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NMI V 1

Uniform Test Procedures for the Verification, Certification and In-service Inspection of Non-automatic Weighing Instruments

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ABBREVIATIONS

d	actual scale interval
e	verification scale interval
E	error
G	gross value
I	indication
I_o	minimum scale spacing
I_{sub}	indication of the substituted load
K	positive or negative whole numbers or equal to zero
L	minimum reading distance
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
N	net value
P	indicated total price
T	tare value
T_{Max}	maximum tare capacity
U	unit price
W	weight
$\hat{=}$	international symbol of correspondence
| ±2 |	denotes absolute value
≥	greater than or equal to
≤	less than or equal to
>	greater than
<	less than

CONTENTS

EXPLANATION OF TERMS

The following explanations of terms are critical to the understanding of this document. For explanations of other terms see *NMI V 0. Uniform Test Procedures: General Information*.

Adjustment

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

Calibration

The set of operations which, under specified conditions, establish the relationship between the indicated or nominal value of an instrument and the corresponding known value of the measured quantity.

Certification

The examination of an instrument by a **certifier** (the holder, or an employee of the holder, of a servicing licence) in order to mark the instrument indicating that it conforms with the relevant test procedures.

- **Initial certification** is the certification of a new instrument by a certifier which does not bear a verification or certification mark and has never been verified or certified before.
- **Subsequent certification** is any certification of an instrument by a certifier because the mark is no longer valid due to such reasons as:
  - repairs or adjustments have been made that affect metrological performance; or
  - the mark has been defaced or removed.

In-service Inspection

The examination of an instrument by an **inspector or certifier** to check that:

- the verification or certification 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 or certification mark.

Verification

The examination of an instrument by an **inspector** in order to mark the instrument indicating that it conforms with the relevant test procedures.

- **Initial verification** is the verification of a new instrument by an inspector which does not bear a verification or certification mark and has never been verified or certified before.
- **Subsequent verification** is any verification of an instrument by an inspector because the mark is no longer valid due to such reasons as:
  - repairs or adjustments have been made that affect metrological performance; or
  - the mark has been defaced or removed.
- **Re-verification** is the examination of an instrument by an inspector to check that:
  - the verification or certification mark is valid; and
  - the instrument has not been modified in any way since verification or certification;

  in order to mark the instrument indicating that it conforms with the relevant test procedures.

1. SCOPE

NMI V 1 describes the test procedures for the verification, certification and in-service inspection of non-automatic weighing instruments to ensure that they measure accurately and that they comply with the certificate of approval.

These test procedures supersede those found in *Inspectors Handbook Number 2*.

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. However the specifications for unclassified non-automatic weighing instruments are given in Appendix D. Unclassified non-automatic weighing instruments 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.

All instruments must comply with the relevant Trade Measurement Act and Regulations.

2. EQUIPMENT

1. Certificate/s of approval.
2. Appropriate reference standards of measurement as follows:
   (a) For instruments with a maximum capacity ≤1 t weights to maximum capacity plus any additive tare including weights of 0.1e to 10e.
   (b) For instruments with a maximum capacity >1 t and ≤5 t weights of at least 1 t plus any additive tare including weights of 0.1e to 10e.
   (c) For instruments with a maximum capacity >5 t weights to at least 20% maximum capacity plus any additive tare including weights of 0.1e to 10e.
3. Suitable substitution load materials.
4. Current Regulation 13 certificates for all reference standards of measurement. Uncertainties must be in accordance with the National Measurement Regulations and not greater than one-third of the MPE of the instrument being tested. Consult the licensing authority for more information.
5. Test report (see Appendix A).

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, certification or in-service inspection (for in-service inspection ensure that the verification/ certification mark is in place).
4. Name of owner/user.
5. Address of owner/user.
6. Contact name.
7. Address of instrument, if applicable.
8. Description of instrument.
9. Manufacturer/s.
10. Model.
11. Instrument serial number.
12. Certificate/s of approval number.
13. The non-metrological characteristics including: Max, Min, verification scale interval (e) and accuracy class.

3.2 Characteristics of the Instrument

1. Does the instrument comply with its certificate/s of approval?
2. Is the instrument being used in an appropriate manner?
3. Are all mandatory descriptive markings clearly and permanently marked on a data plate?
4. Is the data plate fixed on the instrument?
5. Is the instrument complete?

6. Is the instrument broken?
7. Is the instrument clean?
8. Is the instrument operational?
9. Is the level-indicating device (if fitted) secured and functional?
10. Is the instrument level?
11. Are there any apparent obstructions to the operation of the instrument?
12. Is the instrument mounted on a firm base?
13. Does the operator (and where applicable, the customer) have a clear and unobstructed view of the indicating device and the whole weighing operation?
14. Is the instrument adequately protected against abnormal dust, air movement, vibrations, atmospheric conditions and any other influence likely to affect its performance?
15. If applicable, does the steelyard, tare bar or proportional weight comply with the mandatory requirements in respect to design and marking?
16. For overhead track weighing instruments: is the weigh rail of an acceptable form and correctly aligned?
17. For suspended weighing instruments: does it hang freely from the point of support, and are all transparent covers in good repair?
18. For weighbridges: does it comply with the relevant Trade Measurement (Weighbridge) Regulations and the *Code of Practice for Weighbridge Installations* (see Appendix B)?
19. For additional indicating devices: do they exactly repeat the information on the primary indication and does any device for price computation and/or ticket/label printing comply with the requirements of General Supplementary Certificate S1/0/A (or General Supplementary Certificates S1/0 and S2/0 for devices initially verified or certified prior to March 1992)?

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

4.1.1 Verification and Certification

The error limits for verification and certification are shown in Table 1.

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 1.
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

Table 1. MPEs for verification and certification

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

Table 2. MPEs for in-service inspection

MPEs	For loads, m, expressed in verification scale intervals, e			
	Class 1	Class 2	Class 3	Class 4
±1e	0 ≤ m ≤ 50 000	0 ≤ m ≤ 5 000	0 ≤ m ≤ 500	0 ≤ m ≤ 50
±2e	50 000 < m ≤ 200 000	5 000 < m ≤ 20 000	500 < m ≤ 2 000	50 < m ≤ 200
±3e	200 000 < m	20 000 < m ≤ 100 000	2 000 < m ≤ 10 000	200 < m ≤ 1 000

4.1.2 In-service Inspection

The error limits for in-service inspection are shown in Table 2. These are twice those allowed at verification and certification. These error limits are only applicable during the eccentricity, weighing performance and accuracy of tare-setting tests.

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

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 ±1e

(i) For a stable indication of +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

(b) MPE of ±2e

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

(ii) For a stable indication of +2e 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 +3e the instrument is outside the MPE: FAIL

(iii) For a stable indication of –2e from the load value, apply an additional 0.5e. If the indication:
- **changes up and stabilises** at –1e the instrument is within MPE: PASS
- **remains unchanged** the instrument is outside MPE: FAIL

(iv) If the indication is greater than ±2e up or down from the load value: FAIL

(c) MPE of ±3e

(i) For a stable indication of ±1e or ±2e: PASS

(ii) For a stable indication of +3e from the load value, apply an additional 0.5e. If the indication:
- **remains unchanged** the instrument is within the MPE: PASS
- **changes up and stabilises** at +4e the instrument is outside MPE: FAIL

(iii) For a stable indication of –3e from the original indication, apply an additional 0.5e. If the indication:
- **changes up and stabilises** at –2e the instrument is within MPE: PASS
- **remains unchanged** the instrument is outside MPE: FAIL

(iv) For a stable indication greater than ±3e from the load value: FAIL

4.2 Supplementary Weighing

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).

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) Place a load equal to about 10% of Max on the load receptor and switch the main power supply to the instrument off and then back on.
   (c) If the instrument returns to zero:
      (i) increase the load by a small amount and switch the main power supply to the instrument off and then back on;
      (ii) continue this process increasing the load by a small amount each time until it does not re-zero.
   (d) If the instrument does not display zero:
      (i) reduce the load by a small amount and switch the main power supply off and then back on again;
      (ii) continue this process reducing the load by a small amount each time until the instrument displays zero.
   (e) Continue step (c) or (d) until the addition or removal of 10e resets the instrument to zero. This is the positive portion 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. Before certifying such an instrument it is advisable to check with the relevant trade measurement authority where the instrument will be used to ensure you meet their requirements.

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 successive 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.

For a non-self-indicating instrument the absolute value of the MPE for the load applied is a permanent displacement of:

- 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.

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

1. Set the instrument to zero.
2. Apply the load and note the indication.
3. Determine the indication at equilibrium.
4. Remove the load.
5. Reapply the load two more times, for each load measure the permanent displacement (if any) of the indicator from the equilibrium position.
6. Determine whether the instrument has passed or failed.
7. Record results on the test report.

5.1.2 Analogue Indicating Instrument

1. Set the instrument to zero.
2. Apply the load and note 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 on top of the load until the indicator changes up +1e and stabilises; then
   (c) remove 0.5e leaving the additional standard weights with the load.
3. Note 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. Note 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 C.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.

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.

If a high capacity instrument such as a weighbridge has shown 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 surface of the load receptor into approximately four equal segments. Indicate the location of each load by assigning a position number to each segment where the load will be placed. Position 1 is always the centre. Position 2 is located closest to your left when you view the load receptor from the normal operating position for an integrated indicator or from the indicator of a remote primary indicator. Positions 3, 4 and 5 are numbered clockwise from position 2 as shown in Figure 1.

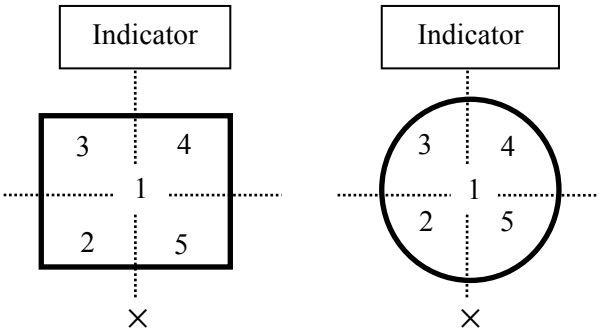


Figure 1. Location of each load
(× indicates the viewing position)

2. Zero the instrument.
3. Apply one-third Max plus maximum additive tare (if applicable) at location 1.
4. Note 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 the four other locations.
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

On an instrument with a load receptor with more than four points of support (e.g. road weighbridge) the fraction 1/(n – 1) of the sum of the maximum capacity and the maximum additive tare effect shall be applied to each point of support (n is the number of points of support) (NMI R 76-1, clause 3.6.2.2).

1. Determine the number of support points.
2. Divide the surface of the load receptor into approximately n equal segments, where n is the number of points of support. Assign a position number to each segment where the load will be placed. Position 1 is always the centre. Position 2 is located closest to your left when you view the load receptor from the normal operating position for an integrated indicator or from the indicator of a remote primary indicator. Positions 3, 4 etc are numbered clockwise from position 2 as shown in Figure 2. Where 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. Indicate on your sketch any segments that span two points of support.

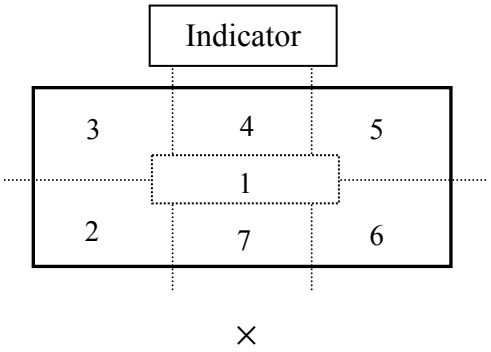


Figure 2. Location of each load
(× indicates the viewing position)

3. Zero the instrument.
4. Apply 1/(n – 1) Max plus Max additive tare (if applicable) at location 1.

5. Note 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 4 to 7 at all the other locations in turn.
9. Determine whether the instrument has passed or failed.
10. 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. Determine the number of support points and allocate a number to each one. Indicate the location of each load by assigning a position number to each support point where the load will be placed. Position 1 is located closest to your left when you view the indicator from a normal operating position. Positions 2, 3 etc are numbered clockwise from position 1.
2. Zero the instrument.
3. Apply one-tenth Max plus Max additive tare (if applicable) at location 1.
4. Note 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 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.

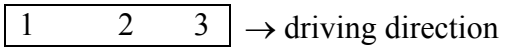


Figure 3. Load positions

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. Note 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 then 0.25e; however, on an instrument with auxiliary indicating devices this effect shall be not more than 0.5d (NMI R 76-1, clause 4.5.2).

Most instruments used for trade are either class 3 or 4 and are unlikely to have an auxiliary indicating device. However, if the instrument being tested has an auxiliary indicating device, then activate the zero-setting device as shown below. If the indication is reading anything other than zero, the instrument is outside the requirements of ±0.5d and has failed.

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, place 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 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 that 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 MPEs for increasing and decreasing loads are shown in clause 4.1.

Criteria for selecting the loads:

- Use at least 5 different loads.
- The loads must span from minimum to maximum capacity for the instrument in approximately equal steps.
- Include the load at the MPE change points. 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.
- Do not select the load at the point where the scale interval changes. 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.

When testing instruments with a maximum capacity greater than 1 tonne, instead of standard weights any other constant load made up of substitution material may be used, provided that for instruments with maximum capacity:

- $1\ t < Max \leq 5\ t$, standard weights to at least 1 tonne plus any additive tare are used; and
- >5 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 (minimum of 5) 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. 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).
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 whether the instrument has passed or failed.
9. Record results on the test report.

5.4.2 Weighing Performance Using Substitution Load Material

This test should not be conducted unless 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 then apply additional standard weights of 0.1e until the indicator changes up and stabilises.
8. Calculate the actual error using the formula $E = I + \frac{1}{2}e - \Delta L - L$, 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 to find the changeover point.
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 indicator changes up and stabilises. Leave these additional standard weights (ΔL) with the substitution load.

(e) Calculate the actual weight (L_{sub}) of the substitution load using the formula $L_{sub} = I_{sub} + ½e – E$. 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 C.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 until the same indicated changeover point as previously determined with standard weights is reached.

(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. Determine whether the instrument has passed or failed.
14. 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).

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. Place a load on the load receptor.
3. Bring the instrument to its equilibrium position.
4. Gently place 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. Place a load on the load receptor. (Hint, bring the indication to a mark by applying a small amount of extra material to the load receptor, before applying the extra load.)
3. Note the initial indication as I_1.
4. Gently place an extra load equal to the absolute value of the MPE for the applied load on the load receptor.
5. Note the new indication as I_2.
6. Calculate the change in the indication by subtracting the initial indication, I_1, from the new indication, I_2, i.e. $I_2 - I_1$.
7. Determine if this change in indication is not less then 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).

1. Zero the instrument.
2. Apply a load to the load receptor.
3. Apply additional standards weights of 0.1e or 0.2e until the indicator changes up +1e and stabilises.
4. Note 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 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 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

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. Activate the tare-setting device in the following way:
   (a) Load the instrument using a weight that is within the tare-setting range and close to an MPE change point.
   (b) Add additional weights to take the total load just **below** the next changeover point.
2. Re-set the indication to zero using the tare-setting device.
3. 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 3(c);
      - **changes up and stabilises** +1e from the original indication: FAIL
   (c) If the indication remains unchanged in step 3(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.
4. 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.
5. Record results on the test report.

5.8 Price Computation

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).

Reading from price scales shall be so possible that the absolute value of the difference between the product of the indicated weight W and unit price U and the indicated total price P is not greater than the product of e and the unit price for that scale (NMI R 76-1, clause 4.15.2):

$$\left| W \times U - P \right| \leq e \times U$$

The total price shall be calculated by multiplication of weight and unit price, both as indicated by the instrument. 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).

This check can be done at any time during the testing procedure. It is carried out to ensure the price calculating function is able to compute the total price. It is recommended that this check be carried out at least 5 times over a range of different loads, it is suggested that it be performed during the weighing test.

1. Apply a load of an appropriate size to the load receptor.
2. Calculate the total price from the unit price and indicated weight.
3. Compare this calculated price with the indicated price.
4. Determine whether the instrument has passed or failed.
5. 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 note of its metrological characteristics.
4. Conduct a repeatability test (clause 5.1).
5. Check zero setting (clause 5.3).
6. For non-self-indicating instruments, check zero setting (clause 5.3) and sensitivity (clause 5.6) during the repeatability test.
7. Conduct an eccentricity test (clause 5.2).
8. Determine the loads for weighing performance and conduct a weighing test (clause 5.4).
9. Conduct a discrimination test (clause 5.5) during the weighing test.
10. On analogue and digital indicating instruments conduct an accuracy of tare setting test (clause 5.7).
11. Conduct a price computation check (clause 5.8).
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. This may include:
    - obliterating verification, certification and control marks from the instrument; and
    - stamping the instrument (for more information on stamping see *NMI V 0. Uniform Test Procedures: General Information*).

APPENDIX A. TEST REPORT

Although the format of the test report may vary according to the individual needs and requirements of trade measurement authorities and licensees, 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 ☐ Certification ☐ In-service inspection

For in-service inspection record the verification/certification mark.....

Name of owner/user .....

Address of owner/user .....

Contact name .....

Address of instrument, if applicable .....

Description of instrument .....

Manufacturer/s .....Model.....

Instrument serial number .....Certificate/s of approval number .....

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

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

Does the instrument comply with its certificate/s of approval?	yes/no
Is the instrument being used in an appropriate manner?	yes/no/na
Are all mandatory descriptive markings clearly and permanently marked on the data plate?	yes/no
Is the data plate fixed on the instrument?	yes/no
Is the instrument complete?	yes/no
Is the instrument broken?	yes/no
Is the instrument clean?	yes/no
Is the instrument operational?	yes/no
Is the level-indicating device (if fitted) secured and functional?	yes/no/na
Is the instrument level?	yes/no
Are there any apparent obstructions to the operation of the instrument?	yes/no
Is the instrument mounted on a firm base?	yes/no
Does the operator (and where applicable, the customer) have a clear and unobstructed view of the indicating device and the whole weighing operation?	yes/no
Is the instrument adequately protected against abnormal dust, air movement, vibrations, atmospheric conditions and any other influence likely to affect its performance?	yes/no
If applicable, does the steelyard, tare bar or proportional weight comply with the mandatory requirements in respect to design and marking?	yes/no/na
For overhead track weighing instruments: is the weigh rail of acceptable form and correctly aligned?	yes/no/na
For suspended weighing instruments: does it hang freely and are all transparent covers in good repair?	yes/no/na
For weighbridges: does it comply with the relevant Trade Measurement (Weighbridge) Regulations and the *Code of Practice for Weighbridge Installations*?	yes/no/na
For additional indicating devices: do they exactly repeat the information on the primary indication and does any device for price computation and/or ticket/label printing comply with the requirements of the General Supplementary Certificates (see clause 3.2.19)?	yes/no/na

Test Results

Repeatability (clause 5.1)	Load			
	First reading			
	Second reading			
	Third reading			
	Difference			
	☐ Pass ☐ Fail			
Eccentricity (clause 5.2)	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	
	☐ Pass ☐ Fail			
Zero setting (clause 5.3)	☐ Pass ☐ Fail			
Weighing performance **not** using substitution load (clause 5.4.1) Note: For weighing performance using substitution load refer to the following page	Loads applied (minimum 5)		Up	Down
	Over-range blanking ☐ Pass ☐ Fail			
	☐ Pass ☐ Fail ☐ na			

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
Overall result	☐ **Pass** ☐ **Fail**

Inspector's/certifier's name..... Identification number.....

Signature .....

Comments .....

Weighing performance using substitution load (clause 5.4.2)										
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	½e	Δ*L*	E	L_{sub}	L_{sub} (rounded)	Pass/fail/ na
Over-range blanking ☐ Pass ☐ Fail										
Down*	*L*		Makeup of load		MPE		I		Pass/fail	

*Note: Zero load must **not** indicate above 0.25e

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
Overall result	☐ **Pass** ☐ **Fail**

Inspector's/certifier's name..... Identification number.....

Signature .....

Comments .....

APPENDIX B. CODE OF PRACTICE FOR WEIGHBRIDGE INSTALLATIONS

B.1 Hybrid and Retrofit Installations

B.1.1 General

B.1.1.1 Load cell to be mounted in accordance with the manufacturer's specifications and the appropriate NMI certificate of approval and technical schedule, and in such a manner that there is ample access to provide readability of the data plate.

B.1.1.2 (a) An entrance to the pit of a minimum height of 1 m and a width of 900 mm.

(b) Where appropriate, a minimum width of 900 mm in the neck of the pit with a minimum clearance of 150 mm to each side of a lever contained therein.

(c) Coverage provided for the neck of the pit.

B.1.1.3 On retrofit installations new capacity must not exceed rated capacity of existing basework.

B.1.1.4 The number of scale intervals applicable to the whole instrument shall be no greater than the number of verified scale intervals approved for the basework, or the load cell, or the headwork, whichever is the smallest.

B.1.2 Cable from Load Cell

B.1.2.1 Ensure flexible connection of cable to avoid resistant effect (this is to include spiral conduit).

B.1.2.2 Cable to be secured to wall or other fixed structure by approved electrical cable clips.

B.1.2.3 Junction box to be secured to fixed structure in accordance with the appropriate NMI certificate of approval and technical schedule.

B.1.2.4 Where cable is run lower than 300 mm from floor of pit, cable to be protected in conduit.

B.1.2.5 Where load cell cable passes through concrete walls etc it is to be protected in conduit or similar.

B.1.3 Office

B.1.3.1 Cable to be fixed to wall, ceiling or other fixed structure by approved electrical cable clips.

B.1.3.2 Junction box to be secured to wall, ceiling or fixed structure in accordance with the appropriate NMI certificate of approval and technical schedule.

B.1.3.3 Where cable is run along the floor it is to be protected in conduit.

B.1.3.4 Any excess cable other than an adequate length to allow for access to and cleaning around indicator to be either:

(a) secured as in clause B.1.3.1; or

(b) coiled, stowed and clipped to prevent damage (office or neck of pit).

B.1.3.5 All cabling and interconnection leads to be presented in a tidy manner and any excess cable adequately protected and tied.

B.2 Pitless Weighbridges

B.2.1 General

B.2.1.1 The weighbridge shall be installed in accordance with the appropriate sections of the Trade Measurement (Weighbridges) Regulations.

B.2.1.2 Load cells to be correctly installed in accordance with the appropriate NMI certificate of approval and technical schedule and in such a manner that there is ample access to provide readability of the data plate.

B.2.1.3 Junction box to be secured to fixed structure in accordance with the appropriate NMI certificate of approval and technical schedule.

B.2.1.4 All load cell and extension cable to be adequately protected from the

environment and from trapping between moving parts.

B.2.1.5 All load cell and extension cable to be secured sufficiently to prevent excess cable trailing.

B.2.1.6 All bolts and nuts to be adequately tightened, with spring washers being provided where appropriate.

B.2.1.7 Platform restraints to be correctly aligned, adjusted and secure.

B.2.1.8 The weighbridge and site to be presented for verification in a clean and tidy manner with surplus components and/or debris removed.

B.2.2 Junction Box to Office

B.2.2.1 Connection from main junction box (when on live portion of weighbridge) to be in flexible conduit and secured to underground conduit.

B.2.2.2 All exposed cable to be protected in conduit.

B.2.2.3 Conduit to be underground except at junction box connection and weighbridge office wall.

B.2.2.4 Where load cell cable passes through concrete walls etc it is to be protected in conduit or similar.

B.2.3 Office

B.2.3.1 Cable to be fixed to wall, ceiling or other fixed structure by approved electrical cable clips.

B.2.3.2 Junction box to be secured to wall, ceiling or fixed structure in accordance with the appropriate NMI certificate of approval and technical schedule.

B.2.3.3 Where cable is run along the floor it is to be protected in conduit.

B.2.3.4 Any excess cable other than an adequate length to allow for access to and cleaning around indicator to be either:

(a) secured as in clause B.1.3.1; or
(b) coiled, stowed and clipped to prevent damage.

B.2.3.5 All cabling and interconnection leads to be presented in a tidy manner with any excess cable adequately protected and tied.

B.3 Full Load Cell (In-ground) Weighbridges

B.3.1 General

B.3.1.1 The weighbridge shall be installed in accordance with the appropriate sections of the Trade Measurement (Weighbridges) Regulations.

B.3.1.2 Load cells to be correctly installed in accordance with the manufacturer's specifications and the appropriate NMI certificate of approval and technical schedule issued and in such a manner that there is ample access to provide readability of the data plate.

B.3.1.3 (a) An entrance to the pit of a minimum height of 1 m and a width of 900 mm.

(b) Coverage provided for the neck of the pit.

(c) Where appropriate, one or more access holes may be provided in the deck.

B.3.1.4 All load cell and extension cable to be adequately protected from damage or trapping between moving parts.

B.3.1.5 All load cell and extension cable to be secure.

B.3.1.6 Where cable is run lower than 300 mm from the floor of pit, cable to be protected in conduit.

B.3.2 Junction Box to Office

B.3.2.1 Connection from main junction box (where on live portion of weighbridge) be in flexible conduit and secured to underground conduit.

B.3.2.2 All exposed cable to be protected in conduit.

B.3.2.3 Conduit to be underground except at junction box connection and weighbridge office wall.

B.3.2.4 Where load cell cable passes through concrete walls etc it is to be protected in conduit or similar.

B.3.3 Office

B.3.3.1 Cable to be fixed to wall, ceiling or other fixed structure by approved electrical cable clips.

B.3.3.2 Junction box to be secured to wall, ceiling or fixed structure in accordance with the appropriate NMI certificate of approval and technical schedule.

B.3.3.3 Where cable is run along the floor it is to be protected in conduit.

B.3.3.4 Any excess cable other than an adequate length to allow for access to and cleaning around indicator to be either:

(a) secured as in clause B.1.3.1; or
(b) coiled, stowed and clipped to prevent damage.

B.3.3.5 All cabling and interconnection leads to be presented in a tidy manner with any excess cable adequately protected and tied.

APPENDIX C. WORKED EXAMPLES

C.1 Repeatability Test — How to Find the Actual Position of a Load (see clause 5.1.2)

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 C.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 note 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 $P_2 = I_2 + ½e - \Delta L_2$.
3. Repeat using the values for the third position of the load to find $P_3 = I_3 + ½e - \Delta L_3$.
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

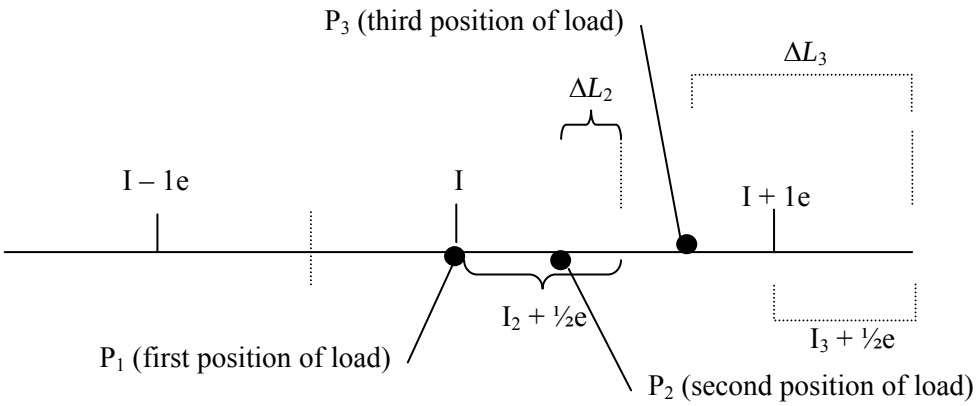


Figure C.1. Finding the actual position of the load

C.2 Weighing Test using Substitution Load Material used (see clause 5.4.2)

In this example method A is used.

The instrument is a class 3 static weighbridge with a maximum capacity of 60 t and e = 0.02 t (20 kg).

You have 16 t of standard weights and a test rig and forklift with a mass of approximately 16 t. Prior to the test you have also organised for a truck loaded with gravel of approximately 30 t.

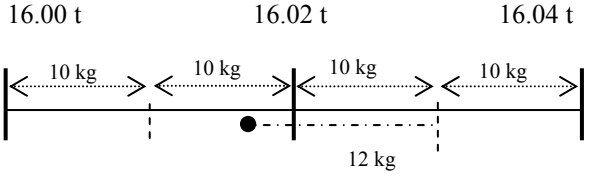
In selecting the loads you are required to use at least 5 loads, to include Min, first MPE change point, second MPE change and Max. The loads for the example shown below are: 0.4 t, 16 t, 32 t, 44 t and near Max.

This example shows both a graphical and mathematical solution. 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 form at the end of this example.

The first substitution load using the test rig plus the forklift will be approximately 16 t and the second substitution load of a truck loaded with gravel will be approximately 32 t.

When 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:

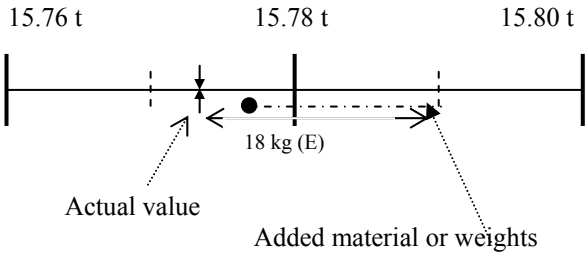


When the 16 t of standard weights were placed on the weighbridge the indication displays 16.02 t (I). A further 12 kg of standard weights (ΔL) was required to take it to the next changeover point and stabilise.

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 + ½e – 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 (forklift plus test rig). 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 changeover point, which is 15.79 t. Do this by adding more substitution material or weights. This additional material or weights becomes part of the substitution load. The actual value of the substitution load is the changeover point less the error.

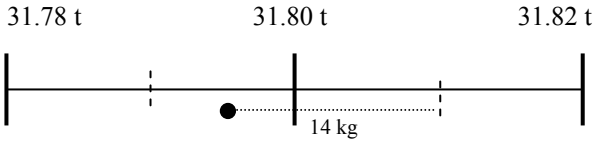
The calculated error in the weighbridge at this point is +18 kg. Taking this into account the point labelled actual is the true position for the substitution load. Graphically we can see the value of the substitution load is:

15.79 t – 0.018 t (error) = 15.772 t

Mathematically using the formula
$L_{sub} = I_{sub}$ + ½e – 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 next load used in this test is made up of the substitution load (15.78 t) plus 16 t of standard weights. This load equals 31.78 t.

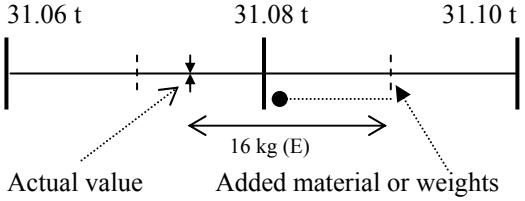
Calculate the error for the weighbridge when using this new known load of 31.78 t. When the load is placed on the weighbridge the indication reads 31.80 t (I). This is represented graphically as follows:



A further 14 kg of standard weights (ΔL) was required to take it to the next 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
$E = I + \frac{1}{2}e - \Delta L - L$ 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 kg.

Now you know the error at this point of the weighbridge you can apply the second substitution load (gravel truck). After the second substitution load was placed on the weighbridge the indication displayed 31.08 t. This is represented graphically as follows:



Take the weighbridge to the next changeover point which is 31.09 t. Do this by adding more substitution material or standard weights. This additional material or standard weights becomes part of the substitution load. The actual value of the substitution load is the 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
$L_{sub} = I_{sub} + \frac{1}{2}e - E$ (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 next load used in this test is made up of the substitution load 31.08 t plus 13 t of standard weights. This load equals 44.08 t.

Make up the final load by adding 15.78 t (forklift plus the test rig) to this load to make 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. The same method for determination of error applies when removing the loads.

Results of Weighing Test Using Substitution Load

Instrument description: Static weighbridge

Max: 60 t

Verification scale interval (e): 0.02 t

Accuracy class: 3

Method used	Method A
MPE change points	10 t, 40 t
Available standard weights	16 t
First substitution load	Test rig + forklift (approximate mass) 16 t
Second substitution load	Gravel truck (approximate mass) 30 t
Third substitution load	—

L	Makeup of load	MPE	I	½e	Δ*L*	E	L_{sub}	L_{sub} (rounded)	Pass/fail/ na
0.4 t	weights	±0.01 t	0.4 t	—	—	—	—	—	pass
16 t	weights	±0.02 t	16.02 t	0.01 t	0.012 t	+0.018 t	—	—	pass
Test rig + forklift	—	—	15.78 t	0.01 t	—	+0.018 t	15.772 t	15.78 t	na
31.78 t	15.78, 16	±0.02 t	31.80 t	0.01 t	0.014 t	+0.016 t	—	—	pass
Gravel truck	—	—	31.08 t	0.01 t	—	+0.016 t	31.074 t	31.08 t	na
44.08 t	31.08, 13	±0.03 t	44.10	—	—	—	—	—	pass
59.86 t	44.08, 15.78	±0.03 t	59.88	—	—	—	—	—	pass
Over-range blanking									pass

L	Makeup of load	MPE	I	
44.08 t	59.86 – 15.78	±0.03 t	44.06	pass
31.78 t	44.08 – 31.08	±0.03 t	31.78	pass
13 t	weights	±0.02 t	13.00	pass
0 t*	—	±0.01 t	0	pass

*Note: Zero load must **not** indicate above 0.25e

APPENDIX D. 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.

D.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.

D.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.

D.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.

D.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 $3 \times L$ millimetres (where L is the minimum reading distance in metres) 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 $3 \times L$ millimetres being less than 5 mm.

D.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).

D.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.

D.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.

D.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.

D.9 Reading Index

D.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.

D.9.2 Width

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

D.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.

D.9.4 Parallax

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

D.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 D.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 D.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 D.1. Lowest permitted maximum capacity

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

D.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.

D.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.

D.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.

D.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.

D.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 D.2. The MPE for even-arm scales shall be half the amount specified in Table D.2 for loads up to half capacity and the whole amount specified for loads from half to maximum capacity.

D.16 Additional Requirements for Particular Types of Instruments

D.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.

D.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.

D.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 D.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

D.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.