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National Instrument Test Procedures for Non-automatic Weighing Instruments

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PREFACE

On 30 June 2010 the uniform test procedures (i.e. relevant NMI V documents) were deemed to be national instrument test procedures (NITPs) for the purposes of section 18GG of the *National Measurement Act 1960* (Cth).

In 2011 the NITPs were renumbered to better align the numbers with the classes of pattern approval and servicing licensee. As a result this document (NMI V 1) became NITP 6.1 to 6.4.

The only changes that have been made to the latest edition of this document are it has been renumbered, renamed and its cross-references have been updated. In all other respects it is identical with NMI V 1.

NMI's Chief Metrologist has determined that NITP 6.1 to 6.4 contains the test procedures for the verification of non-automatic weighing instruments.

ABBREVIATIONS

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
$\lvert \pm 2 \rvert$	denotes absolute value

CONTENTS

EXPLANATION OF TERMS

For explanations of other terms see *General Information for Test Procedures*.

Adjustment

Alteration of the measurement parameters to bring the instrument within the allowable MPEs for an instrument in use.

Calibration

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.

In-service Inspection

The examination of an instrument by a **trade measurement inspector** to check that:

- the verification mark is valid; and
- 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.

Verification

The examination of an instrument by a **trade measurement inspector, servicing licensee or an employee of a servicing licensee** in order to mark the instrument indicating that it conforms with the relevant test procedures.

Initial verification is the verification of a new instrument which does not bear a verification mark and has never been verified before.

1. SCOPE

NITP 6.1 to 6.4 describes the test procedures for the verification and in-service inspection of non-automatic weighing instruments to ensure that they measure to within the maximum permissible errors specified in the *National Trade Measurement Regulations 2009* (Cth) and that they comply with the certificate of approval.

Certificates of approval are based on *NMI R 76-1. Non-automatic Weighing Instruments. Part 1: Metrological and Technical Requirements — Tests*. Refer to NMI R 76-1 for all metrological and technical requirements (please note that in this document some extracts from NMI R 76-1 have been modified slightly to improve clarity). However the specifications for unclassified non-automatic weighing instruments are given in Appendix C.

2. EQUIPMENT

1. Certificate(s) of approval.
2. Appropriate reference standards of measurement as described in Table 1.

   Notes:

   The reference standards of measurement are referred to as Inspectors' class 1, class 2 and class 3 standards, and they are often simply referred to as weights or standard weights. The maximum permissible uncertainties and variations associated with these standards are described in Schedule 9 of the National Measurement Regulations.

   Inspectors' classes 1 and 2 standards are not constructed of iron; Inspectors' class 3 standards are constructed of iron.

   A set of reference standards of measurement of any class from 10 mg to 5 kg consists of the following: 1 × 10 mg, 2 × 20 mg, 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 and 1 × 5 kg.
3. Suitable substitution load materials.
4. Current Regulation 13 certificates for all reference standards of measurement. Uncertainties and variations must be in accordance with the National Measurement Regulations. The combined uncertainties and variations must not be greater than one-third of the MPE for the load applied to the instrument being tested.
5. Test report (see Appendix A).

Table 1. Appropriate minimum reference standards of measurement

Instrument class	Reference standards of measurement required
Classes 1 and 2	Inspectors' class 1 standards of appropriate denominations or weights with the appropriate uncertainties and variations i.e. not greater than one-third of the MPE for the load applied to the instrument being tested
Classes 3 and 4 with 30 kg capacity or less	One set of reference standards of measurement containing: • 50 mg to 5 kg – Inspectors' class 2; and • 10 kg and 20 kg – Inspectors' class 3
Classes 3 and 4 exceeding 30 kg capacity but not exceeding 3 t	One set of reference standards of measurement containing: • 1 g to 5 kg – Inspectors' class 2; • 1 t Inspectors' class 3; and • access to a further 2 t of Inspectors' class 3 standards
Classes 3 and 4 exceeding 3 t	One set of reference standards of measurement containing: • 100 g to 5 kg – Inspectors' class 2; • 3 t Inspectors' class 3; and • access to further Inspectors' class 3 standards sufficient to test to 20% of the largest capacity weighing instrument certified

3. VISUAL INSPECTION

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

3.1 Required Data

1. Test report reference number.
2. Date of test.
3. Type of test: verification or in-service inspection (for in-service inspection ensure that the verification mark is in place).
4. Name of owner/user.
5. Address of owner/user.
6. Name of contact on premises.
7. Address where instrument located, if applicable.
8. Description of instrument.
9. Manufacturer(s).
10. Model.
11. Instrument serial number.
12. Certificate(s) of approval number.
13. The metrological characteristics including: Max, Min, verification scale interval (e) and accuracy class.

3.2 Characteristics of the Instrument

The instrument/simple measure and its application shall comply with the following statements.

1. The instrument complies with its certificate(s) of approval.
2. The instrument is being used in an appropriate manner.
3. All mandatory descriptive markings are clearly and permanently marked on a data plate.
4. The data plate is fixed on the instrument.
5. The instrument is complete.
6. The instrument is clean.
7. The instrument is operational.
8. Where applicable, the level-indicating device is secured and functional.
9. The instrument is level.
10. There are no apparent obstructions to the operation of the instrument.
11. The instrument is mounted on a firm base.
12. The operator (and where applicable, the customer) have a clear and unobstructed view of the indicating device and the whole weighing operation.
13. The instrument is 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 complies with the mandatory requirements in respect to design and marking.
15. For overhead track weighing instruments: the weigh rail is of an acceptable form and correctly aligned.
16. For suspended weighing instruments: the instrument hangs freely from the point of support, and all transparent covers are in good repair.
17. For weighbridges: the weighbridge complies with the *National Trade Measurement Regulations 2009*.
18. For additional indicating devices and point of sale systems: they comply with the applicable general supplementary certificates S1/0B or S1/0/A (or S1/0 or S2/0) or certificate(s) of approval.

4. 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 them.

4.1 Maximum Permissible Error

The error limits for verification and in-service inspection are shown in Table 2.

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

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

4.2 Supplementary Weighing

This test procedure is only required:

- at initial verification;
- when any changes affect the initial zero setting function; or
- at NMI's discretion.

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 (NMI R 76-1, clause A.4.4.2).

Table 2. MPEs for verification and in-service inspection

MPEs	For loads, m, expressed in verification scale intervals, e			
	Class 1	Class 2	Class 3	Class 4
±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

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.

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 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 and switch the main power supply off and then back on; continue this process **reducing** the load by a small amount each time until the instrument displays zero.
   (c) Continue step (i) or (ii) until the addition or removal of 10e resets the instrument to zero. This is the positive limit of the initial zero-setting range.
2. Record this load on the test report.
3. Apply a load equal to the positive limit of the initial zero-setting range.
4. Switch the main power supply to the instrument off and then on.
5. Repeat the appropriate test procedure and record the results on the test report.

5. 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 clause 6.

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.

5.1 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 (NMI 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 = 1e. 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 certificate(s) of approval to determine if the instrument has an initial

zero-setting range >20%. If it has, a supplementary test is required (see clause 4.2).

Determine whether the instrument is:

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

Select and conduct the appropriate test as documented below.

5.1.1 Non-self-indicating Instrument

5.1.1.1 Platform Instrument

1. Set the instrument to zero.
2. Apply the load to the load receptor.
3. Bring the indicating element to the equilibrium position using the proportional weights and/or steelyard poises and record the indication.
4. Remove the load from the load receptor.
5. Reset instrument to zero if the indication is not zero.
6. Apply the load to the load receptor.
7. Bring the indicating element to the equilibrium position using the proportional weights and/or steelyard poises and record the indication.
8. Repeat steps 4 to 7 **once** more.
9. Determine whether the instrument has passed or failed.
10. Record the results on the test report.

5.1.1.2 Equal Arm Instrument

1. Set the instrument to zero.
2. Apply the load to the goods receptor.
3. Apply standard weights to the load receptor until the indicating element is in the equilibrium position and record the mass.
4. Remove the load(s) from both load receptors.
5. Reset instrument to zero if the indication is not zero.
6. Repeat steps 2 to 4.
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.
8. Repeat steps 4 to 7 **once** more.
9. Determine whether the instrument has passed or failed.
10. Record the results on the test report.

5.1.2 Analogue Indicating Instrument

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

5.1.3 Digital Indicating Instrument

1. Set the instrument to zero.
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.
3. Record the indication.
4. Remove the load and the additional standard weights together as one load.
5. Reset instrument to zero if the indication is not showing zero.
6. Apply the load and the additional standard weights together as one load.
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 ±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 ±1e, then this is a FAIL.

8. Record results on the test report.

5.2 Eccentricity

The indications for different positions of a load shall meet the MPEs, when the instrument is tested according to NMI 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 clauses 5.2.1 to 5.2.4. 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 certificate(s) of approval to determine if the instrument has an initial zero-setting range >20%. If it has, a supplementary test is required (see clause 4.2).

5.2.1 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 effect shall be applied (NMI R 76-1, clause 3.6.2.1).

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.

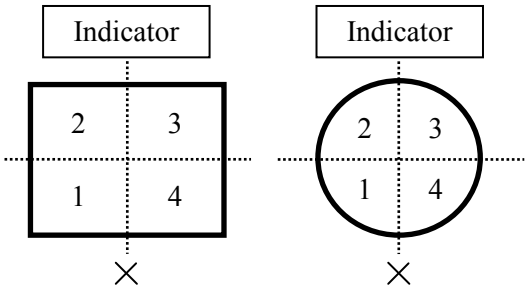


Figure 1. Position of each load
(× indicates the viewing position)

2. Zero the instrument.
3. Apply one-third Max plus maximum additive tare (if applicable) at position 1.
4. Record the load and the indication.

5. Determine if the indication is within the MPE for the load applied. Refer to clause 4.1 for MPE check.
6. Remove the load.
7. Repeat steps 3 to 7 for all points of support.
8. Determine whether the instrument has passed or failed.
9. Record results on the test report.

5.2.2 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 clause 5.2.2.1); **or**
- a vehicle of known weight in the substitution method (see clause 5.2.2.2).

5.2.2.1 Non-substitution Method

1. Determine the number of support points.
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.
3. Zero the instrument.
4. Apply 1/(n – 1) Max plus Max additive tare (if applicable) at location 1.
5. Record the load and the indication.
6. Determine if the indication is within the MPE for the load applied. Refer to clause 4.1 for MPE check.
7. Remove the load.
8. Repeat steps 3 to 7 at all the other locations in turn for all points of support.
9. Determine whether the instrument has passed or failed.
10. Record results on the test report.

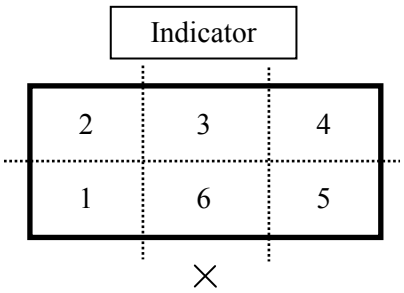


Figure 2. Position of each load
(× indicates the viewing position)

5.2.2.2 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 clause 5.2.2.1.

1. Determine the number of support points.
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.

3. Determine 1/(n – 1) Max plus Max additive tare (if applicable). If this value is:
   - **greater than** 5 tonne go to step 4;
   - **less than or equal to** 5 tonne, use the non-substitution method in clause 5.2.2.1.
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.
5. Zero the instrument.
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 tonne 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.
7. Apply additional standard weights of 0.1e to the load until the indication changes up and stabilises.
8. Record this additional load (ΔL) and the indication (I).
9. Calculate the error in the weighbridge (E) for the load applied (L) using $E = I + 0.5e – \Delta L – L$.
10. Remove the standard weights and ΔL. Ensure that 10e is left on the load receptor for digital instruments to avoid zero tracking.
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.
12. Record the indication for the substitution load (I_{sub}).
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.
14. Calculate the actual load (L_{sub}) of the substitution load using $L_{sub} = I_{sub} + 0.5e – E$.
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.
16. Reposition the vehicle to each point of support and record the indication.
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 clause 5.2.2.1.
18. Record results on the test report.

5.2.3 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 effect shall be applied to each point of support (NMI R 76-1, clause 3.6.2.3).

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.
2. Zero the instrument.
3. Apply one-tenth Max plus Max additive tare (if applicable) at location 1.
4. Record the load and the indication.
5. Determine if the indication is within the MPE for the load applied. Refer to clause 4.1 for MPE check.
6. Remove the load.

7. Repeat steps 2 to 6 at all the other locations in turn.
8. Determine whether the instrument has passed or failed.
9. Record results on the test report.

5.2.4 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 effect, shall be applied at different points on the load receptor (NMI 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.

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.

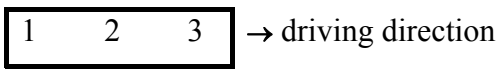


Figure 3. Load positions

2. Zero the instrument.
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.
4. Record the load and the indication.
5. Determine if the indication is within the MPE for the load applied. Refer to clause 4.1 for MPE check.
6. Remove the load.
7. Repeat steps 2 to 6 at positions 2 and 3 and then in the reverse direction 3, 2 and 1 in turn.
8. Determine whether the instrument has passed or failed.
9. Record results on the test report.

5.3 Zero Setting

After zero setting the effect of zero deviation on the result of the weighing shall not be more than ±0.25e (NMI 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.

5.3.1 Non-self-indicating Instrument

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.

At the completion of one of the test sequences when the entire load has been removed check visually 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.
- Record results on the test report.

5.3.2 Analogue Indicating Instrument

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 check visually that the instrument has returned to within ±0.25e of zero.

Record results on the test report.

5.3.3 Digital Indicating Instrument

The procedure used to determine the accuracy of zero setting is only required:

- at initial verification;
- when any system changes affecting zero setting occur; or
- at NMI's discretion.

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 clause 5.3.3.1;
- automatic zero setting, follow the procedure in clause 5.3.3.2.

The majority of instruments currently being used have non-automatic or semi-automatic zero setting so in most cases follow the procedure in clause 5.3.3.1.

These tests are all conducted at 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.

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

5.3.3.1 Non-automatic and Semi-automatic Zero Setting

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.
2. Re-set the indication to zero using the zero-setting device.
3. Apply 10e to the load receptor.
4. Apply an additional 0.25e. If the indication:
   - **remains unchanged** go to step 5;
   - **changes and stabilises** at +1e from the original indication: FAIL
5. If the indication remains unchanged in step 4, apply an additional 0.5e. If the indication:
   - **changes and stabilises** at +1e from the original indication: PASS
   - **remains unchanged**: FAIL
6. Record results on the test report.

5.3.3.2 Automatic Zero Setting

1. Activate the automatic zero-setting device in the following way:
   (a) Apply a load of approximately 5e.
   (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 clause 5.3.3.1.
2. Quickly apply 10e to the load receptor.
3. Apply an additional 0.25e. If the indication:
   - **remains unchanged** go to step 4;
   - **changes and stabilises** at +1e from the original indication: FAIL
4. If the indication remains unchanged in Step 3, apply an additional 0.5e. If the indication:
   - **changes and stabilises** at +1e from the original indication: PASS
   - **remains unchanged**: FAIL
5. Record results on the test report.

5.4 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 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 clause 4.1.

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 tonne, 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 tonne, plus any additive tare are used; and
- >15 t, standard weights to at least 20% maximum capacity plus any additive tare are used.

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

Check the certificate(s) of approval to determine if the instrument has an initial zero-setting range >20%. If it has, a supplementary test is required (see clause 4.2).

5.4.1 Weighing Performance Not Using Substitution Load Material

1. Use the criteria in clause 5.4 to determine the loads to be used in this test.
2. Record these loads on the test report.
3. Zero the instrument.
4. Apply each load increasing from minimum to maximum.
5. Determine if the indication is within the MPE for each load applied (refer to clause 4.1 for MPE check).
6. After applying maximum capacity apply a load up to 10e to ensure over-range blanking is correctly set.
7. Remove the loads in a descending order until the minimum load has been removed.
8. Determine if the indication is within the MPE for each load applied (refer to clause 4.1 for MPE check).
9. Check that the instrument has returned to within ±0.25e of zero.
10. Determine whether the instrument has passed or failed.
11. Record results on the test report.

5.4.2 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 tonne, 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.

1. Use the criteria in clause 5.4 to determine the loads (minimum of 5) to be used in this test.
2. Record these loads on the test report.
3. Determine the number of substitutions required.
4. Zero the instrument.
5. Apply each load increasing from minimum up to maximum until a substitution load is required.
6. At each increasing and decreasing load determine if the indication is within the MPE for the load applied (refer to clause 4.1 for MPE check).
7. When the maximum available standard weights have been applied (load L) then apply additional standard weights of 0.1e (ΔL in total) until the indication changes up (to I) and stabilises.
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 and stabilise.
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 10e is left on the load receptor to avoid zero tracking.

(b) Add substitution material until the indication, I_{sub}, is within –10% or –1 tonne, whichever is smaller, of the standard weights. 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 0.1e until the indication changes up and stabilises. Leave these additional standard weights (ΔL) with the substitution load.

(e) Calculate the actual mass (L_{sub}) of the substitution load 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 10e 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 ($\leq$ 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 L_{sub} plus standard weights to make the next load required for this test.

10. Continue to apply loads using the standard weights and further substitution material using the same procedure as before.
11. After applying maximum capacity apply a load up to 10e to ensure over-range blanking is correctly set.
12. Remove the loads in a **convenient** descending order until the minimum load has been removed.
13. Check that the instrument has returned to within ±0.25e of zero.
14. Determine whether the instrument has passed or failed.
15. Record results on the test report.

5.5 Discrimination

The actual scale interval for a class 1 or 2 digital instrument may be d and not e. As the majority of instruments to be verified will be class 3 or 4 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 certificate(s) of approval to determine if the instrument has an initial zero-setting range >20%. If it has, a supplementary test is required (see clause 4.2).

The test shall be conducted at the same load as the repeatability test (see clause 5.1). Additionally, the test may be conducted at one or more other points at the discretion of the licensee or inspector.

Determine whether the instrument is:

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

Select and conduct the appropriate test as documented below.

5.5.1 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 (NMI R 76-1, clause 3.8.1).

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

5.5.2 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 (NMI R 76-1, clause 3.8.2.1).

1. Zero the instrument.
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.
3. Record the initial indication as I_1.

4. Gently apply an extra load equal to the absolute value of the MPE for the applied load on the load receptor.
5. Record the new indication as I_2.
6. Calculate the difference in the two indications; $I_2 - I_1$.
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.
8. Determine whether the instrument has passed or failed.
9. Record results on the test report.

5.5.3 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 (NMI R 76-1, clause 3.8.2.2).

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

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

5.6 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 class 1 or 2;
- 2 mm for an instrument of class 3 or 4 with Max ≤30 kg; and
- 5 mm for an instrument of class 3 or 4 with Max >30 kg.

The test shall be conducted at the same load as the repeatability test (see clause 5.1).

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

1. Zero the instrument.
2. Apply a load to the load receptor.
3. Bring the instrument to its equilibrium position.
4. Apply an extra load equal to the absolute value of the MPE for the applied load.
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.
6. Determine whether the instrument has passed or failed.
7. Record results on the test report.

5.7 Accuracy of Tare Setting

This test is only required:

- at initial verification;
- when any changes affecting the tare function occur; or
- at NMI'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 (NMI 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 (NMI R 76-1, clause 3.5.3.4).

1. Load the instrument using a weight that exceeds the tare capacity and ensure the tare facility is not functional.
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.
3. Re-set the indication to zero using the tare-setting device.
4. Check the accuracy of tare-setting in the following way:
   (a) Apply 10e to the load receptor.
   (b) Apply an additional 0.25e. If the indication:
      - **remains unchanged** go to step 4(c);
      - **changes up and stabilises** +1e from the original indication: FAIL
   (c) If the indication remains unchanged in step 4(b), apply an additional 0.5e. If the indication:
      - **changes up and stabilises** +1e from the original indication: PASS
      - **remains unchanged**: FAIL
   (d) Record results on the test report.
   (e) Remove 10e, 0.25e and 0.5e to bring the indication back to zero.
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 clause 4.1 for MPE check.
6. Record results on the test report.

5.8 Price Computation

This test is only required:

- at initial verification;
- when any changes affecting the price function occur; or
- at NMI'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 (NMI 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 and shall be within ± 0.5 cents of the instrument's indicated 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 (NMI 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.

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.
2. Calculate the total price from the unit price and indicated weight.
3. Compare the calculated total price with the indicated price.
4. Repeat the test at least **four** more times.
5. Determine whether the instrument has passed or failed.
6. Record results on the test report.

6. SUGGESTED SEQUENCE FOR TESTING

1. Make sure any electronic instrument has been allowed to warm up for about half an hour.
2. Check the certificate(s) of approval for supplementary tests (clause 4.2) and any additional tests required. Make provision for including these tests in the testing sequence.
3. Visually inspect the instrument and make a record of its metrological characteristics.
4. Conduct a repeatability test (clause 5.1).
5. Conduct an eccentricity test (clause 5.2).
6. Check accuracy of zero setting (clause 5.3) if applicable.
7. For non-self-indicating instruments, check zero setting (clause 5.3) and sensitivity (clause 5.6) during the repeatability test.
8. Determine the loads and conduct a weighing performance test (clause 5.4).
9. Conduct a discrimination test (clause 5.5) during the weighing performance test.
10. For digital indicating instruments conduct an accuracy of tare setting test (clause 5.7) if applicable.
11. Conduct a price computation check (clause 5.8) if applicable.
12. Determine whether the instrument has passed or failed.
13. Complete the test report.
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.

APPENDIX 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 record the verification mark

Name of owner/user .....

Address of owner/user .....

Name of contact on premises .....

Address where instrument located, if applicable .....

Description of instrument .....

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

Serial number .....Certificate(s) of approval number.....

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

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

Visual Inspection	Indicate yes/no/na
Does the instrument comply with its 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?	
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 Trade Measurement Regulations?	
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 certificate(s)	

Test Results

Repeatability (clause 5.1)	Load	
	First reading	
	Second reading	
	Third reading	
	Difference	
	☐ Pass ☐ Fail	
Eccentricity (clause 5.2.2) using either:	☐ Pass ☐ Fail	

• **non-substitution** method (clause 5.2.2.1); **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 (clause 5.2.2.2)	MPE change points:								
	Available standard weights:								
	L	Makeup of load	MPE	0.5e	I	ΔL	E	L_{sub}	L_{sub} (rounded)

Zero setting (clause 5.3)	☐ Pass ☐ Fail
Discrimination (clause 5.5)	☐ Pass ☐ Fail
Sensitivity (clause 5.6)	☐ Pass ☐ Fail ☐ na
Accuracy of tare setting (clause 5.7)	☐ Pass ☐ Fail ☐ na
Price computation (clause 5.8)	☐ Pass ☐ Fail ☐ na

Weighing performance (clause 5.4) using either:	☐ Pass ☐ Fail		
• **non-substitution** method (clause 5.4.1); **or**	Loads applied (minimum 5)	Indication up	Indication down
	Over-range blanking ☐ Pass ☐ Fail		

• **substitution** method (clause 5.4.2)			
Method used	☐ Method A	☐ Method B	
MPE change points:			
Available standard weights:			
Substitution load	First:	Second:	Third:

Up	L	Makeup of load	MPE	I	0.5e	ΔL	E	L_{sub}	L_{sub} (rounded)	Pass/fail /na

Over-range blanking	☐ Pass	☐ Fail

Down	L	Makeup of load	MPE	I	Pass/fail

Overall result	☐ **Pass** ☐ **Fail**

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

Signature ....

Comments ....

....

APPENDIX B. WORKED EXAMPLES

B.1 Repeatability Test — How to Find the Actual Position of a Load (see clause 5.1.3)

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 you reach the next changeover point. 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 then the absolute value of the MPE, the instrument has: PASSED
   (b) greater then the absolute value of the MPE, the instrument has: FAILED

B.2 Weighing Performance using Substitution Load Material used (see clause 5.4.2)

In this example method A is used.

The instrument is a Class 3 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.

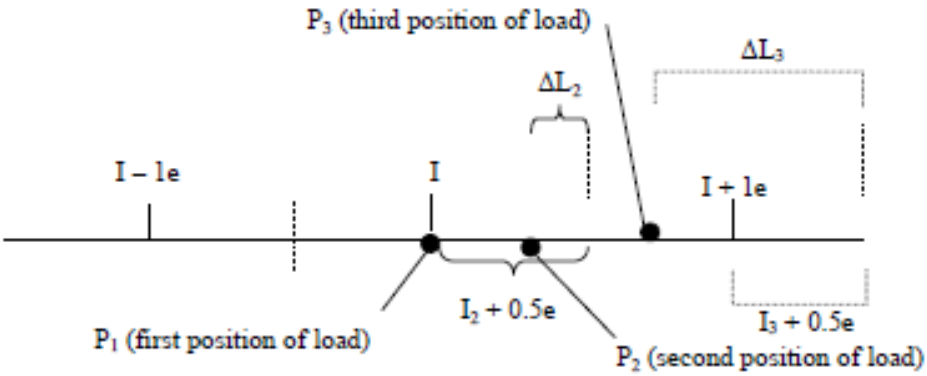


Figure B.1. Finding the actual position of the load

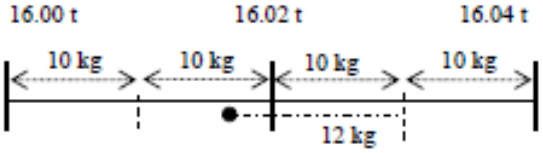
The results have been recorded on a sample test report at the end of this example.

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:

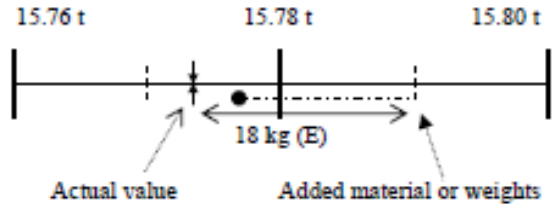


When the 16 t of standard weights were placed on the weighbridge the indication displays 16.02 t (I). Added in steps of 2 kg (0.1e), a further 12 kg of standard weights (ΔL) was required to take it to the next indication changeover point and stabilise.

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 – ΔL – L we can calculate E as
= 16.02 t + 0.01 t – 0.012 t – 16.00 t
= +0.018 t or +18 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. 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). 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:

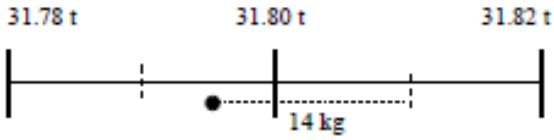
15.79 t – 0.018 t (error) = 15.772 t

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:

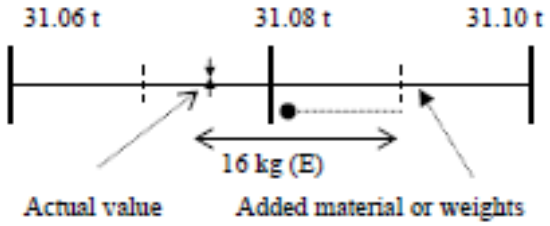


A further 14 kg of standard weights (ΔL) was required to take it to the next indication changeover point and stabilise. Using the diagram you can see it is 16 kg more than 31.78 t. Graphically we can see the error is +0.016 t or 16 kg.

Mathematically using the formula
E = I + 0.5e – ΔL – L we can calculate E as
= 31.80 t + 0.010 t – 0.014 t – 31.78 t
= +0.016 t or 16 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. 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. 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.

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 ±0.25e.

B.3 Appropriate Loads and Unit Prices for Price Computing (see clause 5.8)

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

Results of Weighing Performance Using Substitution Load

Instrument description	Class 3 static weighbridge
Max	60 t
Verification scale interval (e)	0.02 t

Method used	Method A
MPE change points	10 t, 40 t
Available standard weights	16 t
First substitution load (Sub 1)	Test rig + forklift (approximate mass16 t)
Second substitution load (Sub 2)	Gravel truck (approximate mass 32 t)
Third substitution load	Test rig + forklift + gravel truck (approx 48 t)

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

L	Makeup of load	MPE	I	
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	—	±0.25e	0	pass

APPENDIX C. SPECIFICATIONS FOR UNCLASSIFIED NON-AUTOMATIC WEIGHING INSTRUMENTS

Appendix C gives the specifications for unclassified non-automatic weighing instruments. These are instruments without a class mark, which comply with *General Specifications for Measuring Instruments to be used for Trade, Part 9* (superseded in May 1976) and the 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.