

INTERNATIONAL  
RECOMMENDATION

**OIML R 76-5**

Edition 202x (E)

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Non-automatic weighing instruments

Part 5: Verification

Instruments de pesage à fonctionnement non automatique

Partie 5: Vérification

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## Foreword

**LATEST FOREWORD TO BE ADDED BY THE BIML**

## Non-automatic weighing instruments

### Part 5 – Verification

#### 1 Introduction

The applicable error limits and tests to be carried out during type approval and initial verification of a weighing instrument are described in OIML R 76-1.

This Part recommends

- the type of inspections or tests that should be carried out during verification and in-service inspection, considering the limited time and budget available for these activities,
- the type and amount of test-equipment to be used for verification of various types of weighing instruments,
- verification intervals for various types of weighing instruments as well as calibration intervals for reference weights, and
- specific guidance on verification topics.

The focus of this part of the Recommendation is the verification of weighing accuracy. The verification of software, data storage, price computation, printing and Point-of-Sale (POS) systems is not covered. These inspection tasks are typically conducted using specially developed checklists.

*Note:* The information presented in italics is provided as examples or as suggested guidance for verification inspectors or accredited / authorised bodies. Several notes are provided to illustrate a variety of ways the verification inspection and tests can be modified or simplified.

#### 2 Verification activities

The different activities associated with evaluation, verification and inspection are summarized below:

**Table 1 – Verification activities**

Verification activity	Short description	Conducted by <sup>2</sup>
Type evaluation or approval (see also R 76-1, 10.2)	In depth system evaluation, comprehensive functional testing, including influence of environmental conditions such as temperature, humidity, EMC, compatibility checking of modules.	National metrology institute or accredited body
Initial verification	Tests carried out on a certified weighing system either directly after production, or after installation on site.	National metrology institute or accredited body
Subsequent verification	Tests carried out periodically, that cover a subset of initial verification.	Verification inspector or authorised body
In-service inspection	Short verification that could be done at any time, with error limits being twice those of initial verification.	Verification inspector or authorised body

### 3 General recommendations for verification

This section summarises the verifications that should be conducted, depending on the type of weighing instrument. The list of tests normally applied at initial verification is taken as a reference.

*Note:* The verification procedure can be optimised depending on the type of instrument and the application:

The cost of the verification should be covered by the prices fixed in the verification catalogue. The handling of heavy weights and other logistics can be time-consuming and the verification costs must be reasonable.

For example, for a weighing instrument of 1000 kg capacity which is essentially used for weighing containers between 100 kg and 300 kg, the repeatability test could be carried out at 300 kg instead of  $0.8 \times \text{Max}$  as specified in R 76-2, 5.10.

#### 3.1 Initial verification: Summary of tasks

This section describes a summary of tasks carried out for initial verification (see Table 2). These are considered the minimum tests to be carried out on weighing instruments. Verification inspectors may repeat tests or perform additional tests based on the circumstances of the inspection.

**Table 2 - Initial Verification – Summary of Tasks**

No	R 76 reference	Test Description
1		Inspect the instrument's descriptive plate and record: <ul style="list-style-type: none"> <li>▪ manufacturer, type &amp; serial number,</li> <li>▪ instrument characteristics Min, Max, <math>e</math>, <math>d</math>, accuracy class, and temperature range, and</li> <li>▪ type approval mark,</li> </ul>
		Record load receptor dimensions
2		Record information on the weighing instrument: <ul style="list-style-type: none"> <li>▪ application field;</li> <li>▪ certification validity;</li> <li>▪ version of software or checksum, if applicable; and</li> <li>▪ modules, if applicable.</li> </ul>
3		Inspect environmental conditions: The instrument must conform to accuracy class and temperature range, and be protected from dust and water for accuracy classes I, II, III. Determine if the location and installation of the instrument are appropriate: The instrument must be level and / or installed properly on a suitable support.
4		Gravity check for accuracy classes I, II, III instruments which are not equipped with an internal adjustment system.
5	R 76-2, 5.1.10	Preload with $1 \times \text{Max}$
6	R 76-1, 6.4.3	Test overload indication (at $\text{Max} + 9e$ )
7	R 76-1, 6.7.1 R 76-2, 5.2.1	Test range of zero-setting
8	R 76-1, 6.7.2 R 76-2, 5.2.3	Test accuracy of zero setting
9	R 76-2, 5.8 R 76-2, 5.9	Discrimination test (only for instruments with analogue indication) Sensitivity test (only for non-self-indicating instruments)
10	R 76-1, 5.5.4 R 76-2, 5.10	Repeatability test
11	R 76-1, 5.5.5 R 76-2, 5.7	Eccentricity test
12	R 76-2, 5.4	Performance test: increasing and decreasing loads from zero to Max

No	R 76 reference	Test Description
13	R 76-2, 5.6	Test subtractive tare: performance test with tare = Max/2 Test additive tare: successive performance tests followed by tare until the total weighing capacity is reached
14	R 76-2, 6.1.3	Tilt test, specific to “mobile” weighing instruments
15		Marking and securing, initial verification mark

### 3.2 Recommended tasks to be carried out at first subsequent verification

- Record the information on the weighing instrument into an instrument verification database or register;
- Carry out tasks 1, 2, 3, 4 (refer to table 2) as done at initial verification;
- Take photos of the weighing instrument, indication and descriptive marking;
- Determine the optimal verification procedure taking into consideration the instrument type and its application; and
- Define the verification interval according to national regulations.

### 3.3 Tasks to be carried out at any subsequent verifications

Assuming the same authorised body is in charge, the administrative tasks already carried out at first subsequent verification are no longer required. Other tasks may be simplified:

- Tasks 1, 2, 3, 4 having been already carried out at first verification, just check that the instrument's descriptive plate is still present and readable;
- Tasks 6, 7, 8: the overload indication, weighing range, and accuracy of zero-setting are supposed to work identically as long as the instrument has not been modified.
- Task 9: the discrimination and sensitivity are implicitly tested during the performance tests.
- Task 14: the tilt test of mobile instruments is not conducted unless the firmware has been modified or level sensors replaced or adjusted.

**Commented [ID1]:** These need to be considered.

The preload (task 5), repeatability (10), eccentricity (11), performance (12) and tare (13) tests are important and should be carried out.

The existence of securing (task 15) must be checked and the verification mark must be affixed.

*Note:* In order to reduce the number of handling for high capacity weighing scales above 100 kg:

- The repeatability test (10) can be carried out with a reduced load corresponding to the application instead of  $0.8 \times \text{Max}$ ;
- The eccentricity test (11) can be carried out using rolling loads, and for weighbridges a forklift or pallet truck, loading successively the different areas of the load receptor can be used;
- The performance test (12) can be carried out on a limited number of points, but at least three points for each partial weighing range (for multi-interval and multiple range instruments);
- The tare weighing test can be performed numerically by deduction from the performance test (refer to section R 76-2, 5.6.1), and
- The measuring range may be reduced.

### 3.4 Reverification required after modification or repair of a weighing instrument

A secured weighing instrument must be re-verified and sealed after modification or repair. Typical examples are:

- replacement of a load cell, an amplifier or indicator,

- internal adjustment for improvement of weighing accuracy,
- modification of the load receptor,
- modification of the measuring range (see note 4),
- addition of an auxiliary indicating device,
- seal broken by accident.

*Note 1:* Typically weighing instruments are approved as being suitable for a specific application or location (e.g. environment, support, viewing position in direct-sale situations) and reverification may be necessary when an instrument is relocated, or is used in a different weighing application.

*Note 2:* In order to reduce the logistic costs related to such an action, the final test can be carried out by the service technician in the presence of the verification inspector who is in charge of approval and sealing.

*Note 3:* Depending on national regulations and on the type of modification, an “initial verification” may be required.

*Note 4:* The measuring range of a high capacity weighing scale which is never used up to maximum capacity may be reduced in order to facilitate the verification task. A typical example is a 60 t weighbridge used for weighing trucks, which are in any case limited to 40 t due to national regulations.



4       **Examples of equipment for verification**

This section describes the typical test equipment recommended to allow a verification inspector to conduct an adequate test of typical weighing instruments.

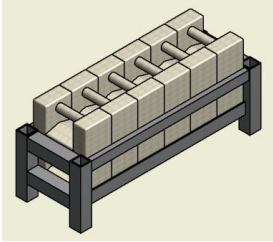
**Table 3 - Typical equipment for verification**

Maximum capacity	Equipment
Up to 100 kg	Set of weights from 1 g to 10 kg Set of additional weights: 2 × 0.1 g, 0.2 g, 0.5 g, 1 g, 2 g, 5 g, 10 g <sup>1</sup>
100 kg to 500 kg	Van equipped with: <ul style="list-style-type: none"><li>▪ Set of weights from 1 kg to 10 kg</li><li>▪ 1-2 calibrated rack(s) including a set of 20 kg weights</li><li>▪ Sets of additional weights<sup>1</sup>: 2 × 10 g, 20 g, 50 g, 100 g</li></ul>
Over 500 kg up to 5000 kg Small weighbridge	Small truck equipped with: <ul style="list-style-type: none"><li>▪ 2-4 calibrated racks, each including a set of 20 kg weights,</li><li>▪ Set of 500 kg weights,</li><li>▪ Sets of additional weights<sup>1</sup>: 2 × 100 g, 200 g, 500 g, 1 kg</li></ul>
Over 5 t to 50 t weighbridge for trucks	Truck equipped with: <ul style="list-style-type: none"><li>▪ Set of 500 kg and 1000 kg weights.</li><li>▪ Sets of additional weights<sup>1</sup>: 2 × 1 kg, 2 kg, 5 kg, 10 kg, 20 kg</li></ul>

<sup>1</sup> These weights are used for determining changeover points of instruments with digital indication and without auxiliary indication (mainly class II & III instruments).



**Figure 1 - Set of calibrated weights from 1 g to 2 kg and a protective carrying case.**



**Figure 2 - Rack containing a set of 20 kg weights that can be handled by a pallet truck or a crane**



**Figure 3 - Van for the verification of medium-size weighing instruments, equipped with a crane, 2-4 racks containing 20 kg weights, a set of 500 kg weights, sets of additional weights, and various accessories**



**Figure 4 - Truck for weighbridge verification, total weight 40 t, equipped with a set of 500 kg and 1000 kg weights that can be handled by a pallet truck**

## 5 Class of weights to be used

This section provides guidance on the class of weight to be used, which is determined based on the accuracy class of the weighing instrument (see Table 4).

**General rule:** The uncertainty or maximum permissible error of reference weights, expressed in weighing units, must be not greater than 1/3 of mpe.

**Table 4 - Weight classes for use with weighing instruments**

Class of weighing instrument	Class of weights according to OIML R 111-1	Relative uncertainty of weights in ppm (parts per million)
I	E <sub>2</sub> / F <sub>1</sub>	1.6 / 5
II	F <sub>1</sub> / F <sub>2</sub>	5 / 16
III	M <sub>1</sub> , M <sub>2</sub>	50 / 160
III	M <sub>3</sub> or better	500

*For example:* Use class M<sub>1</sub> weights with a relative uncertainty of 50 ppm to test a class III retail scale with Max = 10 000 g and  $e = 2$  g.

Measuring range	mpe	Class M <sub>1</sub> weight uncertainty in g	Ratio weight uncertainty / mpe
0 to 1 000 g	$\pm 0.5 e = \pm 1 \text{ g}$	0.05 g at 1000 g	5 %
1 000 g to 4 000 g	$\pm 1.0 e = \pm 2 \text{ g}$	0.2 g at 4000 g	10 %
4 000 g to 10 000 g	$\pm 1.5 e = \pm 3 \text{ g}$	0.5 g at 10 000 g	16.7 %

**Conclusion:** In the worst case, which is at full scale, the reference weight uncertainty is 0.5 g, i. e. negligible compared to an mpe of 3 g.

## 6 Recommended verification and calibration intervals

This section describes:

- recommended verification intervals for a variety of weighing instruments, and
- recommended calibration intervals for reference weights.

**Table 5 - Recommended verification intervals**

Type of weighing instrument	Verification interval <sup>1, 2, 3</sup>
Weighing instruments used intensively (over 500 weighing per year), and mobile instruments	1-2 years
Weighing instruments used occasionally and mechanical weighing instruments	2-4 years

<sup>1</sup> Verification intervals are determined using many factors, and are based on the history of reverification results and typical applications, and depend on, among other factors, frequency of use, typical load, environment, maintenance, and handling.

<sup>2</sup> Instruments used for high-cost products or in high volume weighing should be tested more frequently by the end-user based on a risk-based analysis.

<sup>3</sup> Most class I and II precision scales are equipped with an internal adjustment function that can be activated periodically, typically every day.

**Table 6 - Recommended calibration intervals for reference weights**

Type of reference weights	Calibration interval <sup>4</sup>
Set of weights of class E <sub>2</sub> , F <sub>1</sub> , F <sub>2</sub> made of stainless steel, protected in a suitcase and handled with much care	4-6 years
Set of weights of class F and M, frequently used and without special care, subject to wear and dust	1-2 years

**Note:** In case of very frequent use, or after having been used in a harsh industrial environment, doubtful weights should be verified before the calibration deadline using a precision scale or a comparator.

## 7 Specific topics dealing with verification

### 7.1 Procedure for evaluation of errors for instruments without auxiliary indication

For instruments of class III and IIII without an auxiliary indicating device, the evaluation of errors using small additional weights ( $1/10 e$ ) may be a demanding task. This procedure shows how to proceed using a single additional weight of  $\Delta L = 0.5 e$ :

- Determine the maximum permissible error “mpe” for the load applied using R 76-1 table 6 which is repeated below:

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

- 2) Apply the load to the load receptor.
- 3) If the load and the indication are the same, no further testing is required, as the indication is within the mpe in all cases. The assessment is: Pass
- 4) If the load and the indication are not the same, then use table below:

MPE	$I_1$	$\Delta L$	$I_2$	Assessment
$\pm 0.5 e$	$L - 1e$	-	-	Fail
	$L$	-	-	Pass
	$L + 1e$	-	-	Fail
$\pm 1.0 e$	$L - 2e$	-	-	Fail
	$L - 1e$	$+0.5 e$	$L - 1e$	Fail
	$L - 1e$	$+0.5 e$	$L$	Pass
	$L$	-	-	Pass
	$L + 1e$	$+0.5 e$	$L + 1e$	Pass
	$L + 1e$	$+0.5 e$	$L + 2e$	Fail
	$L + 2e$	-	-	Fail
$\pm 1.5 e$	$L - 2e$	-	-	Fail
	$L - 1e$	-	-	Pass
	$L$	-	-	Pass
	$L + 1e$	-	-	Pass
	$L + 2e$	-	-	Fail
$\pm 2.0 e$	$L - 3e$	-	-	Fail
	$L - 2e$	$+0.5 e$	$L - 2e$	Fail
	$L - 2e$	$+0.5 e$	$L - 1e$	Pass
	$L \text{ to } L \pm e$	-	-	Pass
	$L + 2e$	$+0.5 e$	$L + 2e$	Pass
	$L + 2e$	$+0.5 e$	$L + 3e$	Fail
	$L + 3e$	-	-	Fail
$\pm 3.0 e$	$L - 4e$	-	-	Fail
	$L - 3e$	$+0.5 e$	$L - 3e$	Fail
	$L - 3e$	$+0.5 e$	$L - 2e$	Pass
	$L \text{ to } L \pm e$	-	-	Pass
	$L + 3e$	$+0.5 e$	$L + 3e$	Pass
	$L + 3e$	$+0.5 e$	$L + 4e$	Fail
	$L + 4e$	-	-	Fail

where:

$L$  = applied load

$I_1$  = indication after applying load on load receptor

$I_2$  = indication after applying additional weight  $\Delta L$

## 7.2 Repeatability test

The mpe for the repeatability test is described in R 76-1, 5.5.4 and the procedure is explained in R 76-2, 5.10.

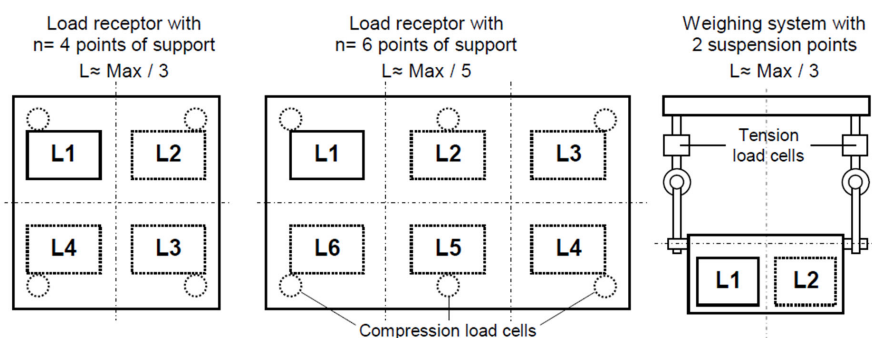
*Note:* For subsequent verification one series of weighings with about  $0.8 \times \text{Max}$  is sufficient. Three weighings on classes III and IIII or six weighings on classes I and II are necessary.

## 7.3 Eccentricity test

As described in R 76-2, 5.7, the load shall be applied over each support on an area of the same order of magnitude as the fraction  $1/n$  of the surface area of the load receptor, where  $n$  is the number of points of support. Load to be applied, according to R 76-1, 5.5.5:

- for  $n = 2$  to  $4$ :  $L \approx \text{Max} / 3$
- for  $n > 4$ :  $L \approx \text{Max} / (n - 1)$

Here are several examples of eccentricity loading:

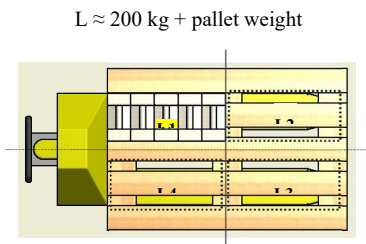
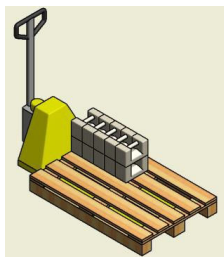


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#### 7.4 Example of eccentricity loading for a hand pallet truck

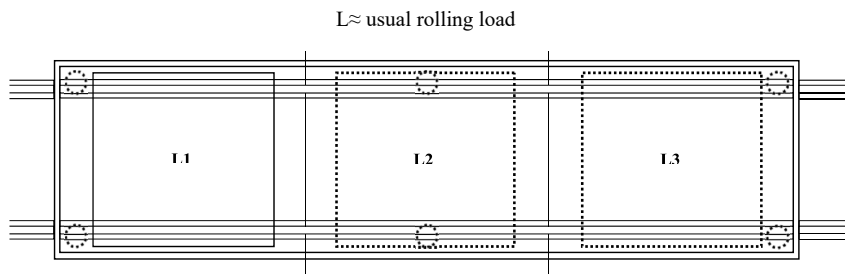
Load receptor with  $n = 4$  points of support,  $\text{Max} = 600 \text{ kg}$ ,  $e = 0.5 \text{ kg}$

A wooden pallet should be systematically used to be close the practical application.



#### Example of eccentricity loading for rail weighbridge:

Due to the railway track, the rolling load cannot be positioning on the left and right sides. As stated in R 76-2, 5.7.4, the rolling load should be applied at the beginning, the middle and at the end of the load receptor, in both directions, and with a test load corresponding to the usual rolling load. Taking into account the high capacity (up to 150 t) of a rail weighbridge, the application of a test load equal to  $1 / (n - 1)$  of  $\text{Max}$  may not be possible.



#### 7.5 Weighing Performance using substitution loads

The conditions for using substitution loads are defined in R 76-1, 5.6.3 and the substitution procedure is explained in R 76-2, 5.4.5.

*Note:* For subsequent verification, the condition for the substitution load is more tolerant than for the initial verification: if the repeatability error is not greater than  $0.3 e$ , the portion of standard weights may be reduced from  $1/2 \text{ Max}$  to  $1/5 \text{ Max}$ .

## 7.6 Weighing Performance of wheel load scales and crane scales

Due to their limited surface (typically  $500 \times 700$  mm) and to their high capacity (typically 5 t to 10 t), wheel load scales cannot be tested up to full scale using calibrated weights.

Due to their limited dimensions and their high capacity (typically 3 t to 20 t), crane scales can hardly be tested up to full scale using calibrated weights.

Portable wheel load scales with control unit



Crane scale



*Note: The weighing performance must be carried out using a specific test equipment that can be: a mechanical press equipped with a calibrated reference load cell or proving ring, or a dead load machine, which is typically only available in metrology institutes.*

## 7.7 Correction of the gravity value

For class I and II weighing instruments equipped with a self-adjustment system, the effect of gravity change and buoyant force of the environmental air are automatically compensated. For class III weighing instruments, the effect of local gravity is negligible.

For other weighing instruments, most of them being of class III, the following rule can be considered:

If the indication error due to the gravity change is greater than  $1/3$  of the mpe, then the gravity value  $g_1$  shall be corrected in the setup of the instrument:

$$\Delta m_{\text{grav}} = m_t \frac{g_{\text{local}} - g_1}{g_1}$$

where:  $\Delta m_{\text{grav}}$  = indication error due to gravity change  
 $m_t$  = mass of test load  
 $g_{\text{local}}$  = local gravity  
 $g_1$  = gravity value at place of adjustment, normally written on the nameplate

See additional information on local gravity at: <http://www.ptb.de/cartoweb3/SISproject.php>

## 7.8 Verification of class I and II weighing instruments

- For class I and II weighing instruments equipped with a self-adjustment device, the self-adjustment must be carried out just before verification in order to compensate the effect of local gravity and air buoyancy.

- b) For class I weighing instruments, an internal self-adjustment device is mandatory, because the effects of the gravity and air buoyancy cannot be neglected. The air density variation essentially depending on  $p$  (hPa) and  $T$  (°C) may affect the measurement by the same order magnitude as the accuracy of the instrument (i.e. 10 ppm).
- c) For class II weighing instruments not equipped with a self-adjustment device, the local gravity value must be verified in the setup of the instrument.
- d) For class I and II weighing instruments, special care must be taken of environmental conditions and weighing instrument installation:
  - The instrument shall be installed on a stable table or other firm support with a smooth and level surface, ideally a heavy marble or concrete table or bench that is non-magnetic and is protected against electrostatic discharge.
  - The environment in which the weighing instrument is used must be controlled (e.g. air circulation, temperature, humidity and other factors such as the effects of magnetism, electrostatic forces, dust, moisture or other contaminants) in accordance with the requirements specified by the manufacturer of the instrument.



**BIBLIOGRAPHY**

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Ref.	Standards and reference documents	Description
[1]		
[2]		
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