BIDCARBON™

BITP 6

Non-automatic Weighing Instruments

Version 1.0

Contents

1. Name of Specifications

This BITP 6 may be cited as the BidCarbon Instrument Test Procedures for Non-automatic Weighing instruments.

2. Definitions

For further explanations of terms see General Information for Test Procedures.

(1) ***Adjustment*** means the measurement parameters to bring the instrument within the allowable MPEs for an instrument in use.

(2) ***the articles*** means the charity's articles of association.

(3) ***the charity*** means the company intended to be regulated by the articles;

(4) ***company*** means the BidCarbon Foundation, under the Companies Act 2006 as a private company, that the company is limited by guarantee, and the situation of its registered office is in England and Wales.

(5) ***Calibration*** means the set of operations that (under specified conditions) establishes the relationship between the indicated or nominal value of an instrument and the corresponding known value of the measured quantity.

(6) ***foreign law*** means a law of a foreign country.

(7) ***foreign country*** includes a region where:

- (a) the region is a colony, territory or protectorate of a foreign country; or
- (b) the region is part of a foreign country; or
- (c) the region is under the protection of a foreign country; or
- (d) a foreign country exercises jurisdiction or control over the region; or
- (e) a foreign country is responsible for the region's international relations.

(8) ***In-service Inspection*** means the examination of an instrument by a ***External auditors*** to check that:

- (a) the verification mark is valid; and
- (b) the errors do not exceed the MPEs permitted for in-service inspection.

In-service inspection does not permit the instrument to be marked with a verification mark.

(9) ***Verification*** means the examination of an instrument by a ***External auditor, servicing licensee or an employee of a servicing licensee*** in order to mark the instrument indicating that it conforms with the relevant test procedures.

(10) ***classes E_1*** has the meaning given by the OIML R 111-1 published by OIML.

(11) ***classes E_2*** has the meaning given by the OIML R 111-1 published by OIML.

(12) ***classes F_1*** has the meaning given by the OIML R 111-1 published by OIML.

(13) ***classes F_2*** has the meaning given by the OIML R 111-1 published by OIML.

(14) ***External auditor*** means a registered greenhouse and energy auditor who is registered as a External auditor under subsection 6.25 (3) of the Greenhouse Gas Reporting Specifications.

(15) ***Initial verification*** means the verification of a new instrument which does not bear a verification mark and has never been verified before.

(16) ***OIML*** followed by a number (for example, OIML R 111-1) means a standard of that number issued by the International Organization of Legal Metrology (Organisation Internationale de Métrologie Légale, OIML) and, if a date is included, of that date.

(17) ***Biochar Trade Specifications*** means the Biochar Trade Measurement (Packaging) Specifications.

3. Scope

BITP 6 describes the test procedures for the verification and in-service inspection of non-automatic weighing instruments to assess whether they measure to within the maximum permissible errors (MPEs) specified in the *Biochar Trade Specifications*.

The charity does not issue OIML certificates. Manufacturers must contact the OIML Issuing Authority for ***OIML Certificate(s) of Approval***.

OIML Certificates of Approval are based on *OIML R 76-1. Non-automatic Weighing Instruments. Part 1: Metrological and Technical Requirements — Tests*. Refer to OIML R 76-1 for all metrological and technical requirements.

Note: Some extracts from OIML R 76-1 have been modified slightly to improve clarity. The specifications for unclassified non-automatic weighing instruments are given in Appendix C.

4. Equipment

(1) Eligible offsets project use an equipment model that:
   (a) not registered for an OIML Certificate, but other equipment made by the manufacturer of that equipment model is registered for an OIML Certificate(s); or
   (b) have registered OIML certificates.

(2) It is essential that appropriate and sufficient reference standards of measurement are in place to ensure that the combined uncertainties and variations are not greater than one-third of the MPE for the load applied to the instrument being tested. The appropriate maximum permissible uncertainty or variation as specified in OIML R 111 must be used in this case.

   Table 1 specifies the minimum reference standards of measurement required, though depending on the instrument, additional or higher accuracy standards may be required.

   Note: The reference standards of measurement are often simply referred to as weights or standard weights.

(3) Suitable substitution load materials.

(4) It is essential that uncertainties and variations comply with local national weights and measures laws and regulations.

(5) Test reports (see Appendix A).

5. Visual Inspection

Visually inspect the instrument for the required data and characteristics of the instrument. Where required record details on the test report.

5.1. Required Data

(1) Test report reference number.
(2) Date of test.
(3) Type of test: verification or in-service inspection (for in-service inspection or reverification ensure that the verification mark is in place).
(4) Verifier's name
(5) Name of owner/user.
(6) Address of owner/user.
(7) Name of contact person on premises.
(8) Address of instrument location.
(9) Description of instrument.
(10) Manufacturer(s).

(11) Model.
(12) Serial number.
(13) OIML Certificate(s) of Approval number, if applicable.
(14) The metrological characteristics including: Max, Min, verification scale interval (e) and accuracy class.

Table 1. Appropriate minimum reference standards of measurement

Instrument class	Minimum reference standards of measurement required
OIML classes F_1, F_2 and External auditor	OIML classes F_1 and External auditor standards of appropriate denominations or weights.
OIML classes M_1, M_2 and External auditor with 30 kg capacity or less	• A set of Inspector's standards as follows: 1 × 50 mg, 1 × 100 mg, 2 × 200 mg 1 × 500 mg, 1 × 1 g, 2 × 2 g 1 × 5 g, 1 × 10 g, 2 × 20 g 1 × 50 g, 1 × 100 g, 2 × 200 g 1 × 500 g, 1 × 1 kg, 2 × 2 kg 1 × 5 kg, 1 × 10 kg, 2 × 20 kg
OIML classes M_1, M_2 and External auditor exceeding 30 kg capacity but not exceeding 3 t	• A set of Inspectors' standards as follows: 1 × 1 g, 2 × 2 g, 1 × 5 g 1 × 10 g, 2 × 20 g, 1 × 50 g 1 × 100 g, 2 × 200 g, 1 × 500 g 1 × 1 kg, 2 × 2 kg, 1 × 5 kg 1 × 1 t
OIML classes M_1, M_2 and External auditor exceeding 3 t	• A set of Inspectors' standards as follows: 1 × 100 g, 2 × 200 g, 1 × 500 g 1 × 1 kg, 2 × 2 kg, 1 × 5 kg 1 × 1 t, 1 × 2 t

5.2. Characteristics of the Instrument

Where applicable the instrument and its use shall comply with the following clauses:
(1) The instrument shall comply with its OIML Certificate(s) of Approval.
(2) The instrument shall be used in an appropriate manner.
(3) All mandatory descriptive markings shall be clearly and permanently marked on a data plate.
(4) The data plate shall be fixed on the instrument.
(5) The instrument shall be complete.
(6) The instrument shall be clean.
(7) The instrument shall be operational.
(8) Where applicable, the level-indicating device shall be secured and functional.
(9) The instrument shall be level.
(10) There shall be no apparent obstructions to the operation of the instrument.
(11) The instrument shall be mounted on a firm base.
(12) The operator (and where applicable, the customer) shall have a clear and unobstructed view of the indicating device and the whole weighing operation.

(13) The instrument shall be adequately protected against abnormal dust, air movement, vibrations, atmospheric conditions and any other influence likely to affect its performance.
(14) Where applicable, the steelyard, tare bar or proportional weight shall comply with the mandatory requirements in respect to design and marking.
(15) For overhead track weighing instruments: the weigh rail shall be of an acceptable form and correctly aligned.
(16) For suspended weighing instruments: the instrument shall hang freely from the point of support, and all transparent covers shall be in good repair.
(17) For weighbridges: the weighbridge shall comply with:
    (i) The Measuring Instruments Regulations 2016; or
    (ii) a foreign law that corresponds to a law mentioned in paragraph (i).

6. Standard Procedures

This section contains two standard procedures which are used a number of times. Whenever one of these procedures is referred to, an appropriate reference is made to it.

6.1. Maximum Permissible Error

The maximum permissible errors for verification and in-service inspection are shown in Table 2.

Table 2. MPEs for verification and in-service inspection, for loads, m, expressed in verification scale intervals, e

MPEs	OIML class F_1 and External auditor	OIML class F_2 and External auditor	OIML class M_1 and External auditor	OIML class M_2 and External auditor
±0.5e	0 < m ≤ 50 000	0 < m ≤ 5 000	0 < m ≤ 500	0 < m ≤ 50
±1e	50 000 < m ≤ 200 000	5 000 < m ≤ 20 000	500 < m ≤ 2 000	50 < m ≤ 200
±1.5e	200 000 < m	20 000 < m ≤ 100 000	2 000 < m ≤ 10 000	200 < m ≤ 1 000

To determine whether or not the indication is within the MPE for a particular load the following procedure is conducted.

Step 1 Determine the MPE for the load applied using Table 2.
Step 2 Apply the load to the load receptor.
Step 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. This is a: PASS

Step 4 If the load and the indication are **not** the same, then for:

(a) MPE of ±0.5e FAIL

(b) MPE of ±1e

(i) For a stable indication +1e from the load value apply an additional 0.5e. If the indication:

- **remains unchanged** the instrument is within MPE: PASS
- **changes up and stabilises** at +2e the instrument is outside MPE: FAIL

(ii) For a stable indication of –1e from the load value apply an additional 0.5e. If the indication:

- **changes up and stabilises** at the load value, the instrument is within MPE: PASS
- **remains unchanged** the instrument is outside MPE: FAIL

(iii) If the indication is greater than ±1e from the load value: FAIL

(c) MPE of ±1.5e

(i) for a stable indication of ±1e from the load value: PASS

(ii) for a stable indication that is more than ±1e from the load value: FAIL

6.2. Supplementary Weighing

This test procedure is only required:

- at initial verification;
- when any changes affect the initial zero-setting function.

For instruments with an initial zero-setting device with a range greater than 20% of Max, a supplementary weighing test shall be performed using the upper limit of the range as zero point (OIML R 76-1, clause A.4.4.2).

When the Certificate of Approval states that the instrument has an initial zero-setting range greater than 20% the performance procedure for repeatability, eccentricity, weighing performance and the discrimination tests are repeated at the positive limit of the initial zero-setting range. Steps 1 and 2 are completed once only. Steps 3 to 5 are carried out for all additional tests.

Step 1 Find the positive limit of the initial zero-setting range as follows:

(a) Set the instrument to zero with the load receptor empty.

(b) Apply a load equal to approximately 10% of Max on the load receptor and switch the main power supply to the instrument off and then back on. If the instrument:

(i) returns to zero:
increase the load by a small amount (e.g.10*e*) and switch the main power supply off and then back on; continue this process **increasing** the load by a small amount each time until the instrument does not re-zero;

(ii) does not display zero:
reduce the load by a small amount (e.g. 10*e*) and switch the main power supply off and then back on; continue this process **reducing** the load by a small amount (e.g. 10*e*) each time until the instrument displays zero.

(c) Continue step (i) or (ii) until the addition or removal of the small load (eg: 10*e*) resets the instrument to zero. This is the positive limit of the initial zero-setting range.

Step 2 Record this load on the test report.
Step 3 Apply a load equal to the positive limit of the initial zero-setting range.
Step 4 Switch the main power supply to the instrument off and then on.
Step 5 Repeat the appropriate test procedure and record the results on the test report.

7. Test Procedures

The following series of test procedures determine if the performance of a non-automatic weighing instrument meets requirements and whether the instrument requires adjustment or service.

Each test procedure is explained as a discrete test. However tests can be combined to expedite the testing procedure. A suggested sequence for testing is shown in section 8.

If an instrument is going to be used in a different geographical location, correct the gravity setting for the intended location. The effects of gravity can be up to 0.3% depending on the variation in latitude and altitude between the location of calibration and the location of use. Refer to the manufacturer's instruction manual.

7.1. Repeatability

The difference between the results of several weighings of the same load shall not be greater than the absolute value of the MPE of the instrument for that load (OIML R 76-1, clause 3.6.1).

This test procedure has been designed to check if the instrument will give a consistent result for the same load when it is applied a number of times in approximately the same position on the load receptor. For the result to be considered consistent, the difference between the largest and smallest readings for the same load must be no greater than the absolute value of the MPE for that load. For example, if the MPE for the load is equal to ±1e, the absolute value of this error is | ±1 | e = 1 e. See Appendix B.1 for a worked example.

Use a load which is just less than the second MPE change point. If the instrument has more or less than 2 MPE change points use a load, which is approximately two-thirds maximum capacity.

Check the OIML Certificate(s) of Approval to determine if the instrument has an initial zero-setting range greater than 20%. If it has, a supplementary test is required (see section 6.2).

Determine whether the instrument is:
- non-self-indicating;
- analogue indicating; or
- digital indicating.

Select and conduct the appropriate test as documented below.

7.1.1. Non-self-indicating Instrument

7.1.1.1. Platform Instrument

Step 1 Set the instrument to zero.
Step 2 Apply the load to the load receptor.
Step 3 Bring the indicating element to the equilibrium position using the proportional weights and/or steelyard poises and record the indication.
Step 4 Remove the load from the load receptor.
Step 5 Reset instrument to zero if the indication is not zero.
Step 6 Apply the load to the load receptor.
Step 7 Bring the indicating element to the equilibrium position using the proportional weights and/or steelyard poises and record the indication.
Step 8 Repeat steps 4 to 7 once more.

Step 9 Determine whether the instrument has passed or failed.
Step 10 Record the results on the test report.

7.1.1.2. Equal Arm Instrument

Step 1 Set the instrument to zero.
Step 2 Apply the load to the load receptor.
Step 3 Apply standard weights to the load receptor until the indicating element is in the equilibrium position and record the mass.
Step 4 Remove the load(s) from both load receptors.
Step 5 Reset instrument to zero if the indication is not zero.
Step 6 Repeat steps 2 to 4.
Step 7 Check that the difference between the loads applied for each application does not exceed the absolute value of the MPE for the load applied.
Step 8 Repeat steps 4 to 7 once more.
Step 9 Determine whether the instrument has passed or failed.
Step 10 Record the results on the test report.

7.1.2. Analogue Indicating Instrument

Step 1 Set the instrument to zero.
Step 2 Apply the load and record the indication.
Step 3 Remove the load.
Step 4 Reset instrument to zero if the indication is not showing zero.
Step 5 Repeat steps 2 to 4 two more times.
Step 6 Determine whether the instrument has passed or failed.
Step 7 Record results on the test report.

7.1.3. Digital Indicating Instrument

Step 1 Set the instrument to zero.
Step 2 Apply the load and set the displayed reading to centre e in the following way:
(a) apply $0.5e$ to the load receptor;
(b) apply additional standard weights of $0.1e$ with the load until the indication changes up and stabilises; then
(c) remove $0.5e$ leaving the additional standard weights with the load.
Step 3 Record the indication.
Step 4 Remove the load and the additional standard weights together as one load.
Step 5 Reset instrument to zero if the indication is not showing zero.
Step 6 Apply the load and the additional standard weights together as one load.
Step 7 Record the indication and determine whether the instrument has passed or failed in accordance with the following requirements:
(a) If the indication is the same as the previous test then simply repeat steps 4 to 6 with the same load. If all three loads show the same indication then this is a PASS.
(b) If the indication for the second or third load changes and stabilises at $\pm 1e$ from the original indication then it will be necessary to find each load's actual position to determine whether the instrument has passed or failed. Appendix B.1 provides an example of how to find the actual position of a load.
(c) If the indication for the second or third load changes and stabilises at a value greater than $\pm 1e$, then this is a FAIL.

Step 8 Record results on the test report.

7.2. Eccentricity

The indications for different positions of a load shall meet the MPEs, when the instrument is tested according to OIML R 76-1, clauses 3.6.2.1 to 3.6.2.4.

Determine whether the load receptor on the instrument has:

- four or less points of support;
- more than four points of support;
- is subject to minimal off-centre loading;
- is subject to rolling loads.

Select and conduct the appropriate test(s) outlined in sections 7.2.1 to 7.2.4. This test is not applicable for instruments with scoop receptors where the product measured gathers at the centre.

Note : If an instrument is designed in such a way that loads may be applied in different manners, it may be appropriate to apply more than one of the tests.

It is suggested that large standard weights be used in preference to several small standard weights. Smaller weights shall be placed on top of larger weights, but unnecessary stacking should be avoided within the segment to be tested. Apply the load centrally in the segment if a single weight is used, and uniformly over the segment if several small weights are used.

When an instrument with a capacity greater than 100 kg shows good zero return during the repeatability test, i.e. it has not been necessary to re-zero the instrument before returning the load to the load receptor, then it is not necessary to completely unload the instrument before returning the load to the load receptor.

Check the OIML Certificate(s) of Approval to determine if the instrument has an initial zero-setting range greater than 20%. If it has, a supplementary test is required (see section 6.2).

7.2.1. Instrument with a Load Receptor with Four or Less Points of Support

On an instrument with a load receptor with four or less points of support, a load corresponding to one-third of the sum of the maximum capacity and the corresponding maximum additive tare shall be applied (OIML R 76-1, clause 3.6.2.1).

Step 1 Divide the load receptor into four approximately equal segments. Assign numbers to the segments with position 1 to the left closest to the viewing position and then label the other segments in a clockwise direction as shown in Figure 1.

Step 2 Zero the instrument.

Step 3 Apply one-third of the Max at position 1.

Note : If the instrument has additive tare, use Max plus maximum additive tare, instead of Max.

Step 4 Record the load and the indication.

Step 5 Determine if the indication is within the MPE for the load applied (refer to section 6.1 for MPE check).

Step 6 Remove the load.

Step 7 Repeat steps 2 to 6 for all other points of support.

Step 8 Determine whether the instrument has passed or failed.

Step 9 Record results on the test report.

7.2.2. Instrument with a Load Receptor with more than Four Points of Support (e.g. Road Weighbridge)

Eccentricity may be tested using either:

- standard weights in the non-substitution method (see section 7.2.2.1); or
- a vehicle of known weight in the substitution method (see section 7.2.2.2).

7.2.2.1. Non-substitution Method

Step 1 Determine the number of support points.

Step 2 Divide the load receptor into n approximately equal segments, where n is the number of points of support. Note each point of support and assign numbers to the segments with position 1 to the left closest to the viewing position and then label the other segments in a clockwise direction as shown in Figure 2.

Note : For rail weighbridges, if two points of support are too close together for the load to be distributed as indicated above, double the load and distribute over twice the area on both sides of the axis connecting the two points of support.

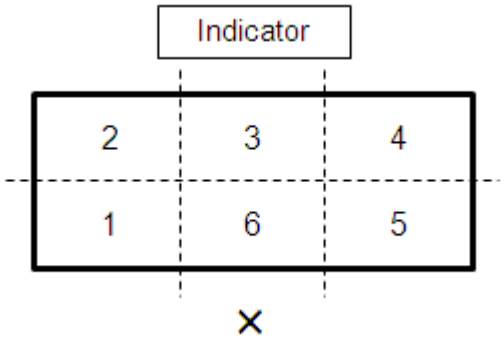


Figure 2. Position of each load (× indicates the viewing position)

Step 3 Zero the instrument.

Step 4 Apply 1/(n – 1) of the Max at location 1.

Note : If the instrument has additive tare, use Max plus maximum additive tare, instead of Max.

Step 5 Record the load and the indication.

Step 6 Determine if the indication is within the MPE for the load applied (refer to section 6.1 for MPE check).

Step 7 Remove the load.

Step 8 Repeat steps 3 to 7 for all other points of support.

Step 9 Determine whether the instrument has passed or failed.

Step 10 Record results on the test report.

7.2.2.2. Substitution Method

Use a suitable vehicle (e.g. a fork lift) to move the loads. Ensure that its:

- wheel track width does not exceed 0.5 the width of the load receptor;
- wheel base length does not exceed 1/n the length of the load receptor; and
- gross weight is greater than 0.5 times and less than the nominated weight required in section 7.2.2.1.

Step 1 Determine the number of support points.

Step 2 Divide the load receptor into n approximately equal segments, where n is the number of points of support. Note each point of support and assign numbers to the segments with position 1 to the left closest to the viewing position and then label the other segments in a clockwise direction as shown in Figure 2.

Note : For rail weighbridges, if two points of support are too close together for the load to be distributed as indicated, double the load and distribute over twice the area on both sides of the axis connecting the two points of support.

Step 3 Determine 1/(n – 1) of the Max

Note : If the instrument has additive tare, use Max plus maximum additive tare, instead of Max.

If this value is:

- **greater than** 5 t go to step 4;
- **less than or equal to** 5 t, use the non-substitution method in section 7.2.2.1.

Step 4 Determine the weight required for testing. The substitution load shall be:
(a) at least 0.5 of the weight determined in step 3; and
(b) no more than the weight determined in step 3.

Step 5 Zero the instrument.

Step 6 Place standard weights onto the load receptor in the required position, equal to or greater than the weight of the vehicle, provided it is within 0.3 t of the vehicle weight. Record this load (L).

Note : Ensure that the placement of the weights does not exceed the wheel track or base dimensions of the vehicle.

Step 7 Apply additional standard weights of 0.1e to the load until the indication changes up and stabilises.

Step 8 Record this additional load (ΔL) and the indication (I).

Step 9 Calculate the error in the weighbridge (E) for the load applied (L) using

$$E = I + 0.5e - \Delta L - L$$

Step 10 Remove the standard weights and ΔL. For digital instruments, ensure that a suitable load (eg: 10e) is left on the load receptor to avoid zero tracking.

Step 11 Drive the vehicle as close as possible to the footprint of the weights in step 6. Remove the 10e placed on the load receptor in step 10.

Step 12 Record the indication for the substitution load (I_{sub}).

Step 13 Add additional standard weights of 0.1e until the indication changes up and stabilises. Leave these additional standard weights (ΔL) with the substitution load.

Step 14 Calculate the actual load (L_{sub}) of the substitution load using

$$L_{sub} = I_{sub} + 0.5e - E$$

Step 15 Round the true value of L_{sub} to a whole scale interval L_{sub} (rounded) by applying or removing additional standard weights, keeping the weights with the vehicle.

Step 16 Reposition the vehicle to each point of support and record the indication.

Step 17 Determine if the instrument passes or fails. To pass each indication for all points of support must be within 0.5e of the applied load L_{sub} (rounded).

Note : If the instrument fails use the non-substitution method described in section 7.2.2.1.

Step 18 Record results on the test report.

7.2.3. Instrument with Special Load Receptors

On an instrument with a load receptor subject to minimal off-centre loading (e.g. tank or hopper) a load corresponding to one-tenth of the sum of the maximum capacity and the maximum additive tare shall be applied to each point of support (OIML R 76-1, clause 3.6.2.3).

Step 1 Divide the load receptor into n approximately equal segments, where n is the number of points of support. Note each point of support and assign numbers to the segments with position 1 to the left closest to the viewing position and then label the other segments in a clockwise direction.

Step 2 Zero the instrument.

Step 3 Apply one-tenth of the Max at location 1.

Note : If the instrument fails use the non-substitution method described in section 7.2.2.1.

Step 4 Record the load and the indication.

Step 5 Determine if the indication is within the MPE for the load applied (refer to section 6.1 for MPE check).

Step 6 Remove the load.

Step 7 Repeat steps 2 to 6 for all other points of support.

Step 8 Determine whether the instrument has passed or failed.

Step 9 Record results on the test report.

7.2.4. Instrument Used for Weighing Rolling Loads

On an instrument used for weighing rolling loads (e.g. rail weighbridge, overhead track scale or rail suspension instrument) a rolling load corresponding to the usual rolling load, the heaviest and the most concentrated one which may be weighed, but not exceeding 0.8 times the sum of the maximum capacity and the maximum additive tare, shall be applied at different points on the load receptor (OIML R 76-1, clause 3.6.2.4).

For the following procedure it is recommended that rolling loads be used. However if these are not available then it is appropriate to use the equivalent static load.

Step 1 Determine the positions 1, 2 and 3 at the beginning, middle and end of the load receptor respectively in the normal driving direction as shown in Figure 3. Indicate the location of each load by assigning a number to each position where the load will be placed. Position 1 is located furthest to your left when you view the indicator from a normal operating position. Positions 2 and 3 are numbered sequentially from position 1.

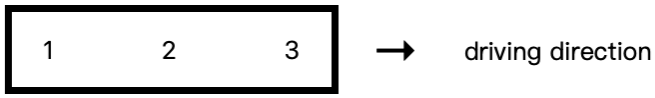


Figure 3. Load positions

Step 2 Zero the instrument.

Step 3 Apply a rolling load no greater than 0.8 Max plus maximum additive tare (if applicable) at location 1. The load selected should be representative of the way the instrument is normally used. It is recommended that the load is no smaller than 0.5 Max and no greater than 0.8 Max.

Step 4 Record the load and the indication.

Step 5 Determine if the indication is within the MPE for the load applied (refer to section 6.1 for MPE check).

Step 6 Remove the load.

Step 7 Repeat steps 2 to 6 at positions 2 and 3 and then in the reverse direction at positions 3, 2 and 1 in turn.

Step 8 Determine whether the instrument has passed or failed.

Step 9 Record results on the test report.

7.3. Zero-Setting and Zero-Tracking

After zero-setting the effect of zero deviation on the result of the weighing shall not be more than ±0.25e (OIML R 76-1, clause 4.5.2).

Determine whether the instrument is:

- non-self-indicating;

- analogue indicating; or
- digital indicating.

Select and conduct the appropriate test as documented below.

Additionally for digital indicating instruments, conduct a test of the operation of any zero-tracking device.

7.3.1. Non-self-indicating Instrument

Step 1 The accuracy of the zero-setting device of a non-self-indicating instrument can be checked at any stage of testing the instrument, as it is essential to ensure that an instrument is set on zero before commencing any procedure.

Step 2 At the completion of one of the test sequences, after removing the entire load, visually check that the instrument has returned to within ±0.25e of its equilibrium position. If it has not returned to its equilibrium position, apply 0.25e on the appropriate load receptor. Then:
- if the indicator has moved through the equilibrium point, the instrument has passed; or
- if the indicator has not moved through the equilibrium point, the instrument has failed.

Step 3 Record results on the test report.

7.3.2. Analogue Indicating Instrument

Step 1 The accuracy of the zero-setting device of an instrument with analogue indication can be checked at any stage during the testing of the instrument, as it is essential to ensure that an instrument is set on zero before commencing any procedure. At the completion of one of the test sequences, visually check that the instrument has returned to within ±0.25e of zero.

Step 2 Record results on the test report.

7.3.3. Digital Indicating Instrument

Step 1 The procedures used to determine the accuracy of zero-setting and test the operation of zero-tracking are only required:
- at initial verification;
- when any system changes affecting zero-setting or zero-tracking occur; or
- at OIML's discretion.

Step 2 The procedure for accuracy of zero-setting will depend on the instrument to be tested. If the instrument has:
- non-automatic or semi-automatic zero-setting, follow the procedure in section 7.3.3.1;
- automatic zero-setting, follow the procedure in section 7.3.3.2.

Step 3 The majority of instruments currently being used have non-automatic or semi-automatic zero-setting so in most cases follow the procedure in section 7.3.3.1.

Step 4 These tests are all conducted at a suitable load (e.g.: 10e) to take the instrument out of its zero-tracking range on the assumption that an electronic instrument will have zero-tracking and it will be in operation.

Step 5 At the completion of one of the test sequences, visually check that the instrument has returned to within ±0.25e of zero.

7.3.3.1. Non-automatic and Semi-automatic Zero-setting

Step 1 Activate the zero-setting device.
(a) Load the instrument using a standard weight that is within the zero-setting range (this range varies between 0 to 4% of Max, in most cases this is ±2% around zero).
(b) Add additional standard weights to take the total load just **below** the next changeover point.

Step 2 Re-set the indication to zero using the zero-setting device.

Step 3 Apply a suitable load (e.g.: 10*e*) to the load receptor to avoid zero-tracking.

Step 4 Apply an additional 0.25*e*. If the indication:
- remains unchanged, go to step 5;
- **changes and stabilises** at +1*e* from the original indication: FAIL

Step 5 If the indication remains unchanged in step 4, apply an additional 0.5*e*. If the indication:
- **changes and stabilises** at +1*e* from the original indication: PASS
- remains unchanged: FAIL

Step 6 Record results on the test report.

7.3.3.2. Automatic Zero-setting

Step 1 Activate the automatic zero-setting device in the following way:
(a) Apply a load of approximately 5*e*.
(b) Zero the instrument and then remove the load.
(c) Wait for the automatic zero-setting to occur and the indication displays zero, this should take a minimum of 5 seconds.

Note : If the display does not return to zero after 15 seconds, the instrument does not have automatic zero-setting, and you should carry out the procedure in section 7.3.3.1.

Step 2 Quickly apply 10*e* to the load receptor.

Step 3 Apply an additional 0.25*e*. If the indication:
- remains unchanged, go to step 4;
- **changes and stabilises** at +1*e* from the original indication: FAIL

Step 4 If the indication remains unchanged in Step 3, apply an additional 0.5*e*. If the indication:
- **changes and stabilises** at +1*e* from the original indication: PASS
- remains unchanged: FAIL

Step 5 Record results on the test report.

7.3.3.3. Zero-tracking

Step 1 Reset the instrument to zero using the zero-setting device.

Step 2 Apply 1*e* to the load receptor.

Step 3 If after 5 seconds the indicator
- **changes and stabilises** at 1*e*: PASS
- remains on zero: FAIL

Step 4 Record results on the test report.

7.4. Weighing Performance

This test procedure is used to establish the weighing performance of the instrument at several loads. When loading and unloading weights, the load shall be progressively increased and decreased. The loads shall be applied evenly distributed over the platform.

When loading and unloading the instrument it must not be allowed to zero-track. This is achieved by maintaining a suitable load (e.g.: 10*e*) on the instrument when loading and unloading. When the instruments normal mode of operation is weighing Max to Min, consider using five decreasing loads and three increasing loads. The MPEs for increasing and decreasing loads are shown in section 6.1.

Criteria for selecting increasing loads:

- Use at least five different loads.
- The loads must span from minimum to maximum capacity for the instrument in approximately equal steps.
- Include the loads at each MPE change point. When selecting the loads for a multi-interval instrument, which has partial weighing ranges, include all the MPE change points.
- Include any load where a unit weight or balance weight is used to engage another range.
- Include a load where the scale interval changes. If the instrument indication is likely from previous test loads to be the same or less than the applied load, the applied load can be the load where the scale interval changes. Otherwise, do not select this point, but instead it is recommended that a load 5e less than this point be used.
- Do not select maximum capacity if over-range blanking occurs at that point. It is recommended that a load of 5e less than maximum be used.

Criteria for selecting **decreasing** loads

- Use at least three different loads from maximum to minimum capacity for the instrument in approximately equal steps.

When testing instruments with a maximum capacity greater than 3 t, instead of standard weights any other constant load made up of substitution material may be used, provided that for instruments with maximum capacity:

- 3 t < Max ≤ 15 t, standard weights to at least 3 t, plus any additive tare are used; and
- >15 t, standard weights to at least 20% of the sum of max and any additive tare.

It is essential that this test be carried out after the repeatability and eccentricity tests, particularly if substitution materials are used.

Check the OIML Certificate(s) of Approval to determine if the instrument has an initial zero-setting range greater than 20%. If it has, a supplementary test is required (see section 6.2).

7.4.1. Weighing Performance Not Using Substitution Load Material

Step 1	Use the criteria in section 7.4 to determine the loads to be used in this test.
Step 2	Record these loads on the test report.
Step 3	Zero the instrument.
Step 4	Apply each load increasing from minimum to maximum.
Step 5	Determine if the indication is within the MPE for each load applied (refer to section 6.1 for MPE check).
Step 6	After applying maximum capacity apply a load up to 10e to ensure over-range blanking is correctly set.
Step 7	Remove the loads in a descending order until the minimum load has been removed.
Step 8	Determine if the indication is within the MPE for each load applied (refer to section 6.1 for MPE check).
Step 9	Check that the instrument has returned to within ±0.25e of zero.
Step 10	Determine whether the instrument has passed or failed.
Step 11	Record results on the test report.

7.4.2. Weighing Performance Using Substitution Load Material

This test should only be conducted if the instrument has satisfied the requirements for both repeatability and eccentricity. It can be difficult to obtain substitution material of the same value as the standard weights. This procedure contains instructions for two methods:

- use **method A** when the substitution material is within –10% of standard weights used or – 1 t, whichever is the smaller; and
- use **method B** when the substitution material is exactly equal to the standard weights.

The decision on which method to use will depend on the availability and suitability of the substitution material.

Step 1 Use the criteria in section 7.4 to determine the loads (minimum of 5) to be used in this test.

Step 2 Record these loads on the test report.

Step 3 Determine the number of substitutions required.

Step 4 Zero the instrument.

Step 5 Apply each load increasing from minimum up to maximum until a substitution load is required.

Step 6 At each increasing and decreasing load determine if the indication is within the MPE for the load applied (refer to section 6.1 for MPE check).

Step 7 When the maximum available standard weights have been applied (L) record the indication (I) then apply additional standard weights of 0.1e (ΔL) with the load until the indication changes up and stabilises.

Step 8 Calculate the actual error using the formula:

$$E = I + 0.5e - \Delta L - L$$

where:

E is the error in the weighbridge for the load applied;

I is the indication of the weighbridge;

L is the load applied; and

ΔL is the total of the additional standard weights required for the indication to change up to (1+*e*) and stabilise.

Step 9 Use either **method A** or **method B** depending on the availability of substitution materials.

Method A

(a) Remove the standard weights and ΔL. For electronic instruments make sure that a suitable load (e.g.: 10*e*) is left on the load receptor to avoid zero-tracking.

(b) Add substitution material until the indication (I_{sub}) is within –10% or –1 t, whichever is smaller, of the standard weights applied in step 7. The substitution material should be placed as close as possible to the same position on the load receptor.

(c) Record the indication for the substitution load (I_{sub}).

(d) Add additional standard weights of 0.1*e* until the indication changes up and stabilises. Leave these additional standard weights (ΔL) with the substitution load.

(e) Calculate the actual mass of the substitution load (L_{sub}) using the formula:

$$L_{sub} = I_{sub} + 0.5e - E$$

Note : The error may be positive or negative.

(f) Use L_{sub} plus standard weights to make the next load required for this test.

See Appendix B.2 for a worked example of method A.

Method B

(a) Remove the standard weights. For electronic instruments make sure that a suitable load (e.g.: 10*e*) is left on the load receptor to avoid zero-tracking.

(b) Leave ΔL on the load receptor.

(c) Replace the standard weights with substitution material. The substitution material should be placed as close as possible to the same position on the load receptor. Continue to add substitution material to the substitution load in sufficiently small increments (≤ 0.1*e*) until the indication changes up and stabilises at the same indicated value determined previously.

(d) Remove ΔL. The substitution material (L_{sub}) will then be equal to the standard weights (L) it is replacing, i.e. $L_{sub} = L$.

(e) Use $Lsub$ plus standard weights to make the next load required for this test.

Step 10 Continue to apply loads using the standard weights and further substitution material using the same procedure as before.

Step 11 After applying a load equal to the maximum capacity apply a load up to 10e to ensure over-range blanking is correctly set.

Step 12 Remove the loads in a convenient descending order until the minimum load has been removed.

Step 13 At each increasing and decreasing load determine if the indication is within the MPE for the load applied (refer to section 6.1 for MPE check).

Step 14 Check that the instrument has returned to within ±0.25e of zero.

Step 15 Determine whether the instrument has passed or failed.

Step 16 Record results on the test report.

7.5. Discrimination

The actual scale interval for a OIML class F_1 or F_2 or External auditor digital instrument may be *d* and not *e*. As the majority of instruments to be verified will be OIML class M_1 or M_2 or External auditor where *e* = *d*, the procedures below have been simplified to refer only to *e*. If the instrument to be tested has *d* ≠ *e* then *e* becomes *d* in this instance for the whole procedure.

Check the OIML Certificate(s) of Approval to determine if the instrument has an initial zero-setting range greater than 20%. If it has, a supplementary test is required (see section 6.2).

The test shall be conducted at the same load as the repeatability test (see section 7.1). Additionally, the test may be conducted at one or more other points at the discretion of the verifier.

Determine whether the instrument is:

- non-self-indicating;
- analogue indicating; or
- digital indicating.

Select and conduct the appropriate test as documented below.

7.5.1. Non-self-indicating Instrument

An extra load equivalent to 0.4 times the absolute value of the MPE for the applied load when gently placed on or withdrawn from the instrument at equilibrium shall produce a visible movement of the indicating element (OIML R 76-1, clause 3.8.1).

Step 1	Zero the instrument.
Step 2	Apply the load to the load receptor.
Step 3	Bring the instrument to its equilibrium position.
Step 4	Gently apply an extra load of 0.4 times the absolute value of the MPE for the applied load on the load receptor.
Step 5	Observe if there is a visible amount of movement of the indicator.
Step 6	Remove the load.
Step 7	Determine whether the instrument has passed or failed.
Step 8	Record results on the test report.

7.5.2. Analogue Indicating Instrument

An extra load equivalent to the absolute value of the MPE for the applied load when gently placed on or withdrawn from the instrument at equilibrium shall cause a permanent displacement of the indicating element corresponding to not less than 0.7 times the extra load (OIML R 76-1, clause 3.8.2.1).

Step 1	Zero the instrument.
Step 2	Apply a load to the load receptor and, bring the indication to a mark by applying a small amount of extra material to the load receptor.
Step 3	Record the initial indication (I_1).
Step 4	Gently apply an extra load equal to the absolute value of the MPE for the applied load on the load receptor.
Step 5	Record the new indication (I_2).
Step 6	Calculate the difference in the two indications ($I_2 - I_1$).
Step 7	Ensure that the change in indication determined in step 6 is greater than or equal to 0.7 times the extra load added in step 4.
Step 8	Determine whether the instrument has passed or failed.
Step 9	Record results on the test report.

7.5.3. Digital Indicating Instrument

An additional load equal to 1.4 times the verification scale interval, when gently placed on or withdrawn from the instrument at equilibrium shall change the initial indication by one actual scale interval (OIML R 76-1, clause 3.8.2.2).

This only applies to instruments with d greater than 5 mg.

Step 1	Zero the instrument.
Step 2	Apply a load to the load receptor.
Step 3	Apply additional standards weights of 0.1e until the indication changes up and stabilises.
Step 4	Record this indication.
Step 5	Gently apply a load of 1.4e. The indication should increase by 1e to the next scale interval.
Step 6	Determine whether the instrument has passed or failed.
Step 7	Record results on the test report.

7.6. Sensitivity

The sensitivity test is only performed on non-self-indicating instruments.

An extra load equivalent to the absolute value of the MPE for the applied load, shall be placed on the instrument at equilibrium and shall cause a permanent displacement of the indicating element of at least:

- 1 mm for an instrument of OIML class F_1 or F_2 or External auditor ;
- 2 mm for an instrument of OIML class M_1 or M_2 or External auditor with Max ≤ 30 kg; and
- 5 mm for an instrument of OIML class M_1 or M_2 or External auditor with Max > 30 kg.

The test shall be conducted at the same load as the repeatability test (see section 7.1).

The sensitivity tests shall be carried out by placing extra loads with a slight impact, in order to eliminate the effects of discrimination threshold (OIML R 76-1, clause 4.1).

Step 1	Zero the instrument.
Step 2	Apply a load to the load receptor.
Step 3	Bring the instrument to its equilibrium position.
Step 4	Apply an extra load equal to the absolute value of the MPE for the applied load.
Step 5	Measure and record the linear distance between the middle points of this reading and the reading without the extra load as the permanent displacement of the indication.
Step 6	Determine whether the instrument has passed or failed.
Step 7	Record results on the test report.

7.7. Accuracy of Tare Setting

This test is only required:

- at initial verification;
- when any changes affecting the tare function occur; or
- at OIML's discretion.

A tare device shall permit setting the indication to zero with an accuracy better than:

- ±0.25e for electronic instruments and any instrument with analogue indication;
- ±0.5d for mechanical instruments with digital indication and instruments with auxiliary indicating devices.

On a multi-interval instrument e shall be replaced by e_1 (OIML R 76-1, clause 4.6.3).

For any tare load applied, the MPE for the remaining weighing capacity is the same as if no tare was being used (OIML R 76-1, clause 3.7.3.4).

Step 1 Load the instrument using a weight that exceeds the tare capacity and ensure the tare facility is not functional.

Step 2 Activate the tare-setting device in the following way:

(a) Load the instrument using a weight that is within the tare-setting range.

(b) Add additional weights to take the total load just **below** the next changeover point.

Step 3 Re-set the indication to zero using the tare-setting device.

Step 4 Check the accuracy of tare-setting in the following way:

(a) Apply a suitable load (e.g.: 10*e*) to the load receptor to avoid zero-tracking.

(b) Apply an additional 0.25*e*. If the indication:

- **remains unchanged** go to step 4(c);
- **changes up and stabilises** +1*e* from the original indication: FAIL

(c) If the indication remains unchanged in step 4(b), apply an additional 0.5*e*. If the indication:

- **changes up and stabilises** +1*e* from the original indication: PASS
- **remains unchanged**: FAIL

(d) Record results on the test report.

(e) Remove the load applied in step 4(a) (e.g.: 10*e*), 0.25*e* and 0.5*e* to bring the indication back to zero.

Step 5 Check the tare weighing device in the following way:

(a) Ascertain whether the instrument has additive or subtractive tare.

(b) Determine the instruments remaining capacity.

(c) Add a load equal to full remaining capacity.

(d) Determine if the indication is within the MPE (refer to section 6.1 for MPE check).

Step 6 Record results on the test report.

7.8. Price Computation

This test is only required:

- at initial verification;
- when any changes affecting the price function occur; or
- at OIML's discretion.

On a price-indicating instrument the supplementary primary indications are unit price and total price and, if applicable, number, unit price and total price for non-weighed articles, prices for non-weighed articles and price totals. Price charts, such as fan charts, are not subject to the requirements of these test procedures (OIML R 76-1, clause 4.15.1).

The total price shall be calculated by multiplication of weight and unit price, both as indicated by the instrument. The instrument's indicated total price shall be within ±0.5 cents of the calculated total price. The device which performs the calculation is in any case considered a part of the instrument. The value of digital price scale intervals shall be 1 cent. All calculations shall be rounded to the nearest cent (OIML R 76-1, clause 4.15.3).

The price computation check is performed to check that the price calculating function is able to compute the total price. Conduct the check over a range of loads, and preferably during the weighing test.

Step 1 Apply a load to the load receptor and input an appropriate unit price. See Appendix B.3 for a worked example of appropriate loads and unit prices.

Step 2 Calculate the total price from the unit price and indicated weight.

Step 3 Compare the calculated total price with the indicated price.

Step 4 Repeat the test at least four more times.
Step 5 Determine whether the instrument has passed or failed.
Step 6 Record results on the test report.

8. Suggested Sequence for Testing

Step 1 Make sure any electronic instrument has been allowed to warm up for about half an hour.
Step 2 Check the OIML Certificate(s) of Approval for supplementary tests (section 6.2) and any additional tests required. Make provision for including these tests in the testing sequence.
Step 3 Visually inspect the instrument and make a record of its metrological characteristics.
Step 4 Conduct a repeatability test (section 7.1).
Step 5 Conduct a discrimination test (section 7.5) during the repeatability test.
Step 6 For non-self-indicating instruments, check zero-setting and zero-tracking (section 7.3) and sensitivity (section 7.6) during the repeatability test.
Step 7 Conduct an eccentricity test (section 7.2).
Step 8 Check zero-setting and zero-tracking (section 7.3), if applicable.
Step 9 Determine the loads and conduct a weighing performance test (section 7.4).
Step 10 For digital indicating instruments conduct an accuracy of tare setting test (section 7.7), if applicable.
Step 11 Conduct a price computation check (section 7.8), if applicable.
Step 12 Determine whether the instrument has passed or failed.
Step 13 Complete the test report.
Step 14 Carry out anything else you need to do to complete the procedure. See General Information for Test Procedures and the Certificate of Approval for more information. This may include:

- obliterating the verification mark from the instrument;
- applying a verification mark; and
- applying a seal.

A. Test Report

The following test report contains the minimum amount of information that must be recorded.

If the Certificate of Approval requires additional tests, attach pages that record the results of these tests.

Number each page of the test report in the style shown at the top of each page.

Test Report for Non-automatic Weighing Instruments

Test report reference number .....Date of test .....

Type of test (tick one) ▫ Verification ▫ In-service inspection

For in-service inspection or reverification, record the verification mark: .....

Name of owner/user .....

Address of owner/user .....

Name of contact person on premises .....

Address of instrument location, if applicable .....

Description of instrument .....

Manufacturer(s) .....Model .....

Serial number .....OIML Certificate(s) of Approval number .....

Max .....Min .....

Verification scale interval (*e*) .....Accuracy class .....

Characteristics of the Instrument (section 5.2)	**Indicate yes/ no or N/A**
Does the instrument comply with its OIML Certificate(s) of Approval?	
Is the instrument being used in an appropriate manner?	
Are all mandatory descriptive markings clearly and permanently marked on the data plate?	
Is the data plate fixed on the instrument?	
Is the instrument complete?	
Is the instrument clean?	
Is the instrument operational?	
Is the level-indicating device (if fitted) secured and functional?	
Is the instrument level?	
Are there any apparent obstructions to the operation of the instrument?	
Is the instrument mounted on a firm base?	
Does the operator (and where applicable, the customer) have a clear and unobstructed view of the indicating device and the whole weighing operation?	
Is the instrument adequately protected against abnormal dust, air movement, vibrations, atmospheric conditions and any other influence likely to affect its performance?	
If applicable, does the steelyard, tare bar or proportional weight comply with the mandatory requirements in respect to design and marking?	

Characteristics of the Instrument (section 5.2)	Indicate yes/ no or N/A
For overhead track weighing instruments: is the weigh rail of acceptable form and correctly aligned?	
For suspended weighing instruments: does it hang freely and are all transparent covers in good repair?	
For weighbridges: does it comply with the national weights and measures laws or regulations of the local country.	
For additional indicating devices and point of sale systems: do they comply with the applicable general supplementary certificates S1/0B or S1/0/A (or S1/0 or S2/0) or relevant OIML Certificate(s) of Approval?	

Test Results

Eccentricity (section 7.2.2) using either:

- **non-substitution** method (section 7.2.2.1); **or**

Number of supports:			
Load used:			
Position 1		Position 7	
Position 2		Position 8	
Position 3		Position 9	
Position 4		Position 10	
Position 5		Position 11	
Position 6		Position 12	

- **substitution** method (section 7.2.2.2)

MPE change points:								
Available standard weights:								
L	Makeup of load	MPE	$0.5e$	I	ΔL	E	L_{sub}	L_{sub} (rounded)

Eccentricity Result:	☐ Pass ☐ Fail

Weighing performance (section 7.4) using either:

- **non-substitution** method (section 7.4.1); **or**

Loads applied (minimum 5)	Indication up	Indication down

Over-range blanking:	☐ Pass	☐ Fail

- **substitution** method (section 7.4.2)

Method used:	☐ Method A ☐ Method B
MPE change points:	
Available standard weights:	
First substitution load:	
Second substitution load:	
Third substitution load:	

Up	L	Makeup of load	MPE	I	$0.5e$	ΔL	E	L_{sub}	L_{sub} (rounded)	Pass/ Fail or N/A

Over-range blanking		☐ Pass ☐ Fail			
Down	L	Makeup of load	MPE	I	Pass/Fail

Weighing performance Result:	☐ Pass ☐ Fail

Repeatability (section 6.1)	Load		
	First reading		
	Second reading		
	Third reading		
	Difference		
	▫ Pass	▫ Fail	
Zero-setting and zero-tracking (section 7.3)	▫ Pass	▫ Fail	
Discrimination (section 7.5)	▫ Pass	▫ Fail	
Sensitivity (section 7.6)	▫ Pass	▫ Fail	▫ N/A
Accuracy of tare setting (section 7.7)	▫ Pass	▫ Fail	▫ N/A
Price computation (section 7.8)	▫ Pass	▫ Fail	▫ N/A

Comments.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Verifier's name .....Identification number.....

Signature.....

B. Worked Examples

B.1. Repeatability Test — How to Find the Actual Position of a Load (see section 7.1.3)

1. In the case where the indication for the second and/or third load changes and stabilises at ±1e from the original indication the maximum difference may still be less than or equal to the absolute value of the MPE. In this case the actual value for each load must be found in order to determine if the instrument has passed or failed the test. You can calculate these actual values as shown in Figure B.1. As the first load was set at centre e the actual position P_1 is equal to the actual true value of the scale interval.

2. To find the actual value P_2 for the second position of the load, you first record the indication I_2. Then add additional weights of 0.1e until the indication changes up and stabilises. The total mass of the additional weights you add is ΔL_2. Substitute the values you have recorded in the formula: $P_2 = I_2 + 0.5e - \Delta L_2$.

3. Repeat using the values for the third position of the load to find $P_3 = I_3 + 0.5e - \Delta L_3$.

4. To find the difference take the smallest value (in the example above this is P_1) from the largest value (in the example above this is P_3). If this value is:

   (a) less than or equal to the absolute value of the MPE, the instrument has: PASSED

   (b) greater than the absolute value of the MPE, the instrument has: FAILED

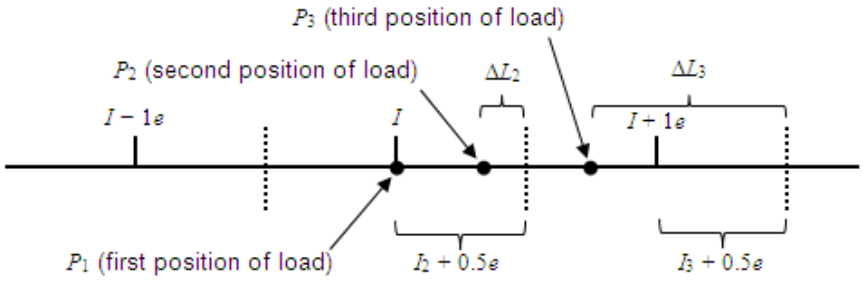


Figure B.1. Finding the actual position of the load

B.2. Weighing Performance using Substitution Load Material used (see section 7.4.2)

In this example method A is used.

The instrument is a OIML class M_1 or External auditor non-automatic weighbridge with a maximum capacity of 60 t and an e value of 0.02 t (20 kg).

There are 16 t of standard weights including suitable standard weights to achieve minimum capacity and indication changeover points. Also available is a test rig and forklift (Sub 1) with a gross mass of approximately 16 t and a truck loaded with gravel (Sub 2) with a gross mass of approximately 32 t.

In selecting the loads you are required to use at least 5 loads, to include Min, first MPE change point, second MPE change, Max and appropriate substitution loads. The loads for the example shown below are: 0.4 t, 10 t, 16 t, 32 t, 40 t, 44 t and near Max.

This example demonstrates both graphical and mathematical solutions for the substitution loads only. The graphical representation shows where the load actually is and how the errors associated

with that load can be determined. The mathematical solution simply confirms the findings of the graphical solution by inserting the values into the appropriate formula.

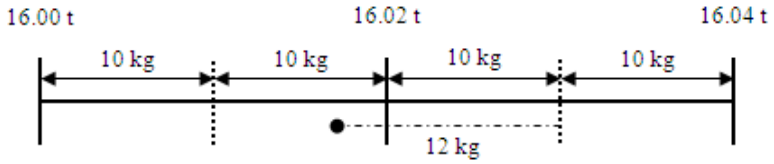
The results have been recorded on a sample test report at the end of this example.

The first test load applied is equal to the minimum capacity of the instrument. This load is made up of standard weights and equals 0.4 t.

The second test load applied is equal to the first MPE change point. The load is made up of standard weights and equals 10 t.

The third test load applied is made up of standard weights and equals 16 t.

Because this is the point at which the first substitution is required you need to determine the error of the weighbridge using the 16 t of standard weights. This is represented graphically as follows:



When the 16 t of standard weights were placed on the weighbridge the indication displays 16.02 t (I). Added in steps of 2 kg ($0.1e$), a further 12 kg of standard weights (ΔL) was required to take it to the next indication changeover point and stabilise.

Using the diagram you can see it is 10 kg plus another 8 kg more than 16 t. Graphically we can see the error is +0.018 t or 18 kg.

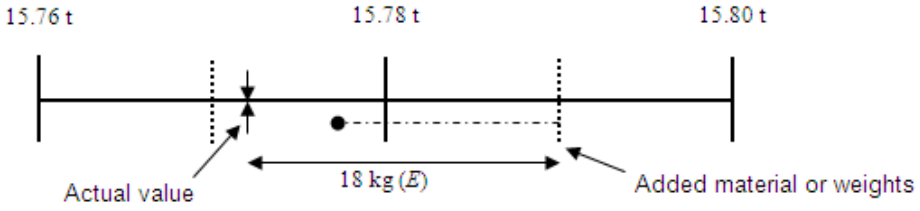
Mathematically using the formula

$E = I + 0.5e - \Delta L - L$ we can calculate E as

$= 16.02\text{ t} + 0.01\text{ t} - 0.012\text{ t} - 16.00\text{ t}$

$= +0.018\text{ t or } +18\text{ kg.}$

Next determine the true value of the first substitution load (Sub 1). Do this by placing the substitution load on the weighbridge. At this point the indication displays 15.78 t (I_{sub}). This is represented graphically as follows:



Take the weighbridge to the next indication changeover point, which is 15.79 t. Do this by adding standard weights in steps of 2 kg ($0.1e$) until the indication changes up and stabilises at 15.80 t. The additional standard weights become part of the substitution load. The actual value of the substitution load is the indication changeover point less the error.

The calculated error in the weighbridge at this point is +18 kg. Taking this into account the point labelled actual is the true position for the substitution load. Graphically we can see the value of the substitution load is:

$$15.79\text{ t} - 0.018\text{ t (error)} = 15.772\text{ t}$$

Mathematically using the formula

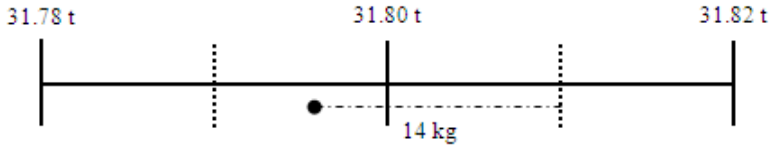
$L_{sub} = I_{sub} + 0.5e - E$ (at 16 t) we can calculate

L_{sub} = 15.78 t + 0.01 t – 0.018 t = 15.772 t

Bring the substitution load to a round figure by adding an additional 8 kg of standard weights. The substitution load now becomes 15.78 t (true value of the substitution load).

The fourth test load applied is made up of Sub 1 plus 16 t of standard weights. This load equals 31.78 t.

Calculate the error for the weighbridge when using this new known load of 31.78 t. When the load is placed on the weighbridge the indication reads 31.80 t (I). This is represented graphically as follows:



A further 14 kg of standard weights (ΔL) was required to take it to the next indication changeover point and stabilise. Using the diagram you can see it is 16 kg more than 31.78 t. Graphically we can see the error is +0.016 t or 16 kg.

Mathematically using the formula

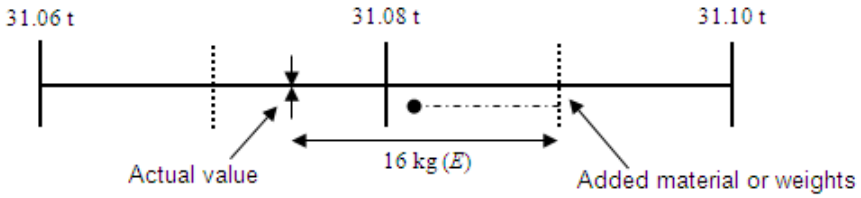
$E = I + 0.5e - \Delta L - L$ we can calculate E as

$= 31.80 \text{ t} + 0.010 \text{ t} - 0.014 \text{ t} - 31.78 \text{ t}$

$= +0.016 \text{ t or } 16 \text{ kg}$

Now you know the error at this point of the weighbridge you can apply the second substitution load (Sub 2).

Next determine the true value of the second substitution load (Sub 2). Do this by placing the substitution load on the weighbridge. At this point the indication displays 31.08 t (I_{sub}). This is represented graphically as follows:



Take the weighbridge to the next indication changeover point which is 31.09 t. Do this by adding more standard weights in steps of 2 kg ($0.1e$) until the indication changes up and stabilises at 31.10 t. This additional material or standard weights becomes part of the substitution load. The actual value of the substitution load is the indication changeover point less the error.

The calculated error in the weighbridge at this point is 16 kg. Taking this into account the point labelled actual is the true position for the substitution load. Graphically we can see the value of the substitution load is 31.09 t – 0.016 t (error) = 31.074 t.

Mathematically using the formula

$L_{sub} = I_{sub} + 0.5e - E$ (at 31.78 t)

$= 31.08 \text{ t} + 0.01 \text{ t} - 0.016 \text{ t} = 31.074 \text{ t}$

Bring the substitution load to a round figure by adding an additional 6 kg of standard weights. The substitution load now becomes 31.08 t (true value of the substitution load).

The fifth test load applied is close to second MPE change point. It is made up of Sub 2 plus 8 t of standard weights. This load equals 39.08 t.

The sixth test load applied is made up of Sub 2 plus 16 t of standard weights. This load equals 47.08 t.

Remove standard weights and add the test rig and forklift that was used for Sub 1. This becomes Sub 3. Determine true value of L_{sub} through method previously used. Alternatively, the true value could be determined directly as a combination of the values of Sub 1 and Sub 2.

The final test load applied is made up of Sub 3 plus 13 t of standard weights. This load equals 59.86 t.

After you have carried out the test at 59.86 t apply a load up to $10e$ above Max in order to check that the over-range blanking is correctly set.

Remove all the loads in a convenient manner applying the appropriate MPEs for the load and ensuring zero returns to within $\pm 0.25e$.

Results of Weighing Performance Using Substitution Load

Instrument description: OIML class M_1 or External auditor static weighbridge

Max: 60 t

Verification scale interval (*e*): 0.02 t

Method used:	☑ Method A ▫ Method B
MPE change points:	10 t, 40 t
Available standard weights:	16 t
First substitution load:	Test rig + forklift (approximate mass16 t)
Second substitution load:	Gravel truck (approximate mass 32 t)
Third substitution load:	Test rig + forklift + gravel truck (approx 48 t)

Up	L	Makeup of load	MPE	I	$0.5e$	ΔL	E	L_{sub}	L_{sub} (rounded)	Pass/ Fail/ na
	0.4 t	weights	±0.01 t	0.4 t	—	—	—	—	—	pass
	10 t	weights	±0.01 t	10 t	—	—	—	—	—	pass
	16 t	weights	±0.02 t	16.02 t	0.01 t	0.012 t	+0.018 t	—	—	pass
	Sub 1	Test rig + forklift	—	15.78 t	0.01 t	—	+0.018 t	15.772 t	**15.78 t**	na
	31.78 t	Sub 1 + 16 t	±0.02 t	31.80 t	0.01 t	0.014 t	+0.016 t	—	—	pass
	Sub 2	Gravel truck	—	31.08 t	0.01 t	—	+0.016 t	31.074 t	**31.08 t**	na
	39.08 t	Sub 2 + 8 t	±0.02 t	39.10 t	0.01 t	0.016 t	+0.014 t	—	—	pass
	47.08 t	Sub 2 + 16 t	±0.03 t	47.10 t	0.01 t	0.016 t	+0.014	—	—	pass
	Sub 3	Sub 1 + Sub 2	—	46.86 t	0.01 t	—	+0.014	46.856 t	46.86 t	na
	59.86 t	Sub 3 + 13 t	±0.03 t	59.88 t	0.01 t	0.018 t	+0.012 t	—	—	pass

Over-range blanking	☑ Pass ▫ Fail

Down	L	Makeup of load	MPE	I	Pass/Fail
	59.86 t	Sub 3 + 13 t	±0.03 t	59.86 t	pass
	28.78 t	59.86 t – Sub 2	±0.02 t	28.78 t	pass
	13 t	28.78 t – Sub 1	±0.02 t	13.00 t	pass

	10 t	13 t – 3 t	±0.01 t	10.00 t	pass
	0 t	—	±0.25*e*	0	pass

B.3. Appropriate Loads and Unit Prices for Price Computing (see section 7.8)

Table B.1 provides an example of appropriate loads and unit prices.

Table B.1. Calculation of the total price from the unit price and indicated weight

Indicated weight (kg)	Unit price ($/kg)	Total price ($)
0.40	0.01	0.00
0.50	0.01	0.01
1.00	123.45	123.45
1.00	678.90	678.90
Test up to Max capacity	Test up to Max unit price	Calculated result

C. Specifications for Unclassified Non-automatic Weighing Instruments

Appendix C sets out the specifications for unclassified non-automatic weighing instruments. These instruments do not have a class mark and comply with the OIML Certificate(s) of Approval relating to that instrument.

C.1. General

Every instrument shall:

(a) be clearly and permanently marked with the capacity and scale interval, on or in the vicinity of any mass-indicating device;

(b) be clearly and permanently marked with the manufacturer's name or mark and serial number;

(c) have a lead cap (stamp plug) located in one of the following positions:

  (i) on the beam of a beam-scale vertically under or over the fulcrum knife edge;

  (ii) on the beam of a counter scale;

  (iii) on the steelyard, dial or housing of other weighing instruments; and

(d) have every steelyard, lever or beam fitted so as to prevent excessive lateral play, the instrument being correct if the knife edges and bearings are moved within their limits of movement.

C.2. Removal or Inter-changeability of Parts

Instruments shall not have parts, the removal of which would affect their accuracy, if they can be used without such parts; or have parts the interchange or reversal of which would affect their accuracy.

C.3. Scale Marks

The scale marks (including the price scale marks) on an indicating device shall be straight lines of uniform thickness, uniformly spaced and with an aspect ratio of not less than two. The principal lines shall be numbered clearly and legibly and marked by longer lines; and, unless every scale mark is numbered progressively from zero, there shall not be more than four consecutive marks of the same length.

This applies provided that on fan-shaped dials a uniform variation in scale spacing shall be permitted such that the mean width of the 5 largest consecutive divisions shall not be more than 20% larger than the mean width of the 5 smallest consecutive divisions.

The scale marks on any steelyard shall be parallel and, if there are notches, shall be correctly placed with reference to such notches; notches shall be uniformly spaced in one plane at right angles to the shank and be protected by a notch-protection bar.

C.4. Form of Digits on Indicators

Indications shall permit readings by simple juxtaposition of the digits and all digits comprising mass, unit price and price indications shall be oriented in the normal viewing position, apart from instruments with fan-shaped dials.

The height, or apparent height, of digits comprising the mass and price indications on analogue indicators shall not be less than three times the minimum reading distance in millimetres, without being less than 2 mm.

The height, or apparent height, of digits comprising the mass and price indications on digital indicators (other than ticket printers) and semi-digital indicators shall not be less than three times the minimum reading distance in millimetres, without being less than 5 mm.

C.5. Printing Requirements

Printed data shall be clear and indelible. If the mass or quantity and price are printed, the unit price or price per item shall also be printed. The decimal marker shall be printed by the printer and shall not be pre-printed on the ticket.

Where statements (numerical value and designation) of mass or quantity, unit price or price per item and price are on one horizontal line there shall be a space of at least one digit between each statement.

Numbers and their designations shall be horizontally aligned. The designations of mass or quantity, unit price or price per item and price shall follow the same horizontal alignment as the numerals or shall all be located immediately above or below them.

When printing a number with a value less than one, the decimal marker shall be preceded by at least one zero digit (one preferred).

C.6. Value of Scale Interval

The value of the scale interval shall be in the form 1, 2 or 5×10^k milligrams, grams, kilograms or tonnes, where k is a positive or negative whole number or zero.

C.7. Scale Spacing

The minimum scale spacing shall be:

(a) 1.25 mm for dial-indicating devices;
(b) 1.75 mm for optical-projection indicating devices;
(c) 5 mm for numerical-analogue indicating devices with or without optical projection;
(d) 2 mm for tare bars and steelyards; and
(e) 2.5 mm for spring balances of a capacity exceeding 15 kg and crane weighers on which the dial is an integral part of the mechanism suspended from the hook.

C.8. Reading Aperture for Analogue Indicators

When an analogue indicator is viewed through an aperture, the width of the aperture, measured along the line of travel of the indicator, shall be such as to allow the numbers of at least two numbered scale marks to be visible at all times.

C.9. Reading Index

C.9.1. Length

The tip of the index shall reach the shortest scale marks, but shall not extend beyond the middle of the marks. However this clause shall not apply to:

(a) an index consisting of a fine wire or thread stretched over the scale marks, including a hairline on a ground glass screen;
(b) an instrument in which the index moves over two concentric sets of scale marks; and
(c) an instrument in which the index is in the same plane as the scale marks and is not more than 1 mm from any scale mark.

C.9.2. Width

The width of the index shall not be greater than the thickness of the scale marks.

C.9.3. Index Stops

Stops shall limit the travel of the index but shall permit the index to move at least four scale intervals below zero and above maximum self-indicating capacity. On fan-shaped dials and single-revolution dials, there shall be no scale marks below zero and above maximum dial capacity.

C.9.4. Parallax

The distance between the dial and the index shall not exceed the width of a scale interval, without exceeding 2 mm.

C.10. Lowest Permitted Maximum Capacity

The lowest permitted maximum capacity, in relation to the scale interval, for a self-indicating instrument or a graduated non-self-indicating instrument is given in Table C.1, provided that:

(a) on a spring balance of 50 kg capacity or over, the scale interval shall not be more than 1/200 of the capacity;

(b) for instruments used only for the weighing of persons, freight, coal, solid fuel, or animals, or for pit-bank weighing instruments, the lowest permitted maximum capacity shall be half that specified in Table C.1; and

(c) scale intervals of 1 kg are permitted to be used on instruments for determining the weight of excess baggage at airports.

Table C.1. Lowest permitted Max

Scale interval	Lowest permitted maximum capacity	Minimum number of scale intervals[a,b]
5 g	250 g	50
10 g	500 g	50
20 g	2 kg	100
50 g	10 kg	200
100 g	25 kg	250
200 g	100 kg	500
500 g	250 kg	500
1 kg	500 kg	500
2 kg	1 t	500
5 kg	2.5 t	500
10 kg	10 t	1 000
20 kg	20 t	1 000
50 kg	50 t	1 000
100 kg	100 t	1 000

[a] Number of scale intervals = capacity/scale interval

[b] Not applicable to centre-zero instruments

C.11. Zero-setting

A zero-setting device, if fitted, shall comply with the following rules:

(a) the range shall not be greater than 4% of the maximum capacity of the instrument and it shall be possible to adjust zero to the middle of the range;
(b) it shall be possible to adjust zero to within 0.25e; and
(c) where zero-setting is effected by means of loose material in a balancing chamber, the loose material shall be secured (sealed) and totally enclosed and shall be prevented from shifting position in such a way as to affect the accuracy of the instrument.

C.12. Taring Device

Where an instrument is fitted with a taring device:
(a) a single taring device, if graduated, shall have the mass value of the scale interval corresponding with that of the mass indicator provided that it may be ungraduated except for a zero scale mark and a scale mark at its capacity; and
(b) a major taring device shall be graduated in multiples of the capacity of the minor taring device.

C.13. Counterpoise Masses

A counterpoise mass shall be clearly and permanently marked with the international symbol of correspondence (≙) and the equivalent mass denomination, e.g. ≙5 kg, and also with the serial number of the instrument.

C.14. Centre-zero Dials

Instruments fitted with a centre-zero dial shall have at least one scale mark on each side of the zero scale mark, the mass value of which shall be marked on the dial.

C.15. Maximum Permissible Error

Every instrument under test shall retain its equilibrium, give constant mass indications on the repeated application of any given load, be correct for increasing or decreasing loads, and indicate zero within ±0.25e when the load is removed.

The MPEs for self-indicating instruments and graduated non-self-indicating instruments, with the instrument adjusted to zero within ±0.25e at no load, shall be:
(a) 0.5e for the first 500e;
(b) 1e over 500 and up to 2 000e; and
(c) 1.5e over 2 000e.

The MPEs for balances, beam scales and counter scales are as shown in Table C.2. The MPE for even-arm scales shall be half the amount specified in Table C.2 for loads up to half capacity and the whole amount specified for loads from half to maximum capacity.

C.16. Additional Requirements for Particular Types of Instruments

C.16.1. Balances and Beam Scales

Every beam scale shall:
(a) be clearly and permanently marked class B or class C;
(b) be correct when a load of one-third the capacity of the instrument is in the middle or near the edge of the pan; and
(c) have a pointer for indicating the position of equilibrium.

C.16.2. Counter Scales

Where the beam of a counter scale has two side-members they shall be connected by at least two crossbars.

A counter scale shall be correct when a load of one-third the capacity of the instrument is placed successively against the mid-point of each edge of the load receptor.

Where the goods pan is in the form of a scoop, the scale shall be correct when half-full load is placed against the middle of the back of the scoop and the other half-full load in any position on the scoop, the weights being entirely on the mass pan but in any position on it.

C.16.3. Spring Balances

Every spring balance of a capacity of less than 50 kg shall be provided with a double-sided dial which is covered by transparent material, provided that this paragraph shall not apply to spring balances which are permanently marked 'for use by itinerant vendors only' or 'hawker's scale only'.

If the pan of a spring balance is below the spring, the instrument shall be correct wherever the load is placed on the pan.

If the pan of a spring balance is above the spring, the instrument shall be correct when a load of one-third the capacity of the instrument is placed successively against the mid-point of each edge of the load receptor.

A spring balance with a multi-revolution index shall have a vertical slide with denominated scale marks indicating mass values representing complete revolutions of the reading index.

Table C.2. MPEs for balances, beam scales and counter scales

Capacity	MPE			
	Balances	Beam scales		Counter scales
		Class B	Class C	
5 g	±4 mg	±10 mg	–	–
25 g	±6 mg	±15 mg	±60 mg	–
50 g	–	±20 mg	–	–
100 g	–	±30 mg	–	–
250 g	–	±60 mg	±240 mg	–
500 g	±12 mg	±100 mg	±400 mg	±1.5 g
1 kg	–	±150 mg	±600 mg	±2.5 g
2 kg	–	±250 mg	±1 g	±3.5 g
5 kg	±70 mg	±500 mg	±2 g	±6 g
10 kg	–	±1 g	±4 g	±8 g
15 kg	–	±1.5 g	±6 g	±10 g
25 kg	±120 mg	±2.5 g	±10 g	±15 g
50 kg	–	±4.5 g	±20 g	±25 g

C.16.4. Self-indicating Counter Machines

Every analogue self-indicating machine for retail counter use shall be provided with mass indications on the purchaser's and the vendor's side of the instrument, covered by transparent material, provided that this paragraph shall not apply to machines used only for ascertaining freight charges and permanently marked 'not for trading direct with the public' or similar wording.

An instrument with analogue indication shall not have a taring device unless the words 'not for retail counter use' are permanently marked on the instrument.

The value of analogue price scale intervals shall be 1, 2, 5 or 10 cents, provided that:

- 2 cent scale intervals are not permitted for unit prices less than 60 cents per kilogram;
- 5 cent scale intervals are not permitted for unit prices less than 150 cents per kilogram; and
- 10 cent scale intervals are not permitted for unit prices less than 300 cents per kilogram;

No price shall be repeated in any column or row, provided that this paragraph shall not apply to any floating column up to 10 cents per kilogram.

An instrument with analogue indication may only be used for prices which can be read directly from the chart and for prices obtained by adding or subtracting the values from two unit-price columns or rows, or by doubling or halving the values from one unit-price column or row.

A self-indicating counter machine shall be correct when a load of one-third the capacity of the instrument is placed successively against the mid-point of each edge of the load receptor.

On a self-indicating counter machine where the goods pan is in the form of a scoop, the scale shall be correct when half-full load is placed against the middle of the back of the scoop and half-full load in any position on the scoop, the weights being entirely on the mass pan but in any position on it.

Abbreviation key

d	actual scale interval
e	verification scale interval
e_1	smallest verification scale interval for multi-interval instruments
E	error
I	indication
I_{sub}	indication of the substituted load
L	load
L_{sub}	actual calculated value of the substituted load
ΔL	additional load to next changeover point
Max	maximum capacity
Min	minimum capacity
MPE	maximum permissible error
n	number of points of support
P	actual position
$\hat{=}$	international symbol of correspondence
| ±2 |	denotes absolute value

Amendment history

Versions	Year	Assent	Provision affected	How affected