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Compressed gaseous fuel measuring systems for vehicles

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Amendments

No.	Date	Page(s)	Location	Details of change
1	Oct 2023	Various	Various	All references to compressed natural gas (CNG) have been amended to compressed gaseous fuel (CGF) to reflect the increased range of fuel types covered by this National Instrument Test Procedure (NITP), in particular compressed hydrogen gas.
2	Oct 2023	Various	Various	The more general term ‘measuring systems for vehicles’ has been introduced to align with the updated OIML/NMI R 139 and to reflect the range of measuring instrument designs covered by this NITP. The more common and dedicated term ‘dispenser’ is generally used throughout for convenience.
3	Oct 2023	Various	Various	All references to in-service inspection have been removed to avoid confusion. In-service inspection shall only be performed by trade measurement inspectors.
4	Oct 2023	2	3.1	The visual inspection procedure has been condensed and included under test procedures.
5	Oct 2023	3	3.2	The maximum permissible errors have been updated to reflect the changes to NMI R 139-1 (2023).
6	Oct 2023	6	3.10	The test procedures have been updated to be more principles-based and to reflect the increased scope of the NITP with respect to product type (e.g. hydrogen).
7	Oct 2023	11	Appendix A	The test report formats have been updated to reflect the amendments to the test procedures.
8	Oct 2023	19	Appendix B	Appendix B has been included to provide guidance in the estimation of uncertainty in the calibration of the control instrument.

Preface

The Chief Metrologist of the National Measurement Institute (NMI) has determined that NITP 12.1 contains the national instrument test procedures for the verification of compressed gaseous fuel (CGF) measuring systems for vehicles, typically known as CGF dispensers.

Contents

Explanation of terms

For explanations of other terms see *General information for test procedures*. For terms relating to compressed gaseous fuel (CGF) dispensers, refer to NMI R 139 (2023) *Compressed gaseous fuel measuring systems for vehicles:*

NMI R 139-1: Metrological and technical requirements
NMI R 139-2: Metrological controls and performance tests
NMI R 139-3: Test report format

Console

A device that controls the authorisation of a delivery. A console may be a self-service device used as part of a self-service arrangement.

Note: The test procedures specified for control systems (consoles) used to control the operation of CGF dispensers are largely equivalent to those used to test control systems used in the delivery of liquid fuels, also known as control systems for liquid measuring systems.

Compressed gaseous fuel

Fuel that is intended to be measured in a compressed gaseous state. Examples include compressed hydrogen gas (CHG) and compressed natural gas (CNG).

Abbreviations

CGF	compressed gaseous fuel
CHG	compressed hydrogen gas
CNG	compressed natural gas
E_{FD}	relative error of indication
E_{min}	minimum specified mass deviation
M_{FD}	mass indicated by the dispenser
M_{MFM}	mass indicated by the mass flowmeter
M_{REF}	mass indicated by the reference standard
MF_{MFM}	mass flowmeter correction factor
MMQ	minimum measured quantity
	Note: Sometimes described as minimum quantity, minimum delivery or M_{min}
MPE	maximum permissible error
P_E	pressure of the CGF test cylinder prior to testing
P_T	pressure of CGF test cylinder at end of test run
P_V	maximum rated pressure of the CGF test cylinder
Q_{max}	maximum flow rate
Q_{min}	minimum flow rate
Q_{av}	average test flow rate

1. Scope

National Instrument Test Procedure (NITP) 12.1 describes test procedures for the verification of compressed gaseous fuel (CGF) dispensers. The test procedures are intended to assess whether CGF dispensers operate within the maximum permissible errors (MPEs) specified in their certificate of approval.

Certificates of approval are based on NMI R 139. There are 3 parts to this recommendation. Refer to NMI R 139-1 for all metrological and technical requirements.

Note: The MPEs for a CGF dispenser are specified in its certificate of approval.

For convenience, the MPEs for CGF dispensers are reproduced in clause 3.2 below and are identical to those specified in NMI R 139-1.

The methods described to test accuracy are:

- the **mass flow method**, which uses a **mass flow meter** as the traceable reference standard
- the **gravimetric method**, which uses **weights in conjunction with a weighing instrument** (control instrument) as the traceable reference standard.

NITP 12.1 also describes test procedures for the verification of consoles.

All CGF dispensers must comply with the *National Measurement Act 1960* (Cth) and the *National Trade Measurement Regulations 2009* (Cth).

2. Equipment

1. Certificate(s) of approval.
2. For the **mass flow method**, suitable standards as follows:
   (a) A mass flow meter with a calibration uncertainty no greater than one-third of the applicable MPE of the instrument under test.
3. For the **gravimetric method**, equipment and suitable standards as follows:
   (a) A suitable weighing instrument (the control instrument) with an appropriate performance and scale interval such that the uncertainty in the measurement of M_{REF} does not exceed one-third of the maximum permissible error (MPE) of the dispenser under test.
   (b) Reference standard weights equivalent to the weight of the
      (i) product for the intended mass delivery plus an additional 10%, when the receiving vessel is tared; or
      (ii) receiving vessel plus the weight of the product for the intended mass delivery plus an additional 10%, when the receiving vessel is not tared.
4. Compressed gaseous fuel (CGF) test cylinders of an appropriate number and capacity and that incorporate suitable flow control valves. When selecting test cylinders, consider the MPE of the dispenser under test, the minimum measured quantity, the potential effects of cylinder capacity on the uncertainty of the reference device and errors of indication of the dispenser under test.

   Note: The CGF test cylinder arrangement should be representative of a typical vehicle storage tank, including appropriate fuelling protocols. For example, see *SAE J2601: Fueling protocols for light duty gaseous hydrogen surface vehicles.*

   Note: As guidance, the mass capacity of a compressed natural gas (CNG) test cylinder should be 12 kg at P_V and 15 °C. The mass capacity of a compressed hydrogen gas (CHG) test cylinder should be 6 kg at P_V at 15 °C. (P_V is the maximum rated pressure of the CGF test cylinder.)

Note: Further considerations when selecting test cylinders include the refuelling site arrangements, and relevant environmental and road safety regulations that determine the dispensing, storage, transportation and venting requirements that apply.

5. A reference standard pressure gauge with a range at least equal to the maximum gas pressure of the system under test (typically 35,000 kPa for CNG and 70,000 kPa for CHG), with a calibration uncertainty no greater than ±1% of full range, and suitable for measuring the pressure of the CGF test cylinders.
6. Valves, hoses and couplings suitable for filling and emptying the cylinders.
7. A timing device.
8. Test reports (see Appendix A).
9. Current Regulation 13 certificates for all reference standards of measurement and/or Regulation 37 certificates for all certified measuring instruments.
   The uncertainties and variations of the calibration of Inspectors' Class reference standards of measurement shall comply with the *National Measurement Regulations 1999* (Cth).
   The combined uncertainties and variations of the reference standard weights used to test the control instrument shall not exceed one-third of the MPE of the control instrument at each load point.
   The uncertainties of the calibration of certified measuring instruments and control instruments shall not exceed one-third of the MPE of the dispenser under test. Appendix B provides guidance on the estimation of measurement uncertainty in the calibration of a control instrument and the use of corrections.

   Note: Pressure gauge traceability can be demonstrated by either a Regulation 13 certificate of verification or a calibration report issued by a NATA-accredited organisation.

3. Test procedures

The following series of test procedures determine whether the dispenser meets the requirements for verification. If the dispenser fails any of the applicable tests, the dispenser cannot be verified.

Note: The methods and test procedures specified in this NITP are those used by Trade Measurement Inspectors for the verification and testing of compressed gaseous fuel (CGF) dispensers.

Should any adjustment be required, the test procedures must be repeated after adjustment to ensure the dispenser meets the requirements for verification.

Each test procedure is explained as a discrete test. However, tests can be combined to improve efficiency. Clause 4 shows a suggested sequence for testing.

When required, record results on the test report (Appendix A).

Note: Compressed gas is highly flammable, and there is a risk of explosion if proper precautions are not followed. Comply with all applicable safety requirements before and during testing.

3.1 Visual inspection

Visually inspect the measuring instrument to confirm compliance with the following characteristics:

1. The dispenser shall comply with its certificate(s) of approval.
2. The dispenser shall be complete, undamaged and operational.
3. The operator (and, when applicable, the customer) shall have a clear and unobstructed view of the indicating device.
4. The indications of mass, unit price and total price shall correctly correspond with the selected hose.
5. All indications shall be clearly visible under all conditions, day and night.

6. All hoses shall be in a serviceable condition; for example, they shall not be badly chafed or split, or worn through to the reinforcing material.
7. There shall be no leaks in any part of the dispenser.

When required, record details on the test report (Appendix A).

3.2 Maximum permissible errors

The maximum permissible errors (MPEs) for the mass indicated by CGF dispensers are specified in Table 1.

Table 1 Maximum permissible errors (MPEs)

Accuracy class		MPE for the meter (%)	MPE for the complete measuring system (%)
General application	**1.5**	±1	±1.5
Hydrogen only	**2**	±1.5	±2
	4	±2	±4

Note: CGF dispensers approved as accuracy class 1.5 are typically intended for use with compressed natural gas.

Consult the certificate of approval to find the MPE(s) applicable to the CGF dispenser under test.

The MPE for quantities at or near the minimum measured quantity (MMQ), is known as the E_{min}. The values of E_{min} are specified in Table 2. The MMQ and the E_{min} are expressed in units of mass; in grams or kilograms [g; kg].

Table 2 Minimum specified mass deviation (E_{min})

Accuracy class	E_{min} (g or kg) for the meter	E_{min} (g or kg) for the complete measuring system
1.5	0.02 MMQ	0.03 MMQ
2	0.03 MMQ	0.04 MMQ
4	0.04 MMQ	0.08 MMQ

Note: The E_{min} is the MPE expressed as an absolute value (in units of mass). See NMI R 139-1 for more information about the derivation of E_{min}.

Whatever the measured quantity may be, the magnitude of the MPE (expressed in units of mass) for the complete system must never be less than the minimum specified mass deviation.

The maximum value of MMQ for all types of CHG measuring systems is 1 kg.

3.3 The checking facility for the indicator

The indicator must be tested. The checking facility shall identify significant faults in the indicator through completing the following display test steps on removing the nozzle from its hang-up position (NMI R 139-1, clause 6.10.4):

1. Displaying all the elements (eights test).
2. Blanking all the elements (blank test).
3. Displaying zeros (zero test).

This test can be carried out in conjunction with the test for zero setting (see clause 3.4):

1. Remove the nozzle from its hang-up position and check that the:

   (a) display test, detailed above, is performed without error

(b) none of the display segments is faulty.

2. Determine whether the dispenser has passed or failed.
3. Record results on test report 1.

3.4 Zero setting

The zero-setting devices of the price-indicating device and of the mass-indicating device shall be designed in such a way that zeroing either indicating device automatically zeros the other (NMI R 139-1, clause 6.5.2).

The zero-setting device shall only permit the measurement result shown by the indicating device to be reset to zero and to no other value (NMI R 139-1, clause 6.5.1.1).

Once the zeroing operation has begun it shall be impossible for the price- or mass- indicating device to show a result different from that of the measurement that has just been made until the zeroing operation has been completed. The price/mass-indicating device must not be capable of being reset to zero during measurement (NMI R 139-1, clauses 6.5.1.3 and 6.5.1.4).

The price/mass indications must return to zero without ambiguity. Follow these steps:

1. Remove the nozzle from its hang-up position and ensure that the display test is performed and the price and mass displays are on zero before any delivery of product is possible.
2. Carefully return the nozzle to its hang-up position.
3. Remove the nozzle a second time and ensure no further deliveries are possible without the display test being performed and the indications returning to zero.
4. Determine whether the dispenser has passed or failed.
5. Record results on test report 1.

3.5 Price computing

If a price-indicating device is present, the price indicated must agree with the price calculated from the mass and unit price indicated to within the MPE of ±0.5 of the scale interval of the total price display (typically this means an MPE of ±0.5 cents).

This test can be done at any time during a test delivery. Follow these steps:

1. Reset the dispenser to zero.
2. Make a delivery of a convenient mass.
3. Calculate the total price (rounded to the nearest 2 decimal places) from the unit price and mass indicated.
4. Compare this calculated price with all price displays.
5. Determine whether the dispenser has passed or failed.
6. Record results on test report 1.

3.6 Meter creep

Measuring systems shall either prevent or compensate for the registration of mass in the absence of any effective flow rate (NMI R 139-1, clause 6.5.3).

This test may be combined with the zero-setting test. Follow these steps:

1. Remove the nozzle from its hang-up position and ensure that the price and mass displays are on zero.
2. Observe the mass and price indications for 1 minute, and ensure that there is no change in the indication.

3. Carefully return the nozzle to its hang-up position.
4. Determine whether the dispenser has passed or failed.
5. Record results on test report 1.

3.7 Preset indications

Measuring systems with a price-indicating device may also be fitted with a price/mass presetting device, which stops the flow of CGF when the price/quantity corresponds to the preset value (NMI R 139-1, clause 6.6.9).

This test can be combined with the preset accuracy test. Follow these steps:

1. Reset the dispenser to zero.
2. Enter a suitable preset value using the presetting device. Make sure the preset amount appears on the display.
3. Commence a delivery with the nozzle fully open; allow the presetting device to slow down and complete the delivery automatically.
4. Check that the price/mass indication on the display corresponds to the preset amount.
5. Determine whether the dispenser has passed or failed.
6. Record results on test report1.

3.8 Preset accuracy

For measurement systems with a price/mass presetting device, a preset accuracy test is conducted to check the accuracy of the preset delivery price/mass. This test may be combined with an appropriate accuracy test (clause 3.10).

1. Enter and record a suitable preset value using the presetting device.
2. Make a delivery at maximum achievable flow rate until the delivery stops. Record the mass indicated by the CGF dispenser (M_{FD}) and the mass indicated by the reference standard (or control instrument) (M_{REF}).
3. Calculate and record the relative error of indication (E_{FD}):

$$E_{FD} = \frac{(M_{FD} - M_{REF})}{M_{REF}} \times 100\%$$

   Note: A positive error means that the flow metering system is over-indicating/under-delivering.
4. Determine if the result is within the MPE (see clause 3.2).
5. Record results on test report 1-1 or 1-2, and label the results as from the preset accuracy test.

3.9 Maximum flow rate

The maximum achievable flow rate shall be within the approved flow rate range (Q_{min} to Q_{max}) marked on the data plate.

It is recognised that the flow rate will vary over the course of the test due to fuelling protocols and changes in pressure in the supply banks and the receiving CGF test cylinders. Similarly, the maximum achievable flow rate will vary according to the pressure in the supply tanks, ambient conditions, the conditions of the CGF test cylinders and other factors.

Testing in accordance with this NITP shall be performed in conditions such that the maximum achievable flow rate (at any point during the testing process) is within the approved flow rate range of the dispenser under test.

The average test flow rate shall be calculated for each test and shall be within the approved flow rate range of the CGF dispenser. A dispenser that is found to operate with an average flow rate outside its approved flow range shall not be verified.

3.10 Accuracy

3.10.1 Principles

CGF dispensers shall be tested for accuracy in accordance with the following principles:

1. The dispenser shall operate accurately across its achievable flow rate range.
2. Measurements made by the dispenser shall be repeatable.
3. Accuracy shall not be significantly affected by large and/or rapid changes in supply pressure. Such changes may happen, for example, at a site where the dispenser is installed with multiple supply banks and a sequential control device allows for switching between supply banks during a delivery.

To demonstrate compliance with these principles, CGF dispensers should be tested in accordance with the procedures specified below. The relevant test procedure for any CGF dispenser depends upon:

- the method used to determine the reference mass
- the approved accuracy class of the dispenser under test
- the use (or not) of sequential control devices allowing for switching of supply banks during a delivery.

A verifier may use an alternative test procedure or method if it provides equivalent confidence that the dispenser demonstrates compliance with the principles listed above.

The certificate of approval may specify alternative or additional test procedures that shall apply to dispensers of that approved pattern.

3.10.2 Measurement methods

3.10.2.1 General

One of 2 methods may be used to determine a reference mass:

1. The **mass flow method,** which uses a **mass flow meter** as the reference standard (see clause 3.10.2.2).
2. The **gravimetric method,** which uses **weights in conjunction with a weighing instrument** as the reference standard (see clause 3.10.2.3).

Regardless of the method used, the uncertainty in the determination of reference mass shall be no more than one-third of the applicable MPE. If relevant, appropriate fuelling protocols between the dispenser and the CGF test cylinders must be used during the delivery process.

3.10.2.2 Mass flow method

For each of the accuracy tests described in clause 3.10.3 the following test procedure shall be followed:

1. Ensure the receiving CGF test cylinders are preconditioned for the specific test as specified in clause 3.10.3.
2. Connect the mass flow meter outlet hose to the inlet of a CGF test cylinder.
3. Connect the dispenser nozzle to the inlet of the mass flow meter.
4. Condition the mass flow meter. This may be done by passing a quantity of CGF through the mass flow meter.
5. Reset the mass flow meter and dispenser to zero.
6. Authorise the dispenser, open the dispenser nozzle and then control the delivery by slowly opening the flow control valve on the mass flow meter to allow testing at maximum achievable flow rate.

7. Record the CGF supply pressure and the pressure of the CGF test cylinder.
8. Make a delivery at the flow rate and pressure for the relevant test specified in clause 3.10.3.
9. Time the filling process and determine the average flow rate.
10. Calculate and record the average flow rate on the test report and check it is within the approved flow rate range of the dispenser under test.
11. Complete the delivery and record the mass indication (M_{FD}) on the dispenser and the mass indicated by the mass flowmeter (M_{MFM}).
12. Record the pressure of the receiving CGF test cylinder and the gas supply pressure.
13. Check the pressure of the CGF test cylinder is within 10% of the maximum rated pressure of the CGF test cylinder (P_V).
14. Use the mass flow meter correction factor (MF_{MFM}) to calculate the reference mass (M_{REF}):

$$M_{REF} = M_{MFM} \times MF_{MFM}$$

Note: Apply the MF_{MFM} corresponding to the calculated average flow rate of the test.

15. Calculate E_{FD}:

$$E_{FD} = \frac{(M_{FD} - M_{REF})}{M_{REF}} \times 100\ \%$$

Note: A positive E_{FD} means that the flow metering system is over-indicating/under-delivering.

16. Repeat steps 5 to 15 for each test specified in clause 3.10.3.
17. Determine if all the results in step 15 are within the MPE (see clause 3.2).
18. If meter adjustments are made, repeat steps 1 to 17 for all tests specified in clause 3.10.3.
19. Record results on test report 1-1.

3.10.2.3 Gravimetric method

For each of the accuracy tests described in clause 3.10.3, the following test procedure shall be followed:

1. Ensure the receiving CGF test cylinders are preconditioned for the specific test as specified in clause 3.10.3.
2. Set up the weighing instrument on a flat surface in a position that will not be affected by wind. Level the instrument, switch it on, and allow for any warm-up time.
3. Test the control instrument for compliance with *NITP 6.1* to *6.4 National instrument test procedures for non-automatic weighing instruments*; test for:

   (a) weighing performance
   (b) eccentricity
   (c) repeatability.

   The weighing instrument must be tested immediately before commencing any testing. It is not necessary to test the weighing instrument to its maximum capacity. It must be tested up to 110% of the maximum delivered quantity of CGF.

   If testing is performed without the cylinders tared off, the weighing instrument must be tested up to 110% of the weight of the cylinders plus the maximum delivered quantity of CGF.
4. Complete the test report in *NITP 6.1* to *6.4 National instrument test procedures for non-automatic weighing instruments* for the tests specified above.
5. Determine the correction(s) to be applied to the measurement indications of the control instrument in the determination of the reference mass (see step 18).

6. Zero the weighing instrument and place the CGF test cylinder on the weighing platform. Either record the mass of the CGF test cylinder or tare off the mass of the CGF test cylinder.
7. Remove the CGF test cylinder from the weighing instrument and place it in the vicinity of the dispenser.
8. Zero the dispenser.
9. Connect the nozzle of the dispenser to the inlet of a CGF test cylinder.
10. Record the gas supply pressure and the pressure of the CGF test cylinder.
11. Check that the pressure of the CGF test cylinder is within 10% of P_V.
12. Authorise the dispenser, open the CGF test cylinder valve, then open the dispenser nozzle and make a delivery at the required flow rate until the pressure in the CGF test cylinder reaches the required pressure. Required flow rates and pressures for each test are specified in clause 3.10.3.
13. Time the filling process and determine the average flow rate.
14. Record the average flow rate on the test report and check it is within the approved flow rate range of the dispenser under test.
15. Close the CGF test cylinder valve and nozzle and return the nozzle to the dispenser.
16. Record the mass indication (M_{FD}) on the dispenser.
17. Record the pressure of the receiving CGF test cylinder and the gas supply pressure.
18. Place the CGF test cylinder on the weighing instrument; determine and record the reference mass (M_{REF}).

    If the cylinder has not been tared off, subtract the tare mass of the cylinder to obtain the reference mass (M_{REF}). Apply any corrections (see step 5 above).
19. Calculate E_{FD}:

$$E_{FD} = \frac{(M_{FD} - M_{REF})}{M_{REF}} \times 100\ \%$$

    Note: A positive E_{FD} means that the flow metering system is over-indicating/under-delivering.
20. Repeat steps 6 to 19 for each test specified in clause 3.10.3.
21. Determine if all the results in step 19 are within the allowable MPE (see clause 3.2).
22. If meter adjustments are made repeat steps 1 to 21 for all tests specified in clause 3.10.3.
23. Record results on test report 1-2.

3.10.3 Accuracy tests

3.10.3.1 Test conditions

Accuracy tests shall be performed at the ambient temperature of the test site and within the rated operating conditions of the dispenser under test.

P_E is defined as a pressure equal to or less than 1500 kPa.

3.10.3.2 Test procedures

Test 1 – For hydrogen dispensers only

This test requires that the receiving CGF test cylinder(s) be filled at the maximum achievable flow rate from P_E to P_V. This test is to be performed 3 times.

This test shall commence with the CGF supply from the low-pressure bank. Ensure that the CGF supply switches to a higher-pressure bank at least once during the test.

Note: Dispensers intended for use with compressed hydrogen gas are typically approved as accuracy class 2 or accuracy class 4.

The remaining accuracy tests are applicable to all accuracy classes of CGF dispensers, including CFG dispensers intended for the dispensing of compressed hydrogen.

Test 2 – High flow rate

This test requires that the receiving CGF test cylinder(s) be filled at the maximum achievable flow rate from P_E to 60% (±15%) of P_V.

Test 3 – Low flow rate

This test requires that the receiving CGF test cylinder(s) be filled at or near the minimum approved flow rate from 60% (±15%) P_V to P_V; this test should be completed using the same test cylinder used in Test 2.

Note: Quantities delivered during this test may be at or near the MMQ. The maximum value of the MMQ for all types of hydrogen CGF measuring systems is 1 kg.

Repeat test 2 and test 3 a further 2 times.

Test 4 – Bank switching

This test is intended to ensure that the accuracy of the dispenser under test is not significantly affected by large or rapid changes in supply pressure. The following conditions apply:

- Where a dispenser is installed with a single supply bank arrangement, this test is not required.
- Where a dispenser incorporates a compensated filling mode (as in hydrogen fuelling protocols), this test can be combined with test 2. For this test, a compensated filling mode is considered to be any automated operation that starts and stops the flow of CGF to allow for the measurement of temperature or pressure at the inlet of the receiving vessel. The results of such measurements are then used to control the subsequent delivery of product. In this case, if the dispenser passes test 2, it is considered to pass test 4 as well.
- Where a dispenser is installed with a multiple supply bank arrangement and the dispenser does not incorporate a compensated filling mode, this test must be performed at initial verification such that
  - the receiving CGF test cylinder is filled at the maximum achievable flow rate from P_E to P_V (this test is to be performed once and may replace one of the test deliveries required under Test 1)
  - the test shall commence with the CGF supply from the low-pressure bank; test conditions shall ensure that the CGF supply switches to a higher-pressure bank least once during the test.

Following initial verification, if the site conditions are changed such that it is not practical to perform test 4 (for the purposes of subsequent verifications), the test may be omitted.

4. Suggested sequence for testing

1. Check the certificate of approval for any additional tests required. Make provision for including these tests in the testing sequence.
2. Visually inspect the dispenser and record the required data and characteristics of the dispenser on the test report.
3. Conduct the accuracy tests as described in clause 3.10.3.
4. While conducting the accuracy test check:
   (a) maximum flow rate (clause 3.9)
   (b) meter creep (clause 3.6)
   (c) the checking facility for electronic indicating devices (clause 3.3)
   (d) zero setting (clause 3.4).

(e) price computing (clause 3.5).

5. Conduct a preset indication test, if required (clause 3.7).
6. Conduct a preset accuracy test, if required (clause 3.8).
7. Determine whether the instrument has passed or failed.
8. Carry out any other tasks needed to complete the procedure. See *General information for test procedures* for more information. This may include:

   (a) obliterating the verification mark from the dispenser
   (b) applying a verification mark to the dispenser
   (c) applying seal(s) as specified in the certificate of approval.

9. If required, verify the console (clause 5).

5. Test procedure for the verification of a console

Verification of a console is carried out to ensure that each dispenser is communicating correctly with its console. This must be carried out:

- at initial installation
- when repairs are carried out that affect the approved functions
- at the request of the owner, user or NMI.

Check the certificate of approval for any additional tests required. Make provision for including these tests in the testing sequence. Follow these steps:

1. Complete a visual inspection to ensure the console is complete, undamaged and complies with its certificate of approval.
2. Ensure that the dispenser is communicating with the console.
3. For self-service systems, ensure that the dispenser number(s) correctly correspond to the console.
4. Authorise the dispenser at the console.
5. Remove the nozzle from its hang-up position and deliver enough product to cause the price and mass indicators to move significantly off zero.
6. Return the nozzle to its hang-up position.
7. Record the dispenser number and nozzle identification and the price and mass displayed on the dispenser.
8. At the console, check that the dispenser number and nozzle identification and the price and mass displayed are the same as recorded from the dispenser.
9. If the console supports stored transaction sales:

   (a) store the current transaction
   (b) repeat steps 3 to 7
   (c) check that the stored transaction and the second transaction can be displayed on the console and correspond with the delivery details recorded from the dispenser.

10. If the console includes a printer, print out a docket to ensure the docket complies with the requirements of the general certificate of approval S1/0B.
11. Complete any other tests required in the certificate of approval, or needed to establish that console warnings and protections are functioning correctly.
12. Record results on test report 2.

APPENDIX A. Test Reports

Appendix A contains 2 test reports:

1. Test report 1 has a front page that must be accompanied by **one** of the following:

   (a) Test report 1-1: this test is for dispensers that are tested using a **mass flow meter**. Multiple copies will be required, because results must be included from all runs required in tests 1 and 2, plus any bank switching and preset accuracy testing.
   (b) Test report 1-2: this test is for dispensers that are tested using **weights and a weighing instrument (control instrument)**.

   In addition, the test report found in NITP 6.1 to 6.4 should be used when testing the control instrument.

2. Test report 2 is for consoles.

Although the formats of the test reports may vary according to the individual needs and requirements of NMI and servicing licensees, the specified test reports contain 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 the sample pages in this appendix.

Test report 1 for CGF dispensers

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

For reverification, record the verification mark.....

Name of owner/user.....

Address of owner/user .....

Name of contact person on premises .....

Trading name .....

Address of instrument location.....

Description of dispenser.....

Manufacturer ..... Model.....

Dispenser number(s) .....

Dispenser serial number ..... Certificate of approval number .....

Fuel product(s) dispenser approved to deliver.....

Accuracy class .....

Approved minimum flow rate (Q_{min}) .....Approved maximum flow rate (Q_{max})…….

Details of the reference standard(s) of measurement used (clause 2)

Reference standard (e.g. mass flowmeter or reference standard weights)	
Make	
Model	
Serial number(s)	
Flow rate range / weight (as applicable)	
Regulation 13 or 37 certificate number	
Certificate expiry date	

Test report 1 for CGF dispensers

Details of the pressure gauge used (clause 2)

Pressure gauge		
Make		
Model		
Serial number(s)		
Operational range		
Calibration certificate number		
Certificate expiry date		

Test report 1 for CGF dispensers

Visual inspection (clause 3.1)	Yes, no or N/A
1. Does the dispenser comply with its certificate(s) of approval?	
2. Is the dispenser complete, undamaged and operational?	
3. Does the operator (and, when applicable, the customer) have a clear and unobstructed view of the indicating device and the entire measuring process?	
4. Do the indications of mass, unit price and total price correctly correspond with the selected hose?	
5. Are all indications clearly visible under all conditions, day and night?	
6. Are all hoses in a serviceable condition; for example, not badly chafed, split, or worn through to the fabric?	
7. Are there any leaks?	

Test procedures 3.3 to 3.7	Pass or fail
Checking facility for electronic indicating devices (clause 3.3)	☐ Pass ☐ Fail
Zero setting (clause 3.4)	☐ Pass ☐ Fail
Price computing (clause 3.5)	☐ Pass ☐ Fail
Meter creep (clause 3.6)	☐ Pass ☐ Fail
Preset indications (clause 3.7)	☐ Pass ☐ Fail

Test report 1-1 for dispensers that are tested using a mass flow meter

Test (see clause 3.10.3)	Test 1/2/3/4			
	Delivery 1	Delivery 2	Delivery 3	Notes
Test cylinder pressure (initial), P_E	kPa	kPa	kPa	
Mass indicated by dispenser, M_{FD}	kg	kg	kg	
Mass indicated by mass flow meter, M_{MFM}	kg	kg	kg	
Time of delivery	s	s	s	
Average flow rate, Q_{av}	kg/min	kg/min	kg/min	
Test cylinder pressure (final), P_T	kPa	kPa	kPa	
Mass flow meter factor, MF_{MFM}				
Reference mass, M_{REF}	kg	kg	kg	
Relative error, E_{FD}	%	%	%	
MPE	%	%	%	
Delivery result	Pass ☐ Fail ☐	Pass ☐ Fail ☐	Pass ☐ Fail ☐	
Test result	Pass ☐	Fail ☐		

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

Signature

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Comments

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Test report 1-2 for dispensers that are tested using weights and a weighing instrument

The test report found in NITP 6.1 to 6.4 shall be used to record the test results of the control instrument.

Test (see clause 3.10.3)	Test 1/2/3/4						
	Delivery 1		Delivery 2		Delivery 3		Notes
Test cylinder pressure (initial), P_E	kPa		kPa		kPa		
Time of delivery	s		s		s		
Average flow rate, Q_{av}	kg/min		kg/min		kg/min		
Mass indicated by dispenser, M_{FD}	kg		kg		kg		
Mass indicated by control instrument, M_{REF}	kg		kg		kg		
Test cylinder pressure (final), P_T	kPa		kPa		kPa		
Relative error, E_{FD}	%		%		%		
Maximum permissible error	%		%		%		
Delivery result	Pass ☐	Fail ☐	Pass ☐	Fail ☐	Pass ☐	Fail ☐	
Test result	Pass ☐	Fail ☐					

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

Signature

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Comments

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Test report 2 for the verification of consoles

Date of test .....

For reverification, record the verification mark.....

Trading name.....

Address of instrument location .....

Description of instrument.....

Manufacturer ……Model .....

Serial number ..... Certificate of approval number .....

Does the dispenser communicate with the console?		☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes	☐ No
		Dispenser	Console	Dispenser	Console	Dispenser	Console
First transaction	Dispenser number and nozzle identification						
	Price displayed						
	Mass displayed						
Second transaction (if console supports stored transactions)	Dispenser number and nozzle identification						
	Price displayed						
	Mass displayed						
Is the first transaction stored and displayed correctly		☐ Yes	☐ No	☐ Yes	☐ No	☐ Yes	☐ No

Does the dispenser communicate with the console?	☐ **Yes**	☐ **No**	☐ **Yes**	☐ **No**	☐ **Yes**	☐ **No**
Before cancelling/clearing transactions 1 and 2, check that no further transactions may be authorised	☐ **Pass**	☐ **Fail**	☐ **Pass**	☐ **Fail**	☐ **Pass**	☐ **Fail**
Overall result	☐ **Pass**	☐ **Fail**	☐ **NA**			

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

Signature

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Comments

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APPENDIX B. Control Instruments

This appendix provides guidance on the suitability, testing and uncertainty of control instruments used as part of the gravimetric method (see clause 3.10.2.3).

B.1 Control instrument suitability

The control instrument shall:

- be a non-automatic weighing instrument
- be able to allow determining the mass of the dispensed CGF with an uncertainty not greater than one-third of the MPE of the dispenser under test
- be capable of having reference standard weights deposited on the load receptor.

B.2 Control instrument testing

The control instrument shall be tested in accordance with *NITP 6.1 to 6.4 national instrument test procedures for non-automatic weighing instruments* from its minimum capacity up to 110% of the maximum delivered quantity of CGF. Tests to be performed are:

(a) weighing performance
(b) eccentricity
(c) repeatability.

The test report in NITP 6.1 to 6.4 shall be completed for the tests specified in (a), (b) and (c) above.

B.3 Reference standard weights

All reference standard weights shall have current Regulation 13 certificates.

Testing shall be performed using reference standard weights equivalent to the weight of the:

- product for the intended mass delivery plus an additional 10%, when the receiving vessel is tared; or
- receiving vessel plus the weight of the product for the intended mass delivery plus an additional 10%, when the receiving vessel is not tared.

The uncertainties of the calibration of reference standard weights used to test the control instrument shall not exceed one-third of the MPE of the control instrument at each load point.

B.4 Control instrument uncertainty

The uncertainty in the calibration of control instruments shall not exceed one-third of the maximum permissible error (MPE) of the dispenser under test.

The calculations to determine the uncertainty in the calibration of the control instrument must consider the effects of at least the following components of uncertainty:

- uncertainty of calibration of the reference standards
- drift in the calibration of reference standards
- control instrument repeatability
- control instrument resolution.

The uncertainty of calibration of the reference standards may be obtained from the Regulation 13 certificate (and accompanying calibration report) of the reference standard weights.

The drift in the calibration of the reference standards should be estimated based on the change in the calibration of the reference standard weights over time.

The control instrument repeatability may be obtained from testing the control instrument in accordance with *NITP 6.1 to 6.4 National instrument test procedures for non-automatic weighing instruments* as described in clause B.2 above.

Table B.1 may be used to calculate the combined expanded uncertainty of the control instrument and determine whether it is suitable for use. The following abbreviations apply:

U_i uncertainty of component

k coverage factor

u standard uncertainty

v degrees of freedom

c sensitivity coefficient

v_{eff} effective degrees of freedom

u_c combine standard uncertainty

U combined expanded uncertainty

Further guidance on the estimation of uncertainty of the control instrument can be found in NMI Monograph 1 *Uncertainty in measurement: the ISO guide* and NMI Monograph 4 *The calibration of weights and balances.*

Table B.1 Control instrument uncertainty calculation

Component of uncertainty	**Units**	**Dist.**	**U_i**	**k**	**u**	**v**	**c**	**cu**	**$(cu)^2$**	**$(cu)^4/v$**
Calibration of reference standards	kg									
Drift in reference standards	kg									
Control instrument repeatability	kg									
Control instrument resolution	kg									
								Sum		
								u_c		
								v_{eff}		
								k		
								U		