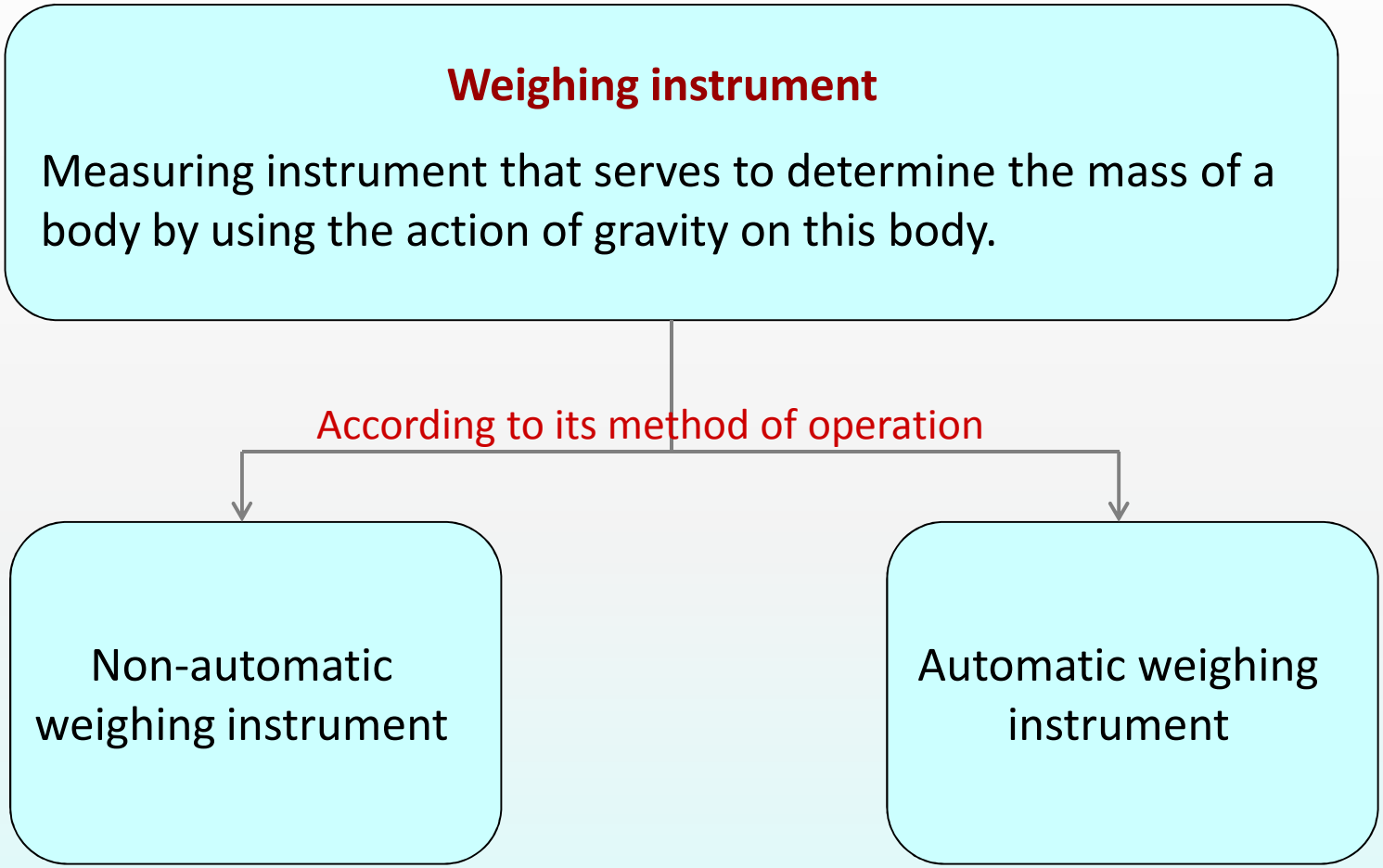
Upon service inspection normally only inspection and tests according to 8.3.2 and 8.3.3 shall be performed, the error limits being twice those on initial verification. Stamping and securing may remain unchanged, or renewed according to 8.4.1.

Example

- If for an instruments of Class II, a load m =500e
  - MPE for Initial verification: $\pm 0.5\ e$
  - MPE for Subsequent verification: $\pm 0.5\ e$
  - MPE for Service inspection: $\pm 1.0\ e$

Maximum permissible errors on initial verification	For loads, m, expressed in verification scale intervals, e			
	Class I	Class II	Class III	Class IIII
$\pm 0.5\ e$	$0 \le m \le 50\,000$	$0 \le m \le 5\,000$	$0 \le m \le 500$	$0 \le m \le 50$
$\pm 1.0\ e$	$50\,000 < m \le 200\,000$	$5\,000 < m \le 20\,000$	$500 < m \le 2\,000$	$50 < m \le 200$
$\pm 1.5\ e$	$200\,000 < m$	$20\,000 < m \le 100\,000$	$2\,000 < m \le 10\,000$	$200 < m \le 1\,000$

Classifications of weighing instrument



Classifications of weighing instrument

Non-Automatic Weighing Instrument (NAWI)

Defined in OIML R76 T.1.2

Instrument that requires the intervention of an operator during the weighing process to decide that the weighing result is acceptable.

Automatic Weighing Instrument (NAWI)

Defined in OIML R50 OR R134 T.1.2

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

Non-automatic weighing instrument

Non-Automatic Weighing Instrument (NAWI)

Defined in OIML R76 T.1.2

Instrument that requires the intervention of an operator during the weighing process to decide that the weighing result is acceptable.

Automatic weighing instrument

- Automatic weighing plays an important part in many fields .
  - Large quantities of commodities and raw materials are handled in trading centers using automatic belt weighers or totalizing hopper weighers for bulk-to- bulk weighing,
  - smaller quantities of commodities being meant for end users are automatically filled and weighed by gravimetric filling instruments, by catch weighers or check weighers.
  - Commodities transported on vehicles or by rail are often weighed automatically by in-motion road vehicle weighing instruments or automatic rail weighbridges, respectively.

Mines transport

Asphalt mixing station

Liquid filling

Weighing vehicle

Continuous totalizing automatic weighing instruments (belt weighers)

An automatic weighing instrument for continuously weighing a bulk product on a conveyor belt, without systematic subdivision of the mass and without interrupting the movement of the conveyor belt.

OIML R50 Continuous totalizing automatic weighing instruments (belt weighers)

Automatic catchweighing instruments

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

OIML R51 Automatic catchweighing instruments

Automatic gravimetric filling instruments

Instrument which fills containers with predetermined and virtually constant mass of product from bulk by automatic weighing, and which comprises essentially automatic feeding device(s) associated with weighing unit(s) and the appropriate control and discharge devices.




- Static weighing process a sample can be tested as NAWI.
- Material test should be performed

OIML R61 Automatic gravimetric filling instruments

Automatic rail-weighbridges

A weighing instrument having a load receptor, inclusive of rails for conveying railway vehicles.

OIML R106 Automatic rail-weighbridges

Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers)

Automatic weighing instrument that weighs a bulk product by dividing it into discrete loads, determining the mass of each discrete load in sequence, summing the weighing results and delivering the discrete loads to bulk.




OIML R107 Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers)

Automatic instruments for weighing road vehicles in motion and measuring axle loads

Automatic weighing instrument, having a load receptor and aprons , that determines the vehicle mass , axle loads , and if applicable the axle-group loads of a road vehicle while the vehicle is crossing over the load receptor of the weighing instrument.

OIML R134 Automatic instruments for weighing road vehicles in motion and measuring axle loads

Automatic weighing instrument

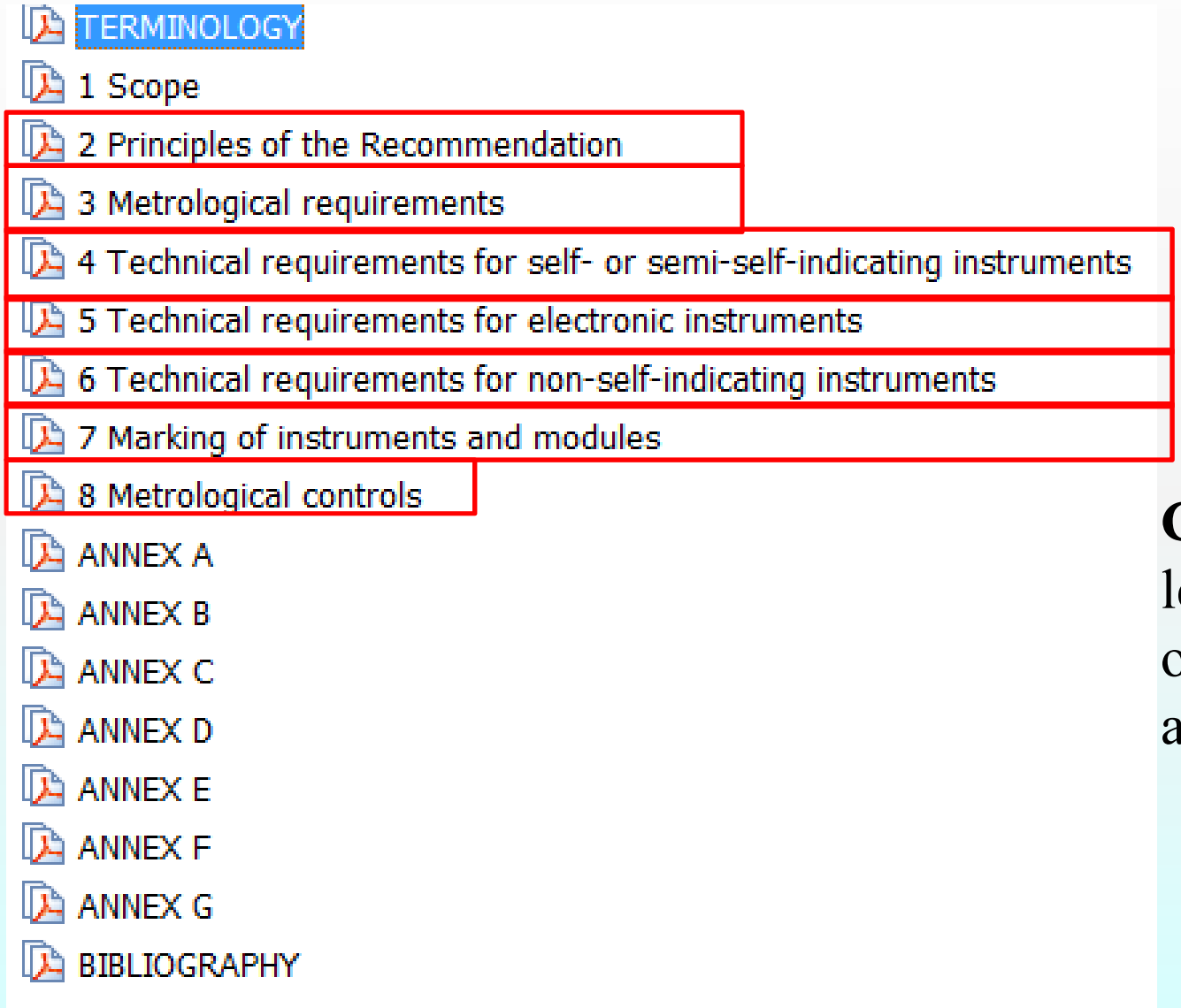
- OIML R50 Continuous totalizing automatic weighing instruments (belt weighers)
- OIML R51 Automatic catchweighing instruments
- OIML R61 Automatic gravimetric filling instruments
- OIML R106 Automatic rail-weighbridges
- OIML R107 Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers)
- OIML R134 Automatic instruments for weighing road vehicles in motion and measuring axle loads

In cases of doubt: Definitions for automatic weighing instruments in OIML R 50, R 51, R 61, R 106, R 107 and R 134 have higher priority!

Next Section

1. Brief Introduction of weighing instruments
2. **Overview of R 76**
3. **Type Evaluation Tests according R76**

Structure of R76 non-automatic weighing instruments



Combination of legal requirements of type evaluation and verification.

A. Testing procedures for non-automatic weighing instruments

B. Additional tests for electronic instruments

C. Testing and certification of indicators and analog data processing devices as modules of non-automatic weighing instruments

D. Testing and certification of digital data processing devices, terminals and digital displays as modules of non-automatic weighing instruments

E. Testing and certification of weighing modules as modules of non-automatic weighing instruments

F. Compatibility checking of modules of non-automatic weighing instruments

G. Additional examinations and tests for software-controlled digital devices and instruments

Overview of R76

- **TERMINOLOGY**
  - (terms, definitions and references)
- **1 Scope (P25 R76)**
  - This Recommendation specifies the metrological and technical requirements for non-automatic weighing instruments that are subject to official metrological control.
  - It is intended to provide standardized requirements and testing procedures to evaluate the metrological and technical characteristics in a uniform and traceable way.

- **2.2 Principles of the metrological requirements (P25 R76)**
  - The requirements apply to all instruments irrespective of their principles of measurement.
  - Instruments are classified according to:
    - the verification scale interval, representing absolute accuracy;
    - and the number of verification scale intervals, representing relative accuracy.

2.2 Principles of the metrological requirements (P25 R76)

- The maximum permissible errors are in the order of magnitude of the verification scale interval.
- They apply to gross loads and when a tare device is in operation they apply to the net loads.
- The maximum permissible errors do not apply to calculated net values when a preset tare device is in operation.
- A minimum capacity (Min) is specified to indicate that use of the instrument below this value is likely to give rise to considerable relative errors.

2.3 Principles of the technical requirements (P25 R76)

- General technical requirements apply to all types of instruments, whether mechanical or electronic, and are supplemented or modified with additional requirements for instruments used for specific applications or designed for a special technology.
- They are intended to specify the performance, not the design of an instrument, so that technical progress is not impeded.

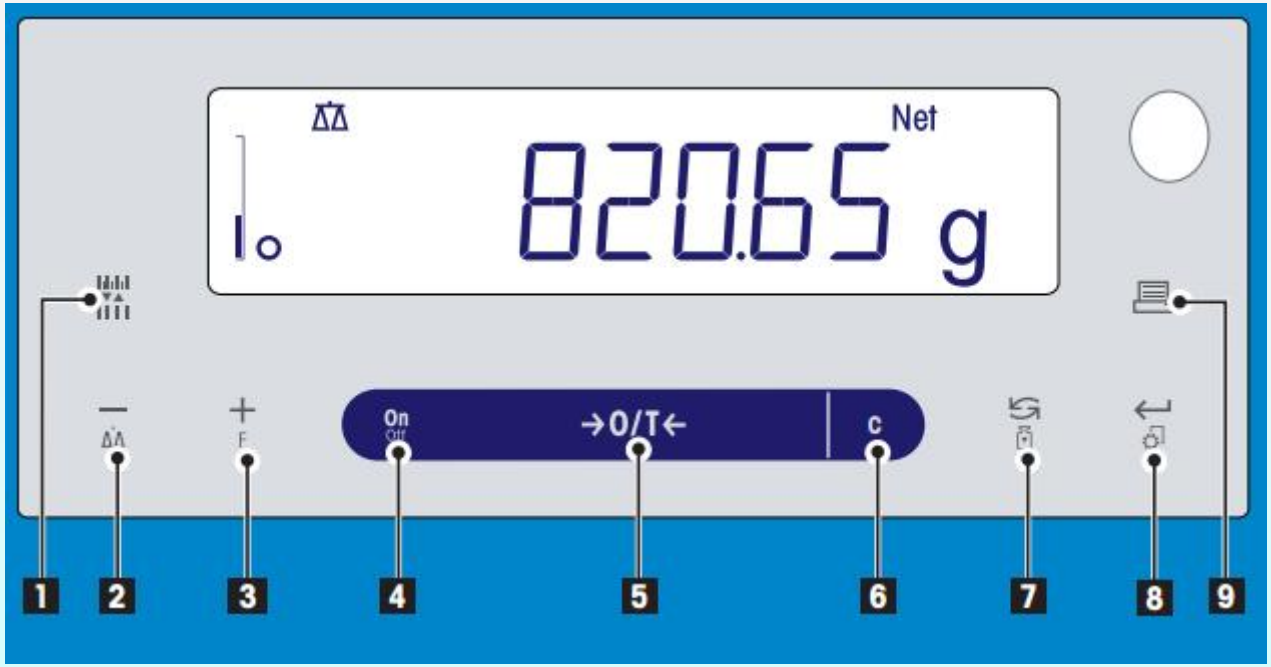
Legal requirements do not impede the technical progress.

2.3 Principles of the technical requirements (P25 R76)

- In particular, functions of electronic instruments not covered by this Recommendation should be allowed provided that they do not interfere with the metrological requirements, and if suitability for use and appropriate metrological control is ensured.
- Testing procedures are provided to establish conformity of instruments with the requirements of this Recommendation. They should be applied, and the Test Report Format (R 76-2) should be used, to facilitate exchange and acceptance of test results by metrological authorities.

- **2.4 Application of requirements (P26 R76)**
- The requirements of this Recommendation apply to all devices performing the relevant functions, whether they are incorporated in an instrument or manufactured as separate units. Examples are:
- load-measuring device;
- displaying device;
- printing device;
- preset tare device; and
- price-calculating device.
- However, devices that are not incorporated in the instrument may, by national legislation, be exempted from the requirements for special applications.

- **What “a device ” means?**
- **T.2 Construction of an instrument (P7 R76)**
  - 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.



T.1.2.1 Graduated instrument *(OIML R76 Edition 2006)*
Instrument allowing the direct reading of the complete or partial weighing result.




T.1.2.2 Non-graduated instrument *(OIML R76 Edition 2006)*
Instrument not fitted with a scale numbered in units of mass.

T.1.2.3 Self-indicating instrument *(OIML R76 Edition 2006)*

Instrument in which the position of equilibrium is obtained without the intervention of an operator.

T.1.2.4 Semi-self-indicating instrument *(OIML R76 Edition 2006)*
Instrument with a self-indicating weighing range, in which the operator intervenes to alter the limits of this range.

T.1.2.5 Non-self-indicating instrument *(OIML R76 Edition 2006)*

Instrument in which the position of equilibrium is obtained entirely by the operator.

T.1.2.6 Electronic instrument *(OIML R76 Edition 2006)*
Instrument equipped with electronic devices.

T.1.2.7 Instrument with price scales *(OIML R76 Edition 2006)*
Instrument that indicates the price to pay by means of price charts or scales related to a range of unit prices.

T.1.2.8 Price-computing instrument *(OIML R76 Edition 2006)*
Instrument that calculates the price to pay on the basis of the indicated weight value and the unit price.

T.1.2.9 Price-labeling instrument *(OIML R76 Edition 2006)*

Price-computing instrument that prints the weight value, unit price and price to pay for prepackages.

2.000 kg * 8.88 RMB/kg = 17.76 RMB

T.1.2.10 Self-service instrument *(OIML R76 Edition 2006)*

Instrument that is intended to be operated by the customer.

T.1.2.11 Mobile instrument *(OIML R76 Edition 2006)*

Non-automatic weighing instrument mounted on or incorporated into a vehicle.

Note 1: A vehicle-mounted instrument is a complete weighing instrument which is firmly mounted on a vehicle, and which is designed for that special purpose.
Example: Postal scale mounted on a vehicle (mobile post office).
Note 2: A vehicle-incorporated instrument uses parts of the vehicle for the weighing instrument.
Examples: Garbage weighers, patient lifters, pallet lifters, fork lifters, wheel chair weighers.

T.1.2.12 Portable instrument for weighing road vehicles

Non-automatic weighing instrument having a load receptor, in one or several parts, which determines the total mass of road vehicles, and which is designed to be moved to other locations.
Examples: Portable weighbridge, group of associated non-automatic axle (or wheel) load weighers.

Note: This Recommendation covers only weighbridges and groups of associated non-automatic axle (or wheel) load weighers that determine simultaneously the total mass of a road vehicle with all axles (or wheels) being simultaneously supported by appropriate parts of a load receptor.

Vehicle is statically stoped on the four load receptor.

T.1.2.13 Grading instrument

Instrument which assigns a weighing result to a predetermined range of mass to determine a tariff or toll.
Examples: Postal scales, garbage weighers.

量程	0～3kg	3～6kg	6～15kg	15～40kg
分度值	1g	2g	5g	10g

Mounted in a post vehicle

Next section

-two important concepts in R76

- Family
- Module

Family *Defined in OIML R76 -1 Edition 2006(E) T.3.5*

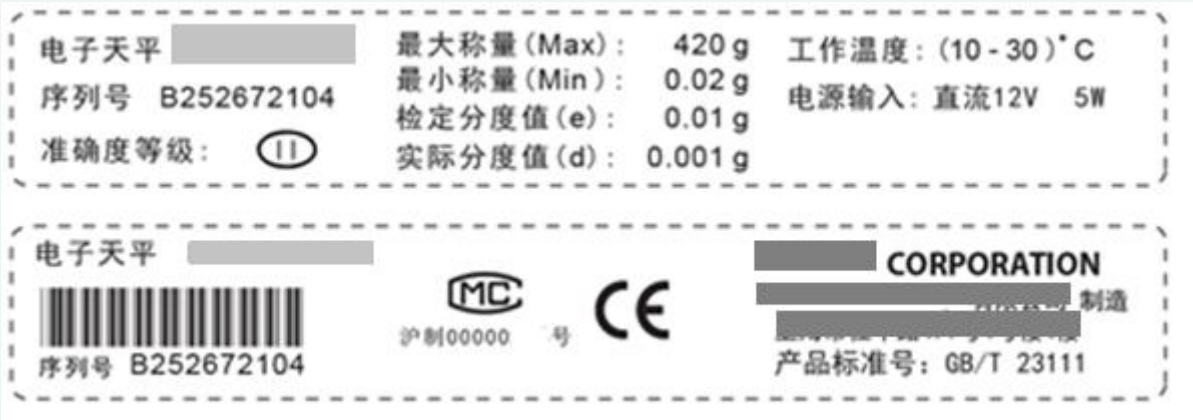
Identifiable group of weighing instruments or modules belonging to the same manufactured type that have the same design features and metrological principles for measurement (for example the same type of indicator, the same type of design of load cell and load transmitting device) but which may differ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

Family *Defined in OIML R76 -1 Edition 2006(E) T.3.5*

- Identifiable group of weighing instruments or modules with:
  - the same manufactured type
  - the same design features
  - the same metrological principles for measurement
  - some different metrological and technical performance characteristics

Example

No.	Type	Max (g)	Min (g)	*e* (g)	*n*	*d* (g)	Class
1	Type 1	220	0.02	0.01	22000	0.001	Ⅱ
2	Type 2	420	0.02	0.01	42000	0.001	Ⅱ
3	Type 3	4200	0.5	0.1	42000	0.01	Ⅱ
4	Type 4	6200	0.5	0.1	62000	0.01	Ⅱ
5	Type 5	6200	0.5	0.1	62000	0.1	Ⅱ
6	Type 6	2200	0.5	0.1	22000	0.01	Ⅱ

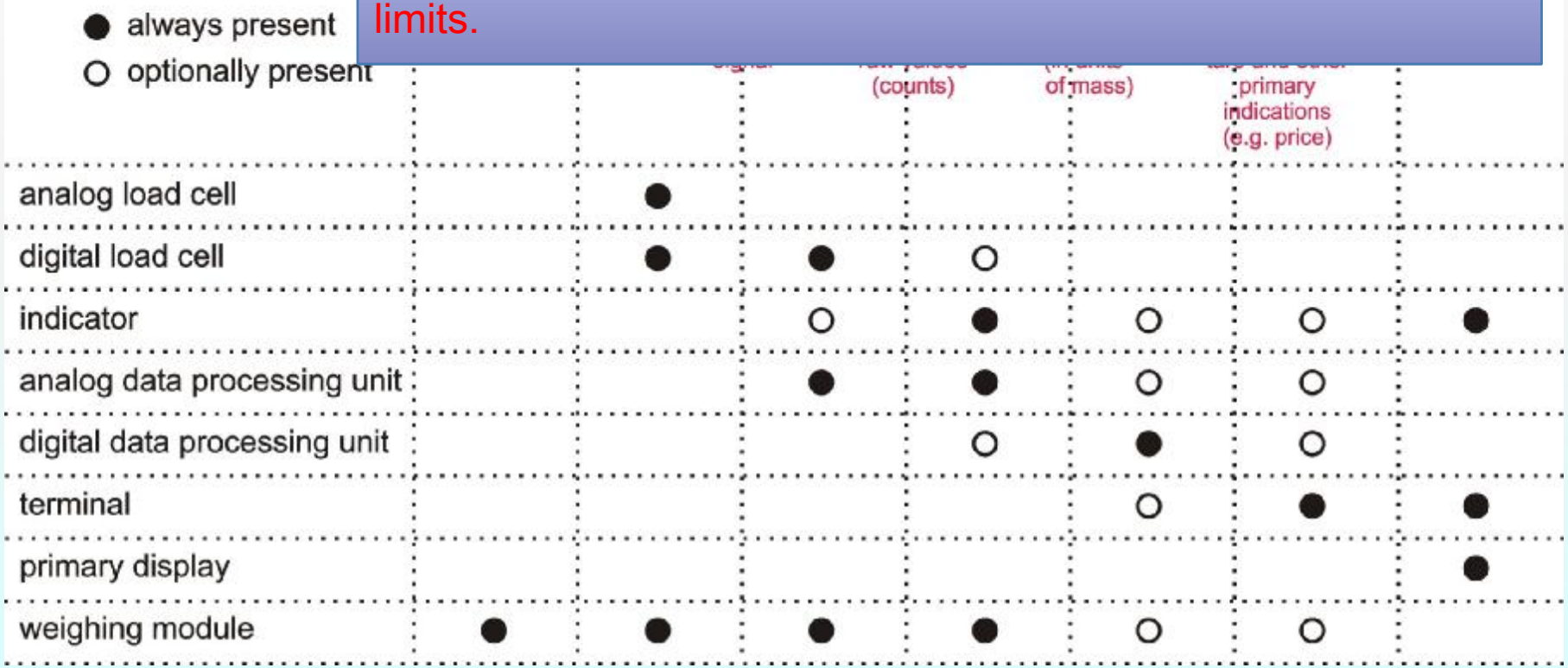


3.10.2 Modules (P36 R76)

- Why needs modules?
- Subject to agreement with the approving authority, the manufacturer may define and submit modules to be examined separately. This is particularly relevant in the following cases:
  - where testing the instrument as a whole is difficult or impossible;
  - where modules are manufactured and/or placed on the market as separate units to be incorporated in a complete instrument; or
  - where the applicant wants to have a variety of modules included in the approved type.
  - Where modules are examined separately in the process of type approval, the following requirements apply.

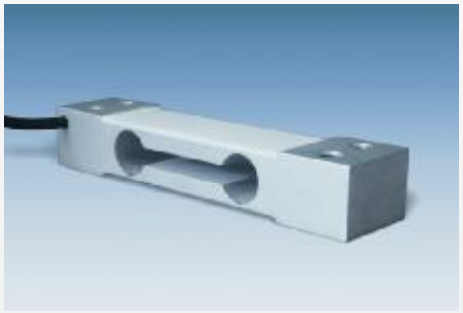
Module

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



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).




analog load cell : analog load cell

digital load cell: analog load cell + A/D converter + data processing (scaling)

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

Must be equipped with

optional

Indicator

Electronic device of an instrument that may perform the analog-to-digital conversion of the output signal of the load cell, and which further processes the data, and displays the weighing result in units of mass.

A/D converter

+

data processing (scaling)

+

further data processing

+

keys/keyboard to operate

+

Primary display

Must be equipped with

optional

Analog data processing device

Electronic device of an instrument that performs the analog-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. It may optionally have one or more keys (or mouse, touch-screen, etc.) to operate the instrument.

A/D converter

+

data processing (scaling)

+

further data processing

+

keys/keyboard to operate

Must be equipped with

optional

Digital data processing device

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

data processing (scaling)

+

further data processing

+

keys/keyboard to operate

Must be equipped with

optional

Terminal

Digital device that has one or more keys (or mouse, touch-screen, etc.) to operate the instrument, and a display to provide the weighing results transmitted via the digital interface of a weighing module or an analog data processing device.

further data processing

+

keys/keyboard to operate

+

Primary display

Must be equipped with

optional

Digital display

A digital display can be realized as a primary display or as a secondary display :

a) Primary 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.

b) Secondary display: Additional peripheral device (optional) which repeats the weighing result and any other primary indication, or provides further, non-metrological information.

Primary display

Must be equipped with

optional

Weighing module

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

mechanical and electrical connecting elements

+

analog load cell

+

A/D converter

+

data processing (scaling)

+

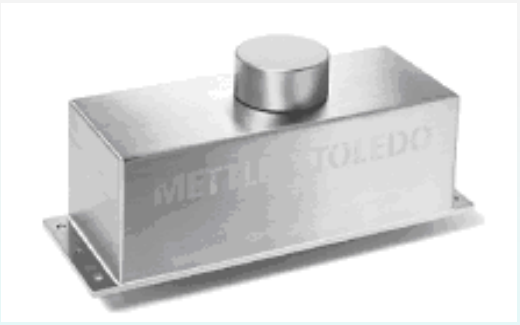
further data processing

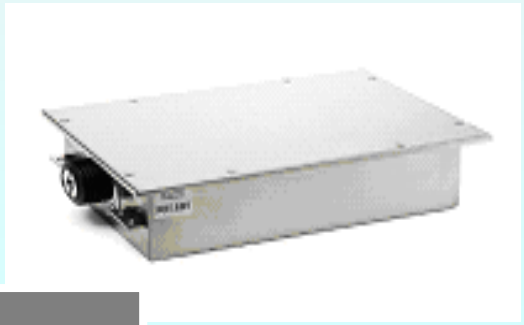
+

keys/keyboard to operate

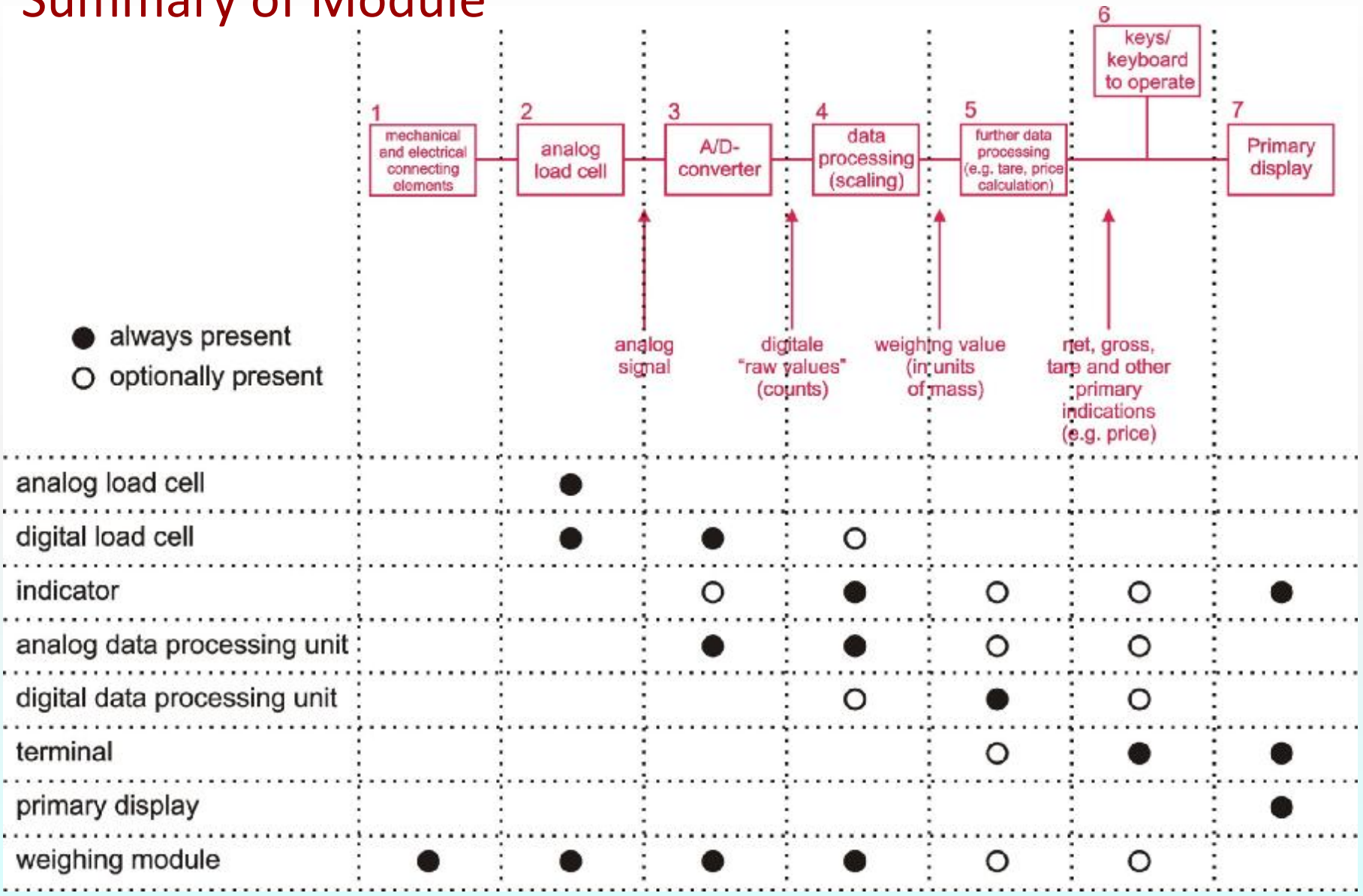
Must be equipped with

optional





Summary of Module



Next section- General characteristics

- Important terms
  - Accuracy classes
  - Maximum capacity
  - Minimum capacity
  - Verification scale interval
  - Number of the Verification scale interval

Accuracy classes

- special accuracy (I)
- high accuracy (II)
- medium accuracy (III)
- ordinary accuracy (IIII)

Roman number in a oval

Terms and Definition

- Maximum capacity Max
  - Maximum weighing capacities, not taking into account the additive tare capacity.
- Minimum capacity Min
  - Value of the load below, which the weighing results may be subject to an excessive relative error.
- Verification scale interval *e*
  - Values, expressed in units of mass, used for the classification and verification of an instrument
- Number of the Verification scale interval *n*
  - Quotient of the maximum capacity and the verification scale interval. $n = \text{Max}/e$

Terms and Definition

Actual scale interval, *d*

Value, expressed in units of mass of:

- the difference between the values corresponding to two consecutive scale marks, for analog indication; or
- the difference between two consecutive indicated values, for digital indication.

Terms and Definition

Verification scale interval, *e*

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

Number of verification scale intervals, *n*

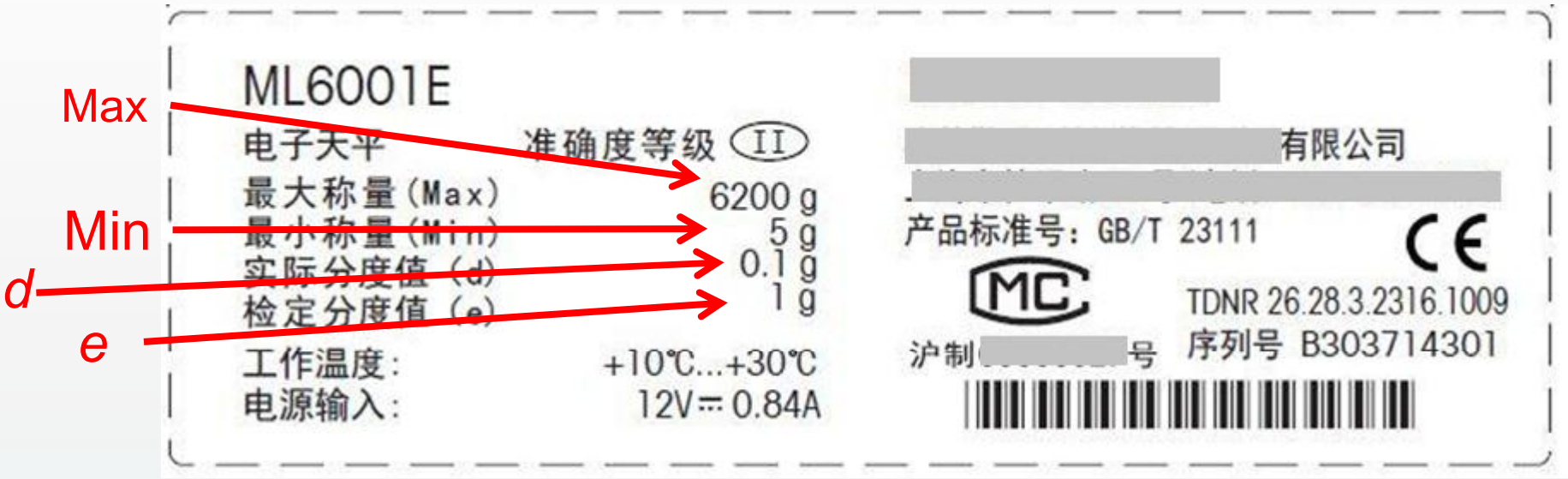
Quotient of the maximum capacity and the verification scale interval:

$$n = \text{Max} / e$$

Example1: Max = 15 kg, e = 5 g, then n = 15 kg / 5 g = 3000

Example2: Max = 3 kg, e = 1 g, then n = 3 kg / 1 g = 3000

Terms and Definition



Describing Marking

Accuracy classes

Table 3

Accuracy class	Verification scale interval, *e*	Number of verification scale intervals, *n* = Max/*e*		Minimum capacity, Min (Lower limit)
		minimum	maximum	
Special (I)	0.001 g ≤ *e**	50 000**	–	100 *e*
High (II)	0.001 g ≤ *e* ≤ 0.05 g 0.1 g ≤ *e*	100 5 000	100 000 100 000	20 *e* 50 *e*
Medium (III)	0.1 g ≤ *e* ≤ 2 g 5 g ≤ *e*	100 500	10 000 10 000	20 *e* 20 *e*
Ordinary (IIII)	5 g ≤ *e*	100	1 000	10 *e*

- How to classify the accuracy of classes of an instrument with n=600 e=5 g?

Either is ok.
Maximum permissible errors for Instrument of Class III and instrument of Class IIII are different.

Accuracy classes

Table 3

Accuracy class	Verification scale interval, *e*	Number of verification scale intervals, *n* = Max/*e*		Minimum capacity, Min (Lower limit)
		minimum	maximum	
Special (I)	0.001 g ≤ *e**	50 000**	–	100 *e*
High (II)	0.001 g ≤ *e* ≤ 0.05 g 0.1 g ≤ *e*	100 5 000	100 000 100 000	20 *e* 50 *e*
Medium (III)	0.1 g ≤ *e* ≤ 2 g 5 g ≤ *e*	100 500	10 000 10 000	20 *e* 20 *e*
Ordinary (IIII)	5 g ≤ *e*	100	1 000	10 *e*

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

** See exception in 3.4.4.

- For Class I, minimum of *n*
  - *3.4.4 Minimum number of verification scale intervals*
    - *For an instrument of class I with d < 0.1 mg, n may be less than 50 000.*

Accuracy classes

Table 3

Accuracy class	Verification scale interval, e	Number of verification scale intervals, n = Max/e		Minimum capacity, Min (Lower limit)
		minimum	maximum	
Special (I)	0.001 g ≤ e*	50 000**	–	100 e
High (II)	0.001 g ≤ e ≤ 0.05 g 0.1 g ≤ e	100 5 000	100 000 100 000	20 e 50 e
Medium (III)	0.1 g ≤ e ≤ 2 g 5 g ≤ e	100 500	10 000 10 000	20 e 20 e
Ordinary (IIII)	5 g ≤ e	100	1 000	10 e

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

** See exception in 3.4.4.

- The verification scale interval, *e*, is replaced by the actual scale interval, *d*

- The minimum capacity is reduced to 5 e for grading instruments, i.e. instruments that determine a transport tariff or toll (e.g. postal scales and instruments weighing waste material).
- On multiple range instruments the verification scale intervals are e_1, e_2, …, e_r with $e_1 < e_2 < \ldots < e_r$.
- Similar subscripts are also used with the terms Min, n and Max.
- On multiple range instruments, each range is treated as if it were an instrument with one range.
- For special applications that are clearly marked on the instrument, an instrument may have weighing ranges in classes I and II, or in classes II and III. The instrument as a whole shall then comply with the more severe requirements of 3.9 applicable to either of the two classes.

Table 3

Accuracy class	Verification scale interval, *e*	Number of verification scale intervals, *n* = Max/*e*		Minimum capacity, Min (Lower limit)
		minimum	maximum	
Special (I)	0.001 g ≤ *e**	50 000**	–	100 *e*
High (II)	0.001 g ≤ *e* ≤ 0.05 g 0.1 g ≤ *e*	100 5 000	100 000 100 000	20 *e* 50 *e*
Medium (III)	0.1 g ≤ *e* ≤ 2 g 5 g ≤ *e*	100 500	10 000 10 000	20 *e* 20 *e*
Ordinary (IIII)	5 g ≤ *e*	100	1 000	10 *e*

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

** See exception in 3.4.4.

- e=1 g d=0.1 g
- Min = ? 50e=50 g or 50d=5 g √

Terms and Definition

Maximum permissible error

- Maximum difference, positive or negative, allowed by regulation between the indication of an instrument and the corresponding true value, as determined by reference standard massed, with the instrument being at zero at no-load, in the reference position.

Terms and Definition

Maximum permissible error, mpe

Maximum difference, positive or negative, allowed by regulation between the indication of an instrument and the corresponding true value, as determined by reference standard masses or standard weights, with the instrument being at zero at no-load, in the reference position.

Maximum permissible errors on initial verification	For loads, m, expressed in verification scale intervals, e			
	Class I	Class II	Class III	Class IIII
± 0.5 e	$0 \le m \le 50\,000$	$0 \le m \le 5\,000$	$0 \le m \le 500$	$0 \le m \le 50$
± 1.0 e	$50\,000 < m \le 200\,000$	$5\,000 < m \le 20\,000$	$500 < m \le 2\,000$	$50 < m \le 200$
± 1.5 e	$200\,000 < m$	$20\,000 < m \le 100\,000$	$2\,000 < m \le 10\,000$	$200 < m \le 1\,000$

Terms and Definition

Maximum permissible error, mpe

- 0 g＜m≤5000 g　　±0.5 g
- 5000 g＜m≤6200 g　　±1.0 g

Maximum permissible errors on initial verification	For loads, *m*, expressed in verification scale intervals, *e*			
	Class I	Class II	Class III	Class IIII
± 0.5 *e*	0 ≤ *m* ≤ 50 000	0 ≤ *m* ≤ 5 000	0 ≤ *m* ≤ 500	0 ≤ *m* ≤ 50
± 1.0 *e*	50 000 < *m* ≤ 200 000	5 000 < *m* ≤ 20 000	500 < *m* ≤ 2 000	50 < *m* ≤ 200
± 1.5 *e*	200 000 < *m*	20 000 < *m* ≤ 100 000	2 000 < *m* ≤ 10 000	200 < *m* ≤ 1 000

Metrological requirements

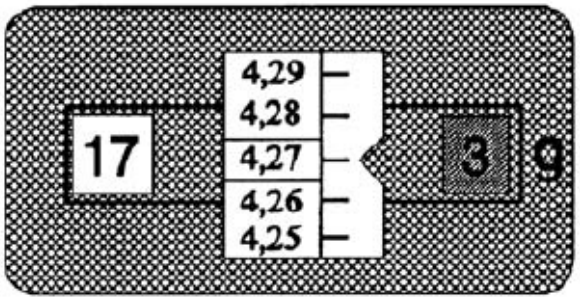
- If no particular working temperature is stated on the descriptive markings of an instrument, this instrument shall maintain its metrological properties within the following temperature limits:

$$-10^{\circ}\ C \sim +40^{\circ}\ C$$

- The ranges within those limits shall be at least equal to:
  - 5 ℃ for instruments of class I;
  - 15 ℃ for instruments of class II; and
  - 30 ℃ for instruments of classes III and IIII.

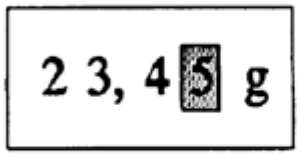
- Metrological requirements
- 3.4 Auxiliary indicating devices
- 3.4.1 Type and application
  - Only instruments of classes I and II may be fitted with an auxiliary indicating device, which shall be:
    - a device with a rider;
    - A device for interpolation of reading;
    - A complementary displaying device (see Figure 4);
    - or an indicating device with a differentiated scale division (see Figure 5).

Figure 4 – Example of a complementary displaying device

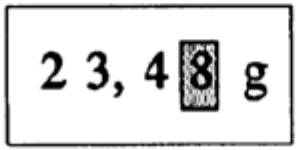


indication: 174.273 g
last figure: 3
d = 1 mg
e = 10 mg

Figure 5 – Examples of indicating devices each with a differentiated scale division



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



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

- **3.5.3 Basic rules concerning the determination of errors**
- **3.5.3.1 Influence factors**
  - Errors shall be determined under normal test conditions. When the effect of one factor is being evaluated, all other factors are to be kept relatively constant, at a value close to normal.

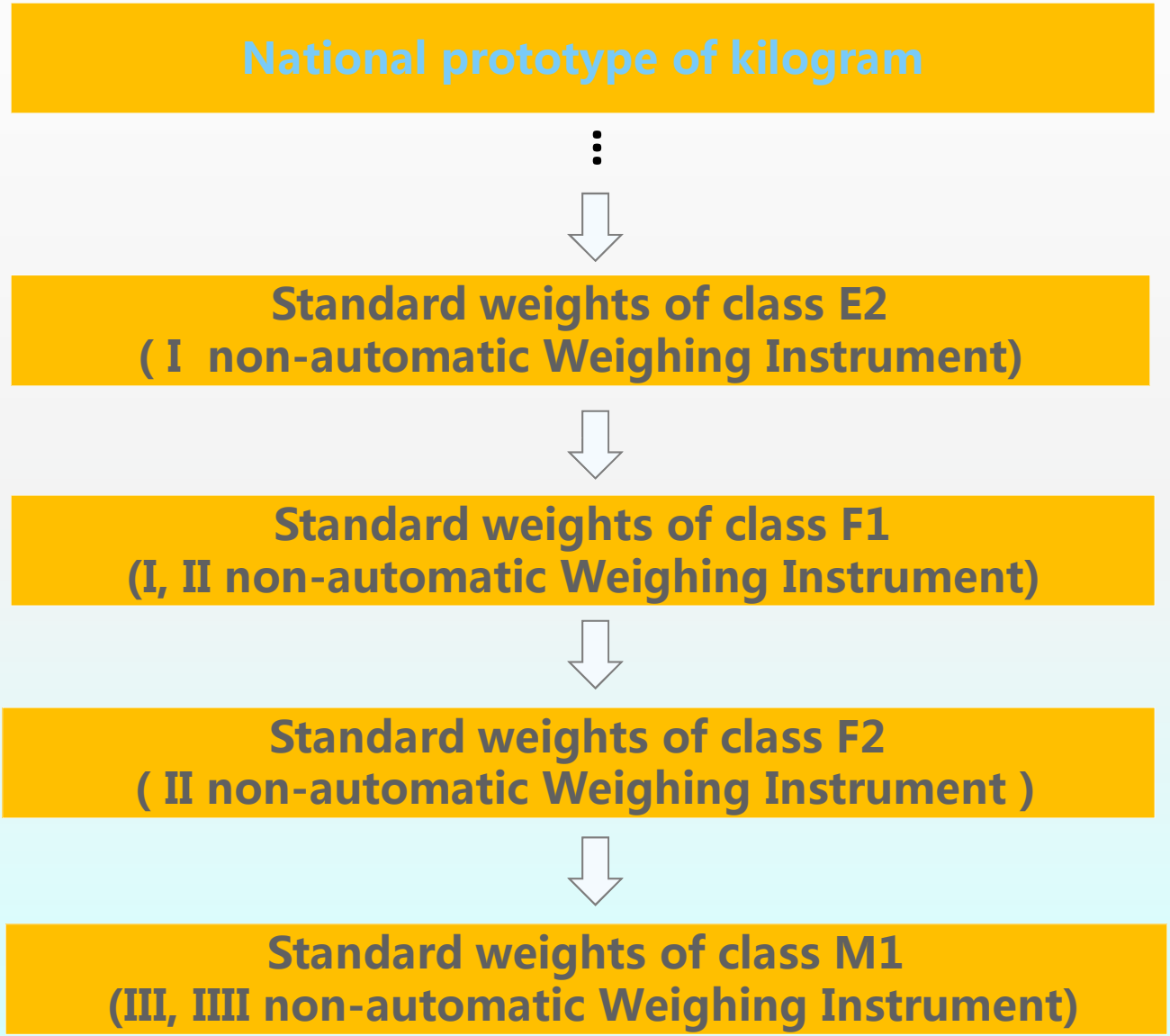
- **3.6 Permissible differences between results**
  - Regardless of what variation of results is permitted, the error of any single weighing result shall by itself not exceed the maximum permissible error for the given load.
- **3.6.1 Repeatability**
  - The difference between the results of several weighings of the same load shall not be greater than the absolute value of the maximum permissible error of the instrument for that load.

Metrological requirements

- **3.7 Test standards (defined in OIML 76)**
- **3.7.1 Weights**
  - In principle, the standard weights or standard masses used for the type examination or verification of an instrument shall meet the metrological requirements of OIML R 111.
  - They shall not have an error greater than 1/3 of the maximum permissible error of the instrument for the applied load. If they belong to class E2 or better, their uncertainty (rather than their error) is allowed to be not greater than 1/3 of the maximum permissible error of the instrument for the applied load, provided that the actual conventional mass and the estimated long-term stability is taken into account.

Hierarchy for Verification of Mass and Weighing Metrology

OIML R111



Technical requirements

- 4.1.2.4 Securing of components and pre-set controls
  - Means shall be provided for securing components and pre-set controls to which access or adjustment is prohibited. National legislation may specify the securing that is required.
  - On a class I instrument, devices to adjust sensitivity (or span) may remain unsecured.
  - Acceptable solution:
    - For application of the control marks, the securing area should have a diameter of at least 5 mm.

Technical requirements

- **4.2.3 Limits of indication**
  - There shall be no indication **above Max + 9 e.**
  - An indication below zero (with minus sign) is possible when a tare device is in operation and the tare load has been removed from the load receptor.
  - It is also possible that negative values down to –20 d are displayed even if there is no tare device in operation, provided these values **cannot be transmitted, printed or used for a price calculation**.

7 Marking of instruments and modules

- 7.1 Descriptive markings
  - Note: The descriptive markings given here are by way of example, but variable according to national regulations.
- An instrument shall carry the following markings.

7.1.1 Compulsory in all cases

- Manufacturer's mark, or name written in full (A);
- Metrological markings (B):
  - Indication of accuracy class in the form of a Roman number in an oval (see footnote to 3.1.1):

    for special accuracy: 

    for high accuracy: 

    for medium accuracy: 

    for ordinary accuracy: 

  - Maximum capacity in the form: Max …
  - Minimum capacity in the form: Min …
  - Verification scale interval in the form: e = ….

- 7.1.2 Compulsory if applicable
  - Name or mark of manufacturer's agent for an imported instrument (C);
  - Serial number (D);
  - Identification mark on each unit of an instrument consisting of separate but associated
  - units (E);
  - Type approval mark (F);

- Supplementary metrological characteristics (G):
  - software identification (compulsory for software-controlled instruments)
  - scale interval, if $d < e$, in the form: $d =$
  - maximum additive tare effect, in the form: T = + …
  - maximum subtractive tare effect if different from Max, in the form: T = – ...
  - counting ratio on a counting instrument according to 4.17, in the form: 1:… or 1/…
  - range of plus/minus indication of a digital comparator instrument, in the form: ±… u_m or –… u_m / +… u_m
    (u_m standing for the unit of mass as in 2.1)
  - ratio between weight platform and load platform as specified in 6.5.1, 6.8.2 and 6.9.4;
- Special limits (H):
  - maximum safe load, in the form: Lim = …
    (if the manufacturer has provided for a maximum safe load of more than Max + T)
  - the special temperature limits according to 3.9.2.2 within which the instrument complies with the prescribed conditions of correct operation, in the form: ... °C/ ... °C.

7.1.3 Additional markings (I)

Additional markings may, if necessary, be required on an instrument according to its particular use or to certain special characteristics, such as:

- not to be used for direct sales to the public/commercial transactions;
- to be used exclusively for: .....;
- the stamp does not guarantee/guarantees only: .....;
- to be used only as follows: .....

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

7.1.4 Presentation of descriptive markings

- The descriptive markings shall be indelible and of a size, shape and clarity allowing easy reading.
- They shall be grouped in one or two clearly visible places either on a plate or sticker fixed permanently to the instrument, or on a non removable part of the instrument itself.
- In case of a plate or sticker which is not destroyed when removed, a means of securing shall be provided, e.g. a control mark that can be applied.

As an alternative all applicable markings in 7.1.1 (B) and 7.1.2 (G) above may be simultaneously displayed by a software solution either permanently or on manual command. In this case the markings are considered as device-specific parameters (see T.2.8.4, 4.1.2.4 and 5.5).

The markings: Max …,

Min …,

e = …, and

d = … if $d \neq e$

shall be shown at least in one place and permanently either on the display or near to the display in a clearly visible position. All additional information as mentioned in 7.1.1 (B) and 7.1.2 (G) above may be shown alternatively on a plate or simultaneously displayed by a software solution either permanently or accessed by a simple manual command. In this case the markings are considered as device-specific parameters (see T.2.8.4, 4.1.2.4 and 5.5).

It shall be possible to seal the plate bearing the descriptive markings unless its removal will result in its destruction. If the data plate is sealed, it shall be possible to apply a control mark to it.

Acceptable solutions:

a) Marking of Max, Min, *e* ... and *d* if $d \neq e$:

These values are permanently and simultaneously shown on the display of the weighing result as long as the instrument is switched on.

They may be automatically scrolled (displayed alternating one after each other) in one display. Automatically scrolling (but not on manual command) is considered as "permanently".

b) Marking for multi-interval and multi range instruments:

In special cases, some of the markings should be in the form of a table. See examples in Figure 8.

Figure 8

For a multi-interval instrument

Max 2/5/15 kg
Min 20 g
e = 1/2/5 g

For an instrument with more than one weighing range (W_1, W_2)

	W_1	W_2
Max	20 kg	100 kg
Min	200 g	1 kg
e =	10 g	50 g

For an instrument with weighing ranges in different classes

	W_1 (II)	W_2 (III)
Max	1 000 g	5 000 g
Min	1 g	40 g
e =	0.1 g	2 g
d =	0.02 g	2 g

- c) Fixing
  - If a plate is used it shall be secured e.g. by rivets or screws with one of the rivets of red copper or material having qualities recognized as similar or by using non removable control marks.
  - It should be possible to secure the head of one of the screws by appropriate means (e.g. by means of a cap of suitable material inserted in a device that cannot be dismantled or other appropriate technical solution).
  - The plate may be glued or consist of a transfer provided its removal results in its destruction.
  - d) Dimensions of the letters. The height of capital letters should be at least 2 mm.

- 7.1.5 Specific cases
  - 7.1.1-7.1.4 apply in their entirety to a simple instrument made by one manufacturer.
  - When a manufacturer builds a complex instrument or when several manufacturers are involved in making a simple or complex instrument, the following additional provisions shall be applied.

7.1.5.1 Instruments having several load receptors and load measuring devices

- Each load measuring device which is connected or can be connected to one or more load receptors, shall bear the descriptive markings relating to these, with:
  - identification mark;
  - maximum capacity;
  - minimum capacity;
  - verification scale interval; and
  - maximum safe load and maximum additive tare effect (if appropriate).

7.1.5.2 Instruments consisting of separately-built main parts

- If main parts cannot be exchanged without altering the metrological characteristics of the instrument,
- each unit shall have an identification mark which shall be repeated in the descriptive markings.

7.1.5.3 Separately tested modules

For load cells having an OIML R 60 Certificate, the markings according to OIML R 60 apply.

For other modules (indicators and weighing modules) the markings according to Annex C or D apply. Each module shall, however, bear at least the following descriptive markings for identification:

- type designation;
- serial number; and
- manufacturer (mark or name).

Other relevant information and characteristics shall be specified in the respective OIML Certificate (kind of module, fraction p_i of the maximum permissible error, OIML Certificate number, accuracy class, Max, e, etc.) and should be written in a document accompanying the respective module.

7.1.5.4 Peripheral devices

Peripheral devices that are mentioned in an OIML Certificate shall bear the following descriptive markings:

- type designation;
- serial number;
- manufacturer; and
- other information as far as applicable.

7.2 Verification marks

An instrument shall have a place for the application of verification marks.

This place shall:

- be such that the part on which it is located cannot be removed from the instrument without damaging the marks;
- allow easy application of the marks without changing the metrological qualities of the instrument; and
- normally be visible without the instrument having to be moved when it is in service.

Note: If technical reasons restrict or limit the verification mark(s) to be fixed only in a "hidden" place (e.g. when an instrument – in combination with another device – is integrated in other equipment) this can be accepted if these marks are easily accessible, and if there is a legible notice provided on the instrument in a clearly visible place that points to these marks or if its location is defined in the operation manual, the OIML Certificate and OIML Test Report.

Acceptable solution:

An instrument required to bear verification marks shall have a verification mark support, at the place provided for above, which ensures the conservation of the marks:

a) when the mark is made with a stamp, this support may consist of a strip of suitable metal or any other material with qualities similar to lead (for example plastic, brass, etc. depending on national legislation), inserted into a plate fixed to the instrument, or a cavity bored in the instrument; or

b) when the mark is of the self-adhesive type, a space should be provided on the instrument for the application of this mark.

Acceptable solutions

For application of the verification marks a stamping area of at least 150 mm^2 is required.

If self-adhesive stickers are used as verification marks the space for these stickers should have a diameter of at least 15 mm. These marks should be adequately durable for the intended use of the instrument, e.g. by means of suitable protection.

Type of Metrological controls

- Type approval
  - Application for type approval
  - Process of Type evaluation
- Initial verification
- Subsequent metrological control
  - Subsequent verification
  - Service inspection

8.2 Type approval

- **8.2.1 Application for type approval**
- The application for type approval shall include the submission to the approving authority of normally one instrument representative of the submitted type.
- The modular approach (3.10.2) and testing of a family of instruments or modules (3.10.4) may be more appropriate and efficient.
- The applicant shall provide the following information, as far as applicable and in accordance with national legislation.

- **8.2.1.1 Metrological characteristics**
  - characteristics of the instrument, as in 7.1(**Descriptive markings**); and
  - specifications of the modules or components of the measuring system as in 3.10.2(**Modules**).
- **8.2.1.2 Descriptive documents**
  - Note: The numbers in parentheses in the table below refer to clauses in this Recommendation.

8.2.1.2 Descriptive documents

Item	Documentation required
1	General description of the instrument, description of the function, intended purpose of use, kind of instrument (e.g. platform, plus-minus scale, price labeler).
2	General characteristics (manufacturer; Class, Max, Min, *e*, *n*, single-/multi-interval, multiple range, temperature range, voltage, etc.).
3	List of descriptions and characteristic data of all devices and modules of the instrument.
4	Drawings of general arrangement and details of metrological interest including details of any interlocks, safeguards, restrictions, limits, etc.
4.1	Securing components, adjustment devices, controls, etc. (4.1.2), protected access to set-up and adjustment operations (4.1.2.4).
4.2	Place for application of control marks, securing elements, descriptive markings, identification, conformity and/or approval marks (7.1, 7.2).
5	Devices of the instrument.
5.1	Auxiliary, or extended indicating devices (3.4, 4.4.3, 4.13.7).

8.2.1.2 Descriptive documents

Item	Documentation required
5.2	Multiple use of indicating devices (4.4.4).
5.3	Printing devices (4.4.5, 4.6.11, 4.7.3, 4.14.4, 4.16).
5.4	Memory storage devices (4.4.6).
5.5	Zero-setting, zero-tracking devices (4.5, 4.6.9, 4.13.2).
5.6	Tare devices (4.6, 4.10, 4.13.3) and preset tare devices (4.7, 4.13.4).
5.7	Leveling device and level indicator, tilt sensor, upper limit of tilting (3.9.1).
5.8	Locking devices (4.8, 4.13.5) and auxiliary verification devices (4.9).
5.9	Selection of weighing ranges on multiple range instruments (4.10).
5.10	Connection of different load receptors (4.11).
5.11	Interfaces (types, intended use, immunity to external influences instructions (5.3.6)).

8.2.1.2 Descriptive documents

5.12	Peripheral devices, e.g. printers, secondary displays, for including in the type approval certificate and for connection for the disturbance tests (5.4.2).
5.13	Functions of price-computing instruments (e.g. for direct sales to the public) (4.14), self-service (4.13.11), price labeling (4.16).
5.14	Other devices or functions, e.g. for purposes other than determination of mass (not subject to conformity assessment).
5.15	Detailed description of the stable equilibrium function (4.4.2, A.4.12) of the instrument.

8.2.1.2 Descriptive documents

6	Information concerning special cases.
6.1	Subdivision of the instrument in modules - e.g. load cells, mechanical system, indicator, display - indicating the functions of each module and the fractions p_i . For modules that have already been approved, reference to test certificates or type approval certificates (3.10.2), reference to evaluation to R 60 for load cells (Annex F).
6.2	Special operating conditions (3.9.5).
6.3	Reaction of the instrument to significant faults (5.1.1, 5.2, 4.13.9).
6.4	Functioning of the display after switch-on (5.3.1).

8.2.1.2 Descriptive documents

7	Technical description, drawings and plans of devices, sub-assemblies, etc. particularly those in 7.1-7.4.
7.1	Load receptor, lever systems if not according to (6.3.2-6.3.4), force transmitting devices.
7.2	Load cells, if not presented as modules.
7.3	Electrical connection elements, e.g. for connecting load cells to the indicator, including length of signal lines (necessary for surge test, see B.3.3).
7.4	Indicator: block diagram, schematic diagrams, internal processing and data exchange via interface, keyboard with function assigned to any key.
7.5	Declarations of the manufacturer, e.g. for interfaces (5.3.6.1), for protected access to set-up and adjustment (4.1.2.4), for other software based operations.
7.6	Samples of all intended printouts.

8.2.1.2 Descriptive documents

8	Results of tests performed by the manufacturer or from other laboratories, on protocols from R 76-2, including proof of competence.
9	Certificates of other type approvals or separate tests, relating to modules or other parts mentioned in the documentation, together with test protocols.
10	For software controlled instruments or modules, additional documents according to 5.5.1 and 5.5.2.2 (Table 11).
11	Drawing or photo of the instrument showing the principle and the location of verification and securing marks are to be applied, which is necessary to be included in the OIML Certificate or Test Report.

- All documents of the weighing instrument with the exception of the drawing or photograph (item 11) shall be kept confidential by the approving authority, except to the extent agreed with the manufacturer.

8.2.2 Type evaluation

- The submitted documents shall be examined to verify compliance with the requirements of this Recommendation (*OIML R76*).
- Suitable checks shall be performed to establish confidence that the functions are performed correctly in accordance with the submitted documents. Reactions to significant faults need not be triggered.
- The instruments shall, on the basis of **3.10(Type evaluation tests and examinations)** and with test standards according to **3.7.1(Weights)**,
- be submitted to the testing procedures of Annex A, and of Annex B if applicable. For peripheral devices see **3.10.3(Peripheral devices)**.

- **8.2.2 Type evaluation**
- The approving authority may, in special cases, require the applicant to supply test loads, equipment and personnel to perform the tests.
- The approving authorities are advised to consider the possibility of accepting, with the consent of the applicant, test data obtained from other national authorities, without repeating these tests.
- They may, at their discretion and under their responsibility, accept test data provided by the applicant for the submitted type, and reduce their own tests accordingly.

Next section

1 Brief Introduction of weighing instruments

2 Overview of R 76

3 **Type Evaluation Tests according R76**

Type Evaluation Tests (*Annex A R76*)

Weighing Performance Test
Eccentricity
Discrimination and Sensitivity
Repeatability
Time dependence
Stability of equilibrium
Tilting
Tare
Warm-up test
Voltage various
Temperature test
Temperature effect on no-load indication
Endurance

Type Evaluation Tests (*Annex B R76*)

Short time power reduction
Electrical bursts: (a) Power supply lines (b) I/O circuits and communication lines
Electrical discharge:(a) Direct application (b) Indirect application
Surge
Immunity to radiated electromagnetic fields
Damp heat, steady state
Span stability test

Additional tests for electronic instruments (Mandatory)

National Institute of Metrology

Thank you very much for your attention!