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NITP 10.1

National Instrument Test Procedures for LPG Dispensers

With associated National Instrument Test Procedures for Control Systems for Liquid Measuring Systems under servicing licence sub-class 18.1

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AMENDMENTS

Item no.	Date	Page/s	Location	Details of change
1	February 2015	-	Multiple	Removed all references to “certification” of the dispenser.
2	February 2015	-	Multiple	Removed references to the “licensing authority”, etc with NMI.
3	February 2015	-	Multiple	Various editorial amendments have been made throughout the document.
4	February 2015	iii	Preface	Removed references to transitional arrangements.
5	February 2015	vi	Explanation of Terms	Removed terminology now found in *General Information for Test Procedures.* Included definition of “console”
6	February 2015	1	1. Scope	Corrected references to current regulations.
7	February 2015	1	2. 3. (a)	Slightly reworded paragraph.
8	February 2015	2	2. 5.	Included option of having a Reg 37 certificate for the reference meter.
9	February 2015	2-3	3.1	Added clarification that the list of safety items is intended as guidance only. Also, provided clarification to some items.
10	February 2015	6	4.5	Re-ordered test procedure steps 7 and 8.
11	February 2015	7	4.7.1	Reworded such that test procedure is now applicable for all dispensers.
12	February 2015	11	4.8.3	Provided more detail regarding the testing of the control instrument.
13	February 2015	12	4.9	Included pre-set accuracy test.

Item no.	Date	Page/s	Location	Details of change
14	February 2015	12	4.10	Corrected MPD to MPE throughout clause.
15	February 2015	19	Test Report 1	Removed exemption temperature compensation calculations.

PREFACE

The Chief Metrologist of the National Measurement Institute (NMI) has determined that NITP 10.1 contains the test procedures for the verification of LPG dispensers and control systems for liquid measuring systems.

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CONTENTS

EXPLANATION OF TERMS

For explanations of other terms see *General Information for Test Procedures*. For other terms relating to LPG Dispensers, refer to NMI R 117 *Measuring Systems for Liquids Other than Water*.

Console

A device which controls the authorisation of a delivery. A console may be a self-service device used as part of a self-service arrangement. This is also known as a control system for liquid measuring systems.

ABBREVIATIONS

C_{pl}	pressure conversion factor on the liquid
C_{plMM}	pressure conversion factor for the master meter
C_{tl}	temperature conversion factor on the liquid
C_{tlFD}	temperature conversion factor for the LPG dispenser
C_{tlMM}	temperature conversion factor for the master meter
D_{15}	density at 15°C
D_p	pressure difference
E_{AV}	average relative error
$E_{AV,c}$	average error for the conversion device
E_C	conversion device error
E_{FD}	relative error
E_{FD15}	relative error in temperature **compensated** mode
LPG	liquefied petroleum gas
M_{MFM}	mass indicated by the mass flowmeter
MF_{MFM}	mass flowmeter correction factor
MF_{MM}	master meter correction factor
MMQ	minimum measured quantity
MPD	maximum permissible difference
MPE	maximum permissible error
P_e	equilibrium vapour pressure
P_{MM}	pressure of the liquid passing through the master meter
Q_{max}	maximum flow rate
Q_{min}	minimum flow rate
T_{FD}	temperature of the liquid passing through the LPG dispenser
T_{FDI}	temperature measured by the LPG dispenser
T_{MM}	temperature of the liquid passing through the master meter
V_{FD}	volume indicated by LPG dispenser in temperature **uncompensated** mode
V_{FD15}	volume indicated by LPG dispenser in temperature **compensated** mode
$V_{FD,c}$	V_{FD} converted to base conditions
V_{MM}	volume indicated by the master meter
V_{REF}	volume indicated by the reference standard measure
WPCG	Work Place Clearance Group

1. SCOPE

NITP 10.1 describes the test procedures for the verification and in-service inspection of liquefied petroleum gas (LPG) dispensers, and assess they measure within the maximum permissible errors (MPEs) specified in the *National Trade Measurement Regulations 2009* (Cth) and that they comply with their Certificate of Approval. The test procedures for all other fuel dispensers are described in NITP 5.1.

Certificates of Approval are based on *NMI R 117-1 Measuring Systems for Liquids Other than Water*. Refer to NMI R 117-1 for all metrological and technical requirements.

Three test methods are described to test accuracy:

- the **volumetric** method which uses a **master meter** as the traceable reference standard;
- the **volumetric** method which uses a **mass flowmeter** as the traceable reference standard; and
- the **gravimetric** method which uses weights in conjunction with a weighing instrument (control instrument) as the traceable reference standard.

NITP 10.1 also describes the test procedures for the verification and in-service inspection of consoles.

All instruments must comply with the *National Measurement Act 1960* (Cth), the *National Measurement Regulations 1999* (Cth) and the *National Trade Measurement Regulations 2009* (Cth).

2. EQUIPMENT

1. Certificate(s) of Approval.
2. For the **volumetric** method, suitable standards as follows:
   (a) A master meter or mass flowmeter (±0.2% uncertainty) with reference standard thermometer (±0.2 °C uncertainty) and 2 500 kPa reference standard pressure gauge (±25 kPa uncertainty) fitted to the inlet of the master meter.
   (b) A hydrometer pressure vessel with a reference standard hydrometer (uncertainty of ±1 kg/m^3 for master meters and ±0.5 kg/m^3 for mass flowmeters), a reference standard thermometer (±0.2 °C uncertainty) and a 2 500 kPa reference standard pressure gauge (±25 kPa uncertainty).
   (c) A reference standard thermometer (±0.2 °C uncertainty) suitable for inserting into the thermowell of the dispenser.
3. For the **gravimetric** method, equipment and suitable standards as follows:
   (a) A weighing instrument (the control instrument) with a suitable scale interval such that the uncertainty in the measurement of the delivered quantity does not exceed one-third of the MPE of the dispenser under test.
   (b) Reference standard weights equivalent to the weight of the:
      i. Product for the intended delivery volume plus an additional 10% where the receiving vessel is tared; or
      ii. Receiving vessel plus the weight of the product for the intended delivery volume plus an additional 10% where the receiving vessel is not tared.
   (c) A hydrometer pressure vessel with a reference standard hydrometer (±0.5 kg/m^3 uncertainty) and a reference standard thermometer (±0.2 °C uncertainty).
   (d) A reference standard thermometer (±0.2 °C uncertainty) suitable for inserting into the thermowell of the dispenser.
   (e) A receiving vessel of sufficient capacity, capable of accommodating a flow rate of 50 L/min and containing an appropriate flow control valve.

4. Current Regulation 13 certificates for all standards of measurement
5. Current Regulation 13 or Regulation 37 certificates for all certified measuring instruments.

   Uncertainties and variations of reference standards of measurement shall comply with the *National Measurement Regulations 1999* (Cth). The uncertainties of reference standard weights shall not exceed one-third of the MPE of the control instrument. The uncertainties for certified measuring instruments shall not exceed one-third of the MPE of the dispenser under test.

   Note: Pressure gauges and thermometers can be traceable by either a NATA certificate or a Regulation 13 certificate.
6. Safety equipment (see clause 3.1).
7. Relevant material safety data sheets.
8. Test report (see Appendix A).
9. Work Place Clearance Group (WPCG) work clearance forms.
10. Fuel withdrawal advice.
11. The following publications:
    (a) ASTM–IP–API Petroleum Measurement Tables for Light Hydrocarbon Liquids — Density Range 0.500 to 0.653 kg/L at 15 °C.
    (b) API Manual of Petroleum Measurement Standards, Chapter 11.2.2M — Compressibility Factors for Hydrocarbons: 350–637 kg/m^3 Density (15 °C) and –46 °C to 60 °C Metering Temperature.

3. VISUAL INSPECTION

Visually inspect the dispenser.

Gather the require data (see clause 3.2).

Determine compliance with applicable characteristics (see clause 3.3.).

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

Always follow the safety requirements in clause 3.1.

3.1 Safety Requirements

Testing dispensers is potentially dangerous due to the highly flammable nature of the product dispensed and the movement of vehicles in and out of the service station. Persons and organisations should comply with existing workplace health and safety requirements and procedures relevant for LPG handling and dispensing. The list below is offered as guidance only and is not intended to replace any existing requirements or procedures.

1. Consult the relevant material safety data sheets.
2. Follow the WPCG work clearance procedure and complete associated work clearance forms.
3. At all times minimise exposure to petroleum products, move away from the dispenser whenever possible, work up-wind to reduce inhalation, wear gloves and wash hands after testing.
4. Wear anti-static clothing (e.g. 100% cotton), long pants, a long-sleeved shirt, safety shoes, a safety vest, gauntlet gloves and a face shield.
5. Use equipment approved for use in hazardous areas, e.g. torch and equipment requiring a power supply.
6. Ensure that a suitable fire extinguisher is available and within easy reach at all times.
7. Ensure that there are no potential ignition sources (e.g. lit cigarettes and battery-operated equipment) within the hazardous zones (such as the tank fill points, dispensers and tank vents) of the service station.
8. Place a suitable sign such as ‘dispenser being tested’ in a position so that it is clearly visible to the public.

9. Position safety cones or bollards to prevent vehicle access into the filling position of the dispenser being tested. Ensure that the safety cones are visible to all pedestrian and vehicular traffic.
10. Use a static lead to dissipate any potential static electricity.
11. When checking for leaks:
    (a) stop testing immediately if there is any sign of a leak; and
    (b) check the meter and pipe work carefully.

    To locate a leak, use appropriate gas detection equipment or spray a soapy water solution on the pipe work to determine if a leak is present..
12. Ensure the LPG emergency stop button is functioning. Take note of whether the emergency stop button is for all fuels or LPG only.

3.2 Required Data

1. Test report reference number.
2. Date of test.
3. Type of test: verification or in-service inspection (for in-service inspection or re-verification, ensure that the verification mark is in place).
4. Verifier's name.
5. Name of owner/user.
6. Address of owner/user.
7. Name of contact person on premises.
8. Trading name.
9. Address of dispenser location.
10. Description of instrument.
11. Manufacturer.
12. Model.
13. Dispenser number(s).
14. Dispenser serial number.
15. Certificate(s) of Approval number.
16. LPG density range that the dispenser is approved to deliver.
17. Minimum and maximum flow rate.

3.3 Characteristics of the Instrument

Where applicable the dispenser and its use shall comply with the following clauses:

1. The dispenser shall comply with its Certificate(s) of Approval.
2. The dispenser shall be used in an appropriate manner.
3. All mandatory descriptive markings as required by the relevant Certificate of Approval shall be clearly and permanently marked on the data plate.
4. The data plate shall be fixed on the dispenser.
5. The dispenser shall be complete.
6. The dispenser shall be clean.
7. The dispenser shall be operational.
8. The operation of the dispenser shall be free of any apparent obstructions.
9. The dispenser shall be firmly fixed on its foundations.
10. All external panels shall be secure.

11. Cover windows shall be not be broken.
12. The operator (and where applicable, the customer) shall have a clear and unobstructed view of the indicating device.
13. The indications of volume, unit price and total price shall correctly correspond with the selected hose.
14. All indications shall be clearly visible under all conditions day and night.
15. All hoses shall be in a serviceable condition, e.g. they shall not be badly chafed, split, or worn through to the reinforcing material.
16. There shall be no leaks in any part of the dispenser.
17. For self-service systems, the dispenser number(s) shall correctly correspond with the console.

4. TEST PROCEDURES

The following series of test procedures determine if the performance of a dispenser meets requirements and whether the dispenser 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 5.

For each nozzle, record the readings on the volume totaliser at the start and end of testing to calculate the total volume of LPG used.

Remember to follow the safety requirements in clause 3.1.

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

4.1 Checking Facility for Electronic Indicating Devices

The checking facility for an electronic indicating device shall provide visual checking of the entire display, which shall meet the following description (NMI R 117-1, clause 4.3.4.2):

1. displaying all the elements (eights test);
2. blanking all the elements (blank test); and
3. displaying zeros.

This test can be carried out in conjunction with the test for zero setting (see clause 4.2).

1. Remove the nozzle from its hang-up position and check that the:
   (a) display test is performed; and
   (b) display segments are not faulty.
2. Determine whether the dispenser has passed or failed.
3. Record results on Test Report 1.

4.2 Zero Setting

The zero-setting devices of the price-indicating device and of the volume-indicating device shall be designed in such a way that zeroing either indicating device automatically involves zeroing the other (NMI R 117-1, clause 3.3.5).

The zero-setting device shall not permit any alteration of the measurement result shown by the price/volume-indicating device other than by making the result disappear and displaying zeros (NMI R 117-1, clause 3.2.4.2).

Once the zeroing operation has begun it shall be impossible for the price/volume-indicating device to show a result different from that of the measurement which has just been made, until the zeroing operation has been completed. The price/volume-indicating device shall not be capable of being reset to zero during measurement (NMI R 117-1, clause 3.2.4.3).

For electronic indicating devices, the price/volume indication after return to zero shall be zero without any ambiguity (NMI R 117-1, clauses 3.2.4.5 and 3.3.9).

1. Remove the nozzle from its hang-up position and ensure that the display test is performed and the price and volume displays are on zero before any delivery of product is possible.
2. Carefully return the nozzle to its hang up position and ensure that when the nozzle is then removed no further deliveries are possible without the segment test being initiated and the indications returning to zero.
3. Determine whether the dispenser has passed or failed.
4. Record results on Test Report 1.

4.3 Price Computing

The price indicated shall equal the price calculated from the volume and unit price indicated within the MPEs in Table 1.

Table 1. MPEs for price computing

Unit Price	MPE
Not more than $1 per litre	±0.9 cents
More than $1 per litre but not more than $2 per litre	±1.0 cents
More than $2 per litre but not more than $5 per litre	±2.5 cents
More than $5 per litre but not more than $10 per litre	±5.0 cents

This test can be done at any time during a test delivery.

1. Reset the dispenser to zero.
2. Make a delivery of a convenient volume.
3. Calculate the total price (rounded to two decimal places) from the unit price and volume 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.

4.4 Interlock

In measuring systems intended to deliver liquids, no means shall be provided by which any measured liquid can be diverted (NMI R 117-1, clause 2.16.1).

The selected unit price shall be displayed by an indicating device before the start of the measurement (NMI R 117-1, clause 3.3.2).

These requirements are interpreted to mean that no LPG can be dispensed unless it is measured and that the unit price indicated corresponds to the unit price of the LPG selected and delivered.

Determine whether the hoses have a common indicator or whether they share a pumping unit, and conduct the appropriate test as documented below.

4.4.1 Hoses Sharing a Common Indicator

1. Select and authorise one hose and remove the nozzle from its hang-up position.
2. Check that the price and volume indications for the hose selected reset to zero, and for dispensers:

   (a) **with** separate unit price display:
   the unit price display for the type of LPG selected is transferred to the main indication;

(b) **without** separate unit price display:
the unit price display for the hose selected is displayed and all other unit price displays disappear until the delivery has been completed.

3. Check that all other hoses sharing the same indicator are disabled, by removing the other nozzles from their hang up position and confirming that they do not authorise.
4. Determine whether the dispenser has passed or failed.
5. Record results on Test Report 1.

4.4.2 Hoses Sharing a Pumping Unit

1. Select and authorise any hose that shares the common pumping unit with the hose under test.
2. While the pumping unit is operating, attempt to make a delivery from the hose under test without allowing the dispenser to be actuated where the indicator will reset to zero.
3. Check that it is not possible to make a delivery from the hose under test.
4. Determine whether the dispenser has passed or failed.
5. Record results on Test Report 1.

4.5 Temperature and Density Settings

In addition to the volume at metering conditions and the volume at 15 °C, the values of other measured quantities (e.g. density, pressure, temperature) shall be accessible for each test measurement (NMI R 117-1, clause 3.7.7).

The following requirements must be met:

(a) the density displayed or set by the dispenser must be within ±10 kg/m^3 of the value measured by the certified hydrometer; and

(b) the temperature displayed by the dispenser must be within ±0.5 °C of the value measured by the certified thermometer.

To accurately compare the reference volume and indicated dispenser volume these volumes must be corrected to a base temperature (i.e. 15 °C).

In addition to temperature corrections, pressure corrections are also required for the master meter indications to determine the volume at base conditions. To make these pressure calculations it is necessary to determine the equilibrium vapour pressure of the LPG. To complete these corrections the LPG density, temperature and equilibrium vapour pressure must be measured.

This procedure is generally completed after the first accuracy test has been completed to ensure the sample of LPG is a representative sample of the LPG in the supply tank.

1. Obtain the necessary information from the Certificate of Approval and/or the manual for the dispenser to access the display of LPG density and temperature.
2. Place oil or glycol in the thermowell of the dispenser and insert the thermometer.
3. Circulate LPG through the dispenser until the temperature has stabilised and record T_{FD}.
4. Check that the temperature displayed by the dispenser is within ±0.5 °C of the temperature determined in step 3.
5. Introduce a sample of LPG from the dispenser into the hydrometer pressure vessel until the certified hydrometer is floating.
6. Disconnect the hydrometer pressure vessel from the dispenser.
7. Place the hydrometer pressure vessel in a safe place out of direct sunlight until the LPG temperature has stabilised.
8. Slowly reduce the vapour pressure in the pressure vessel until the LPG just starts to boil. Record the density and temperature. For the volumetric method also record the equilibrium vapour pressure (P_e).

   Note: Remember to include the calibration correction factor for the hydrometer, thermometer and pressure gauge.

9. Use the corrected density and temperature readings in conjunction with ASTM–IP–API Table 53 to calculate the density at 15 °C.
10. Record the density at 15 °C (D_{15}).
11. Check that the density displayed or set by the dispenser is within ±10 kg/m^3 of D_{15} (determined in step 9).
12. Record results on Test Report 1.
13. Release the LPG from the pressure vessel in a safe manner

4.6 Pre-set Indications

Measuring systems with a price-indicating device may also be fitted with a price/volume pre-setting device, which stops the flow of the liquid when the price/quantity corresponds to the pre-set value (NMI R 117-1, clause 3.6.10).

This test can be combined with the pre-set accuracy test.

1. Reset the dispenser to zero.
2. Enter a suitable pre-set value using the pre-set facility. Make sure the pre-set amount appears on the display.
3. Commence a delivery with the nozzle fully open allowing the pre-set facility to slow down and complete the delivery automatically.
4. Check that the price/volume indication on the display corresponds to the pre-set amount.
5. Determine whether the dispenser has passed or failed.
6. Record results on Test Report 1.

4.7 Maximum Flowrate

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

In some cases (e.g. due to the size of the vapour return line) it may not be practical to operate all meters connected to the same pump. Operate as many meters as possible and compare the drop in flow rate due to the increase in the number of meters operated. Evaluate whether or not the system is designed to deliver at flow rates not less than Q_{min} had all the meters (connected to the same pump) operated simultaneously. If less than Q_{min} then the system has failed.

4.7.1 All Hoses

This is a requirement for all dispensers regardless of whether they share or have their own pumping unit.

1. Commence and time a delivery at the maximum achievable flow rate.
2. Stop the delivery after at least 10 s.
3. Note the indication on the dispenser and calculate the flow rate.
4. Determine whether the dispenser has passed or failed.
5. Record results on Test Report 1.

4.7.2 Hoses Sharing a Pumping Unit

This is a requirement at initial verification, when any site changes occur, or at the discretion of NMI. Refer to the Certificate of Approval for additional specific tests.

1. Ensure no other dispenser sharing the common pumping system is operating.
2. Commence a delivery and allow the flow rate to stabilise at the maximum achievable flow rate.
3. Time a 30 s delivery noting the initial and final volume indications.
4. Use these volume indications to calculate the maximum achievable flow rate.

5. Commence deliveries from all dispensers which share the common pumping system.
6. Once all the dispensers have stabilised at their maximum attainable flow rate, time a 30 s delivery noting the initial and final volume indications.
7. Use these volume indications to calculate the maximum achievable flow rate or use the value calculated by the master meter.
8. Determine whether the flow rates calculated in steps 4 and 7 are within the approved range.
9. Record results on Test Report 1.

4.8 Accuracy

LPG must be sold at converted volume measured at 15 °C. Unconverted volume is a delivery made at ambient temperature.

When testing the accuracy of a dispenser both converted volume and unconverted volume are required.

When a dispenser delivers converted volume the dispenser is said to be in temperature compensated mode and when it delivers unconverted volume it is said to be in temperature uncompensated mode.

In some dispensers it is possible to switch between the temperature compensated mode and temperature uncompensated mode for the same delivery. In this case the dispenser is able to display the volume at 15 °C and then a switch (V_{FD}/V_{FD15}) is used to display the temperature uncompensated mode for the same delivery. This type of instrument reduces the number of test deliveries.

Table 2. MPEs for the accuracy test

Accuracy Class	MPE
Verification	±0.6%
In-service inspection	±1%

In this section, three test methods are described to test accuracy:

1. the **volumetric** method which uses a **master meter** as the reference standard (see clause 4.8.1);
2. the **volumetric** method which uses a **mass flowmeter** as the reference standard (see clause 4.8.2);
3. the **gravimetric** method (see clause 4.8.3) which uses weights in conjunction with a weighing instrument as the reference standard.

Testing shall be carried out at the following flow rates and the results analysed to determine whether the dispenser requires adjustment:

(a) three deliveries at the maximum achievable flow rate; and

(b) one delivery at the minimum flow rate $Q_{min.}$

4.8.1 Volumetric Method using a Master Meter

1. Ensure the dispenser is in temperature uncompensated mode.

   Note: If this is not possible make the delivery in temperature compensated mode and use the appropriate switch to view $V_{FD.}$
2. Place oil or glycol in the thermowell of the dispenser and insert the thermometer. This is where you measure the temperature, T_{FD}.
3. Connect the master meter outlet hose to the vapour return line in the dispenser.
4. Connect the dispenser nozzle to the inlet of the master meter.
5. Slowly open the dispenser nozzle and then fully open the flow control valve on the master meter unit to allow testing at maximum flow rate.

6. Open the master meter nozzle and circulate at least 100 L of product through the system and back to the supply tank until the temperature and master meter pressure readings have stabilised.

7. Reset the master meter and dispenser to zero.

8. Make a delivery at the maximum achievable flow rate for a volume which is at least equal to the greatest of:

   (a) 1 minute delivery at the maximum achievable flowrate;

   (b) 2 × MMQ; or

   (c) the minimum quantity for the master meter as specified in the certificate of verification.

9. Approximately half way through the delivery, record the temperature of the product in the dispenser and the master meter (T_{FD} and T_{MM}) and pressure at the master meter (P_{MM}).

10. Complete the delivery using the master meter nozzle and record the indicated volume from the master meter (V_{MM}) and the uncompensated volume from the dispenser (V_{FD}).

    Note: If the dispenser allows the display of both compensated (V_{FD15}) and uncompensated volume (V_{FD}), record both indications. You need only record the compensated volume (V_{FD15}) once during testing. Use the value for V_{FD15} to assess if the conversion is working correctly (see clause 4.10).

11. Use D_{15}, T_{FD} and T_{MM} in conjunction with ASTM–IP–API Table 54 to determine the conversion factors C_{tlFD} and C_{tlMM} for the effect of temperature on LPG at the dispenser and at the master meter respectively.

12. Calculate the pressure conversion factor (C_{plMM}) for the effect of pressure on LPG at the master meter by using D_{15}, P_e, P_{MM}, T_{MM} and the compressibility factor from the API Manual of Petroleum Measurement Standards, Chapter 11.2.2M. Alternatively, use the simplified abridged tables given in Appendix B.

13. Determine the meter factor for the master meter MF_{MM} using the indicated flowrate and the Regulation 13 certificate of verification.

14. Calculate the converted and corrected master meter volume as follows:

$$V_{REF} = V_{MM} \times C_{tlMM} \times C_{plMM} \times MF_{MM}$$

15. Calculate the converted dispenser volume as follows:

$$V_{FD,c} = V_{FD} \times C_{tlFD}$$

16. Calculate the relative error (E_{FD}) by comparing the calculated converted volume for the dispenser with the converted test volume.

$$E_{FD} = \frac{(V_{FD,c} - V_{REF})}{V_{REF}} \times 100$$

    Note: A positive error indicates that the dispenser is over-indicating and under-delivering.

17. Repeat steps 7 to 16 **twice more**.

18. Repeat steps 7 to 16 at Q_{min}.

19. Determine if all the results in step 16 are within the allowable MPE (see Table 2).

20. If meter adjustments are made repeat steps 7 to 19.

21. Record results on Test Report 1.

22. Ensure the dispenser is left in temperature compensated mode.

4.8.2 Volumetric Method using a Mass Flowmeter

1. Ensure the dispenser is in temperature uncompensated mode.

   Note: If this is not possible make the delivery in temperature compensated mode and use the appropriate switch to view V_{FD}

2. Place oil or glycol in the thermowell of the dispenser and insert the thermometer. This is where you measure the temperature, T_{FD}.
3. Connect the mass flowmeter outlet hose to the vapour return line of the dispenser.
4. Connect the dispenser nozzle to the inlet of the mass flowmeter.
5. Slowly open the dispenser nozzle and then fully open the flow control valve on the mass flowmeter to allow testing at maximum flow rate.
6. Open the mass flowmeter nozzle and circulate at least 100 L of product through the system and back to the supply tank until the temperature and mass flowmeter have stabilised.
7. Reset the mass flowmeter and dispenser to zero.
8. Make a delivery at the maximum achievable flow rate for a volume which is at least equal to the greatest of:
   (a) 1 minute delivery at the maximum achievable flowrate;
   (b) 2 × MMQ; or
   (c) the minimum quantity for the mass flowmeter as specified in the certificate of verification.
9. Approximately half way through the delivery, record the temperature of the product in the dispenser and mass flowmeter (T_{FD} and T_{MFM}) and pressure at the mass flowmeter (P_{MFM}).
10. Complete the delivery and record the uncompensated volume indication (V_{FD}) on the dispenser and the mass indicated by the mass flowmeter (M_{MFM}).
11. Determine the meter factor for the mass flowmeter (MF_{MFM}) using the indicated flowrate, T_{MFM}, D_{15} and the Regulation 13 certificate of verification.
12. Calculate the converted and corrected mass flowmeter volume as follows:

$$V_{REF} = \frac{(M_{MFM} \times MF_{MFM})}{D_{15}}$$

13. Use D_{15} and T_{FD} in conjunction with ASTM–IP–API Table 54 to determine the temperature conversion factor (C_{tlFD}).
14. Calculate the converted flowmetering system volume as follows:

$$V_{FD,c} = V_{FD} \times C_{tlFD}$$

15. Calculate the relative error (E_{FD}) by comparing the calculated converted volume for the flowmetering system with the converted test volume.

$$E_{FD} = \frac{(V_{FD,c} - V_{REF})}{V_{REF}} \times 100$$

   Note: A positive error means that the flowmetering system is over-indicating and under-delivering.
16. Repeat steps 7 to 15 **twice more.**
17. Repeat steps 7 to 15 at Q_{min}.
18. Determine if all the results in step 15 are within the allowable MPE (see Table 2).
19. If meter adjustments are made repeat steps 7 to 18.
20. Record results on Test Report 1.

4.8.3 Gravimetric Method

1. Ensure the dispenser is in temperature uncompensated mode.

   Note: If this is not possible make the delivery in temperature compensated mode and use the appropriate switch to view $V_{FD.}$
2. Place oil or glycol in the thermowell of the dispenser and insert the thermometer. This is where you measure the temperature, T_{FD}.

3. Set up the weighing instrument (control instrument) on a flat surface in a position which will not be affected by wind gusts. Level the instrument, switch on, and allow for any warm-up time.

4. Test the weighing instrument for compliance with *NITP 6.1 to 6.4 National Instrument Test Procedures for Non-automatic Weighing Instruments*, for the following tests:

   a. weighing performance;

   b. eccentricity; and

   c. repeatability.

   Record any errors and apply as applicable. The weighing instrument should be tested immediately before commencing any testing. It is not necessary to test the weighing instrument to its maximum capacity. It is sufficient to test the weighing instrument up to 110% of the maximum delivered quantity of LPG.

5. Place the pressurised LPG cylinder on the weighing instrument, tare off the cylinder by using the taring device or by recording the tare value.

6. Reset the dispenser to zero.

7. Make a delivery at the maximum achievable flow rate for a volume which is at least equal to the greater than:

   (a) 1 minute delivery at the maximum achievable flowrate; or

   (b) 2 × MMQ.

   Note: To maintain the delivery at maximum flow rate, it may be necessary to only half fill the LPG cylinder.

8. Approximately half way through the delivery, record the temperature of the product in the dispenser (T_{FD}).

9. Complete the delivery and record the uncompensated volume indication (V_{FD}) on the dispenser and the mass of the product delivered.

   Note: If the dispenser allows the display of both compensated (V_{FD15}) and uncompensated volume (V_{FD}), record both indications. You need only record the compensated volume (V_{FD15}) once during testing. Use the value for V_{FD15} to assess if the conversion is working correctly (see clause 4.10).

10. Convert the mass to a volume at base conditions (V_{REF}) by dividing the mass by D_{15} (see clause 4.5).

11. Use D_{15} and T_{FD} in conjunction with ASTM–IP–API Table 54 to determine the temperature conversion factor, (C_{tlFD}).

12. Calculate the converted dispenser volume as follows:

$$V_{FD,c} = V_{FD} \times C_{tlFD}$$

13. Calculate the relative error (E_{FD}) by comparing the calculated converted volume for the dispenser with the converted test volume.

$$E_{FD} = \frac{(V_{FD,c} - V_{REF})}{V_{REF}} \times 100$$

   Note: A positive error means that the dispenser is over-indicating and under-delivering.

14. Repeat steps 5 to 13 **twice more.**

15. Repeat steps 5 to 13 at Q_{min}.

16. Determine if all the results in step 13 are within the allowable MPE (see Table 2).

17. If meter adjustments are made repeat steps 5 to 16.

18. Record results on Test Report 1.

19. Ensure the dispenser is left in temperature compensated mode.

4.9 Accuracy of Pre-set

A pre-set accuracy test is only conducted when it is necessary to check the accuracy of the pre-set delivery volume.

This test may be combined with pre-set indication test (clause 4.6) and the accuracy test (clause 4.8).

1. Ensure the dispenser is in temperature uncompensated mode.
2. Place oil or glycol in the thermowell of the dispenser and insert the thermometer to measure T_{FD}.
3. Appropriately condition the dispenser under test and the reference standard or control instrument (see clause 4.8).
4. Reset the dispenser under test (and reference standard or control instrument) to zero.
5. Enter and record a suitable pre-set value using the pre-set facility.
6. Perform an accuracy test at the maximum achievable flow rate in accordance with either:
   (a) clause 4.8.1 steps 8 to 16; or
   (b) clause 4.8.2 steps 8 to 16; or
   (c) clause 4.8.3 steps 7 to 13

   until the delivery stops.
7. Determine if the result is within the MPE (see Table 2).
8. Record results on Test Report 1.

4.10 Conversion Device

The MPE between the percentage error for the unconverted volume and the volume converted to 15 °C shall not exceed the MPE specified in Table 3.for the applicable accuracy class (NMI R 117-1, clause 2.7.1).

Table 3. MPE for conversion device

Accuracy Class	MPE
1.0	0.4%

The MPE specified for the conversion device is applicable when comparing the converted volume of a dispenser against a traceable, calculated converted volume.

The traceable, calculated converted volume is obtained using traceable temperature and density measurements with the unconverted volume indicated by the dispenser.

Thus, the MPE for the conversion device is to allow for the error due to the measurement of parameters (such as temperature, pressure and density of the product) as well as using the appropriate conversion tables to produce the converted volume.

If the parameters measured by the flowmetering system (such as temperature and density of the product) are accepted as correct, the conversion device is treated as a calculator for which the MPE is one-tenth the value specified for verification, i.e. the error is due to the conversion tables (algorithm) present in the calculator.

4.10.1 Method 1

Use Method 1 for dispensers fitted with a switch (V_{FD}/V_{FD15}) that allows the dispenser to be switched between compensated and uncompensated mode for the same delivery.

This test would normally be carried out during the accuracy test.

1. Circulate product through the dispenser until the temperature has stabilised and the system is conditioned.
2. Reset the dispenser to zero.
3. Make a delivery that is greater than twice the MMQ (V_{min}) specified for the dispenser.

4. Approximately halfway through this delivery, measure and record the temperature of the product at the dispenser (T_{FD}).
5. Complete the delivery and record the volume indicated by the dispenser in compensated mode (V_{FD15}).
6. Switch the dispenser to uncompensated mode and record the volume indicated by the dispenser in uncompensated mode (V_{FD}).
7. Use D_{15}, T_{FD} in conjunction with ASTM–IP–API Table 54 to determine the temperature conversion factor, C_{tlFD}.
8. Calculate the converted dispenser volume as follows: $V_{FD,c} = V_{FD} \times C_{tlFD}$
9. Calculate the percentage error for the conversion device as follows:
   $E_C = (V_{FD15} – V_{FD,c}) \div V_{FD,c} \times 100$
10. Ensure that EC is no greater than **0.4%**.
11. Record the result on Test Report 1.
12. Ensure the dispenser is left in temperature compensated mode.

4.10.2 Method 2

Use Method 2 for dispensers not fitted with a switch that allows the dispenser to be switched between compensated and uncompensated mode for the same delivery.

This test would normally be carried out after the accuracy test.

1. Calculate and record the average relative error (E_{AV}) of three deliveries made in uncompensated mode which were completed at the maximum achievable flowrate during accuracy testing (see clause 4.8).
2. Circulate product through the dispenser until the temperature has stabilised and the dispenser is conditioned.
3. Complete three deliveries in temperature compensated mode at maximum achievable flow rate in accordance with either:
   (a) clause 4.8.1 steps 7 to 14; or
   (b) clause 4.8.2 steps 7 to 12; or
   (c) clause 4.8.3 steps 5 to 10.
4. Calculate the relative error in temperature compensated mode for each delivery (E_{FD15}) as follows: $E_{FD15} = (V_{FD15} – V_{REF}) / V_{REF} \times 100$
5. Calculate the average relative error $E_{AV,C}$ for the three deliveries.
6. Calculate the conversion device error as follows: $E_C = E_{AV,C} – E_{AV}$.
7. Ensure that E_C is no greater than **0.4%**.
8. Record results Test Report 1.
9. Ensure the dispenser is left in temperature compensated mode.

5. SUGGESTED SEQUENCE FOR TESTING

1. Consult the relevant materials safety data sheets.
2. Raise a WPCG work clearance permit and a fuel withdrawal advice form.
3. Check the Certificate(s) of Approval for any additional tests required. Make provision for including these tests in the testing sequence.
4. Visually inspect the dispenser and record the required data and characteristics of the dispenser on the test report.
5. Conduct an accuracy test (clause 4.8) and after the first delivery conduct a density and temperature setting test (clause 4.5). Where required, this may be combined with the pre-set accuracy test (clause 4.9).
6. Whilst conducting the accuracy test check:

(a) interlock (clause 4.4);

(b) the checking facility for electronic indicating devices (clause 4.1);

(c) zero setting (clause 4.2);

(d) price computing (clause 4.3); and

(e) maximum flow rate (clause 4.7) (may also be done during the stabilising delivery when testing volumetrically).

7. Conduct a pre-set indication test (clause 4.6). Where required, this may be combined with the pre-set accuracy test (clause 4.9).

8. Conduct the appropriate conversion device test (clause 4.10).

9. Determine whether the instrument has passed or failed.

10. Carry out anything else you need to do 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; and

    (c) applying a seal as specified in the Certificate of Approval.

11. If required, check the console (clause 6).

12. Complete the WPCG work clearance forms and the fuel withdrawal advice.

6. TEST PROCEDURE FOR THE VERIFICATION AND IN-SERVICE INSPECTION OF A CONSOLE

Verification and in-service inspection of a console are carried out to ensure that a dispenser is communicating correctly with its console. They are carried out:

(a) at initial installation;

(b) when repairs are carried out that affect the approved functions;

(c) 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.

1. Ensure that the dispenser is communicating with the console.

2. Authorise the dispenser at the console.

3. Remove the nozzle from its hang-up position and deliver sufficient product to cause the price and volume indicators to move significantly off zero.

4. Return the nozzle to its hang-up position.

5. Record the dispenser number/nozzle identification and the price/volume displayed on the dispenser.

6. At the console check that the dispenser number/nozzle identification and the price/volume displayed is the same as recorded from the dispenser.

7. If the console supports stored transaction sales:

    (a) store the current transaction;

    (b) repeat steps 2 to 5; and

    (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.

8. Record results on Test Report 2.

APPENDIX A. TEST REPORTS

Appendix A contains two test reports:

1. Test Report 1 has a front page which must be accompanied by **one** of the following:
   (a) Test Report 1-1 is for dispensers **with** a V_{FD}/V_{FD15} switch which are tested **volumetrically** using a **master meter**; or
   (b) Test Report 1-2 is for dispensers **without** a V_{FD}/V_{FD15} switch which are tested **volumetrically** using a **master meter**; or
   (c) Test Report 1-3 is for dispensers **with** a V_{FD}/V_{FD15} switch which are tested **volumetrically** using a **mass flowmeter**; or
   (d) Test Report 1-4 is for dispensers **without** a V_{FD}/V_{FD15} switch which are tested **volumetrically** using a **mass flowmeter**; or
   (e) Test Report 1-5 is for dispensers **with** a V_{FD}/V_{FD15} switch which are tested **gravimetrically**; or
   (f) Test Report 1-6 is for dispensers **without** a V_{FD}/V_{FD15} switch which are tested **gravimetrically**; and
2. Test Report 2 is for consoles.

Although the format of the test reports may vary according to the individual needs and requirements of NMI and servicing licensees, the following test reports 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 1 for LPG Dispensers

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

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

For in-service inspection or re-verification, 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(s) of Approval number.....................................

LPG density range dispenser approved to deliver ....

Minimum flowrate ....Maximum flowrate ....

Details of the Reference Standards of Measurement (clause 2)

Reference standards	
Make	
Model	
Serial number	
Flowrate range/weight	
Regulation 13/37 certificate number	
Certificate expiry date	

Test Report 1 for LPG Dispensers

General Characteristics (clause 3.3)	Yes, no or N/A
Does the dispenser comply with its Certificate(s) of Approval?	
Is the dispenser being used in an appropriate manner?	
Are all mandatory descriptive markings clearly and permanently marked on the data plate?	
Is the data plate fixed on the dispenser?	
Is the dispenser complete?	
Is the dispenser clean?	
Is the dispenser operational?	
Is the operation of the dispenser free of any apparent obstructions?	
Is the dispenser firmly fixed on its foundations?	
Are all external panels secure?	
Are the cover windows broken?	
Does the operator (and where applicable, the customer) have a clear and unobstructed view of the indicating device and the entire measuring process?	
Do the indications of volume, unit price and total price correctly correspond with the selected hose?	
Are all indications clearly visible under all conditions day and night?	
Are all hoses in a serviceable condition, e.g. not badly chafed, split, or worn through to the fabric?	
Are there any leaks?	
For self-service systems, do the dispenser number(s) correctly correspond with the console?	
Checking facility for electronic indicating devices (clause 4.1)	☐ Pass ☐ Fail
Zero setting (clause 4.2)	☐ Pass ☐ Fail
Price computing (clause 4.3)	☐ Pass ☐ Fail
Interlock (clause 4.4)	☐ Pass ☐ Fail
Density and temperature settings (clause 4.5)	☐ Pass ☐ Fail
Pre-set indications (clause 4.6)	☐ Pass ☐ Fail

.

Test Report 1 for LPG Dispensers

Test Report 1-1 for LPG Dispensers with V_{FD}/V_{FD15} Switch which are Tested Volumetrically using a Master Meter

Master meter serial number.................................... Density displayed by dispenser.........................kg/L Temperature displayed by dispenser (T_{FDI}) ....°C

Hydrometer readings	Observed P_e = kPa	Observed temperature = °C		Observed density = kg/L		Density at 15°C	
	Corrected P_e = kPa	Corrected temperature = °C		Corrected density = kg/L		D_{15} = kg/L	
Totaliser at the end L Totaliser at the start L Total vol used L	Delivery 1 Q_{max}	Delivery 2 Q_{max}	Delivery 3 Q_{max}	Spare	Compensated with V_{FD}/V_{FD15} switch	Delivery 1 Q_{min}	Spare
T_{MM}	°C	°C	°C	°C		°C	°C
P_{MM}	kPa	kPa	kPa	kPa		kPa	kPa
D_p	kPa	kPa	kPa	kPa		kPa	kPa
V_{MM}	L	L	L	L		L	L
Maximum achievable flow rate	L/min	L/min	L/min	L/min		L/min	L/min
MF_{MM}							
C_{tlMM} (using density at 15°C, T_{MM})							
C_{plMM} (using P_e, density at 15°C, T_{MM}, P_{MM})							
V_{REF}♦ ($V_{MM} \times C_{tlMM} \times C_{plMM} \times MF_{MM}$)	L	L	L	L		L	L
T_{FD}	°C	°C	°C	°C	°C	°C	°C
T_{FD} - T_{FDI}	°C	°C	°C	°C	°C	°C	°C
V_{FD}	L	L	L	L	L	L	L
V_{FD15}					L		
C_{tlFD} (using density at 15°C, T_{FD})							
$V_{FD,c}$ ($V_{FD} \times C_{tlFD}$)	L	L	L	L	L	L	L
E_{FD} [($V_{FD,c} - V_{REF}$) / $V_{REF} \times 100$]	%	%	%	%		%	%
E_C [($V_{FD15} - V_{FD,c}$) / $V_{FD,c} \times 100$]					E_C = %		

♦ The correction factor MF_{MM} is the meter factor obtained from a traceable measurement report.

Inspector's name ....Identification number ....

Signature ....

Comments ....

Test Report 1 for LPG Dispensers

Test Report 1-2 for LPG Dispensers without V_{FD}/V_{FD15} Switch which are Tested Volumetrically using a Master Meter

Master meter serial number.................................... Density displayed by dispenser..........................kg/L Temperature displayed by dispenser (T_{FDI}) ....°C

Hydrometer readings	Observed P_e = kPa	Observed temperature = °C	Observed density = kg/L	Density at 15°C
	Corrected P_e = kPa	Corrected temperature = °C	Corrected density = kg/L	D_{15} = kg/L

Totaliser at the end L / Totaliser at the start L	Total vol used L	Delivery 1 Q_{max}	Delivery 2 Q_{max}	Delivery 3 Q_{max}	Compensated no V_{FD}/V_{FD15} switch: Delivery 1, Q_{max}	Delivery 2, Q_{max}	Delivery 3, Q_{max}	Delivery 1 Q_{min}
T_{MM}		°C	°C	°C	°C	°C	°C	°C
P_{MM}		kPa	kPa	kPa	kPa	kPa	kPa	kPa
D_p		kPa	kPa	kPa	kPa	kPa	kPa	kPa
V_{MM}		L	L	L	L	L	L	L
Maximum achievable flow rate		L/min	L/min	L/min	L/min	L/min	L/min	L/min
MF_{MM}								
C_{tlMM}	(using density at 15°C, T_{MM})							
C_{plMM}⊗	(using P_e, density at 15°C, T_{MM}, P_{MM})							
V_{REF}♦	($V_{MM} \times C_{tlMM} \times C_{plMM} \times MF_{MM}$)	L	L	L	L	L	L	L
T_{FD}		°C	°C	°C	°C	°C	°C	°C
T_{FD} - T_{FDI}		°C	°C	°C	°C	°C	°C	°C
V_{FD}		L	L	L				L
V_{FD15}					L	L	L	
C_{tlFD}	(using density at 15°C, T_{FD})				1.000*	1.000*	1.000*	
$V_{FD,c}$	($V_{FD} \times C_{tlFD}$)	L	L	L	L	L	L	L
E_{FD}	[($V_{FD,c}$ – V_{REF}) / $V_{REF} \times 100$]	%	%	%	%	%	%	%
		E_{AV} = %			$E_{AV,C}$ = %			
E_C	($E_{AV,C}$ – E_{AV})				E_C = %			

♦ The correction factor MF_{MM} is the meter factor obtained from a traceable measurement report.
* For compensated delivery the conversion factor C_{tlFD} must be set to unity.

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

Signature ....

Comments ....

Test Report 1 for LPG Dispensers

Test Report 1-3 for LPG Dispensers with V_{FD}/V_{FD15} Switch which are Tested Volumetrically using a Mass Flowmeter

Mass flowmeter serial number .... Density displayed by dispenser .... kg/L Temperature displayed by dispenser .... °C

Hydrometer readings	Observed temperature = °C		Observed density = kg/L	Density at 15°C D_{15} = kg/L
	Corrected temperature = °C		Corrected density = kg/L	

Totaliser at the end L Totaliser at the start L Total vol used L	Delivery 1 Q_{max}	Delivery 2 Q_{max}	Delivery3 Q_{max}	Spare	Compensated with V_{FD}/V_{FD15} switch	Delivery 1 Q_{min}	Spare
M_{MFM}	kg	kg	kg	kg		kg	kg
P_{MFM}	kPa	kPa	kPa	kPa		kPa	kPa
T_{MFM}	°C	°C	°C	°C		°C	°C
MF_{MFM}							
V_{REF} $(M_{MFM} \times MF_{MFM})/D_{15})$	L	L	L	L		L	L
Maximum achievable flow rate	L/min	L/min	L/min	L/min		L/min	L/min
T_{FD}	°C	°C	°C	°C	°C	°C	°C
V_{FD}	L	L	L	L	L	L	L
V_{FD15}					L		
C_{tlFD} (using density at 15°C, T_{FD})							
$V_{FD,c}$ $(V_{FD} \times C_{tlFD})$	L	L	L	L	L	L	L
E_{FD} $[(V_{FD,c} - V_{REF}) / V_{REF} \times 100]$	%	%	%	%		%	%
E_C $[(V_{FD15} - V_{FD,c}) / V_{FD,c} \times 100]$					E_C = %		

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

Signature ....

Comments ....

Test Report 1 for LPG Dispensers

Test Report 1-4 for LPG Dispensers without V_{FD}/V_{FD15} Switch which are Tested Volumetrically using a Mass Flowmeter

Mass flowmeter serial number .... Density displayed by dispenser .... kg/L Temperature displayed by dispenser .... °C

Hydrometer readings	Observed temperature = °C		Observed density = kg/L	Density at 15°C D_{15} = kg/L
	Corrected temperature = °C		Corrected density = kg/L	

Totaliser at the end L / Totaliser at the start L / Total vol used L	Delivery 1 Q_{max}	Delivery 2 Q_{max}	Delivery 3 Q_{max}	Compensated no V_{FD}/V_{FD15} switch: Delivery 1 Q_{max}	Delivery 2 Q_{max}	Delivery 3 Q_{max}	Delivery 1 Q_{min}
M_{MFM}	kg	kg	kg	kg	kg	kg	kg
P_{MFM}	kPa	kPa	kPa	kPa	kPa	kPa	kPa
T_{MFM}	°C	°C	°C	°C	°C	°C	°C
MF_{MFM}							
V_{REF} $(M_{MFM} \times MF_{MFM}) / D_{15}$	L	L	L	L	L	L	L
Maximum achievable flow rate	L/min	L/min	L/min	L/min	L/min	L/min	
T_{FD}	°C	°C	°C	°C	°C	°C	°C
V_{FD}	L	L	L				L
V_{FD15}				L	L	L	
C_{tlFD} (using density at 15°C, T_{FD})				1.000*	1.000*	1.000*	
$V_{FD,c}$ $(V_{FD} \times C_{tlFD})$	L	L	L	L	L	L	L
E_{FD} $[(V_{FD,c} - V_{REF}) / V_{REF} \times 100]$	%	%	%	%	%	%	%
	E_{AV} = %			$E_{AV,C}$ = %			
E_C $(E_{AV,C} - E_{AV})$				E_C = %			

* For compensated delivery the conversion factor C_{tlFD} must be set to unity.

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

Signature ....

Comments ....

Test Report 1 for LPG Dispensers

Test Report 1-5 for LPG Dispensers with V_{FD}/V_{FD15} Switch which are Tested Gravimetrically

Density displayed by dispenser .... kg/L Temperature displayed by dispenser ....°C

Hydrometer readings	Observed temperature = °C				Observed density = kg/L		Density at 15°C D_{15} = kg/L	
	Corrected temperature = °C				Corrected density = kg/L			
Totaliser at the end L	Total vol used L	Delivery 1 Q_{max}	Delivery 2 Q_{max}	Delivery3 Q_{max}	Spare	Compensated with V_{FD}/V_{FD15} switch	Delivery 1 Q_{min}	Spare
Totaliser at the start L								
Mass of LPG		kg	kg	kg	kg		kg	kg
V_{REF}	[mass (kg) of LPG/density at 15°C]	L	L	L	L		L	L
Maximum achievable flow rate		L/min	L/min	L/min	L/min		L/min	L/min
T_{FD}		°C	°C	°C	°C	°C	°C	°C
V_{FD}		L	L	L	L	L	L	L
V_{FD15}						L		
C_{tlFD}	(using density at 15°C, T_{FD})							
$V_{FD,c}$	($V_{FD} \times C_{tlFD}$)	L	L	L	L	L	L	L
E_{FD}	[($V_{FD,c} - V_{REF}$) / $V_{REF} \times 100$]	%	%	%	%		%	%
E_C	[($V_{FD15} - V_{FD,c}$) / $V_{FD,c} \times 100$]					E_C = %		

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

Signature ....

Comments ....

....

....

Test Report 1 for LPG Dispensers

Test Report 1-6 for LPG Dispensers without V_{FD}/V_{FD15} Switch which are Tested Gravimetrically

Density displayed by dispenser .... kg/L   Temperature displayed by dispenser ....^{o}C

Hydrometer readings	Observed temperature = ^{o}C		Observed density = kg/L	Density at 15°C D_{15} = kg/L
	Corrected temperature = ^{o}C		Corrected density = kg/L	

Totaliser at the end L / Totaliser at the start L	Total vol used L	Delivery 1 Q_{max}	Delivery 2 Q_{max}	Delivery 3 Q_{max}	Compensated no V_{FD}/V_{FD15} switch: Delivery 1, Q_{max}	Compensated no V_{FD}/V_{FD15} switch: Delivery 2, Q_{max}	Compensated no V_{FD}/V_{FD15} switch: Delivery 3, Q_{max}	Delivery 1 Q_{min}
Mass of LPG		kg	kg	kg	kg	kg	kg	kg
V_{REF} [mass (kg) of LPG/ density at 15°C]		L	L	L	L	L	L	L
Maximum achievable flow rate		L/min	L/min	L/min	L/min	L/min	L/min	
T_{FD}		^{o}C	^{o}C	^{o}C	^{o}C	^{o}C	^{o}C	^{o}C
V_{FD}		L	L	L				L
V_{FD15}					L	L	L	
C_{tlFD} (using density at 15°C, T_{FD})					1.000*	1.000*	1.000*	
$V_{FD,c}$ ($V_{FD} \times C_{tlFD}$)		L	L	L	L	L	L	L
E_{FD} [$(V_{FD,c} – V_{REF}) / V_{REF} \times 100$]		%	%	%	%	%	%	%
		E_{AV} = %			$E_{AV,C}$ = %			
E_C ($E_{AV,C} – E_{AV}$)					E_C = %			

* For compensated delivery the conversion factor C_{tlFD} must be set to unity.

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

Signature ....

Comments ....

....

Test Report 2 for Consoles

Test Report 2 for the Verification or In-service Inspection of Consoles (clause 6)

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						
	Volume displayed						
Second transaction (if console supports stored transactions)	Dispenser number and nozzle identification						
	Price displayed						
	Volume displayed						
Is the first transaction stored and displayed correctly		☐ **Yes**	☐ **No**	☐ **Yes**	☐ **No**	☐ **Yes**	☐ **No**
Overall result		☐ **Pass**	☐ **Fail**	☐ **N/A**			

APPENDIX B.
CONVERSION FACTORS FOR DENSITY, TEMPERATURE AND PRESSURE

Due to the nature of LPG with its significant expansion and contraction due to temperature and corresponding pressure, it is necessary to consider the temperature and pressure of LPG whenever comparing volume measurements.

This section gives procedures and examples showing how to obtain the conversion factors for the effect of temperature and pressure on LPG in order to convert the measured volume at operating conditions to a volume at base conditions.

Theoretically, all conversions should be applied to all measurements but in practice some may be ignored depending on the conditions. For example, if the temperature of the liquid is the same in both the proving device and in the flowmeter-under-test, the conversion factor for the change in volume due to temperature need not be applied.

B.1 Density

In order to perform various other conversions and calculations associated with the measurement of LPG quantities, the density of LPG at 15 ^{o}C is required. For this purpose an LPG hydrometer pressure vessel is used in accordance with international standard ISO 3993.

In practice the measurement of LPG density is seldom carried out at 15 ^{o}C and as such, ASTM–IP–API Table 53 is used for converting the measured density at observed temperature to density at 15 ^{o}C. It is used as follows.

Consider that the certified hydrometer gives an observed density of 0.505 kg/L, after applying any correction specified in the measurement report for the traceable hydrometer. Suppose that the observed density of LPG using the hydrometer pressure vessel was determined at a temperature of 25 ^{o}C, then using the table the density of LPG at 15 ^{o}C is 0.520 kg/L; obtained at the intersection of the column for observed density 0.505 and the row for temperature 25 ^{o}C.

Note: There is a negligible difference between hydrometers marked in specific gravity 60/60°F and those marked with density at 15^{o}C, for which ASTM–IP–API Table 21 can be used.

B.2 Temperature

Volumes at different temperatures must either be converted to a common temperature, or as recommended by standards, converted to base temperature before comparing the volumes measured. The conversion factor, C_{tl}, is used for converting the volume at operating temperature to a volume at 15 ^{o}C, and is obtained using ASTM–IP–API Table 54. It is used as follows.

Consider that the temperature of LPG is 25 °C, and using the hydrometer pressure vessel the density of LPG at 15 °C was calculated to be 0.520 kg/L, then using the table the volume conversion factor C_{tl} = 0.972; obtained at the intersection of the column for density 0.520 and the row for the observed temperature 25 ^{o}C.

B.3 Pressure

Volumes at different pressures must either be converted to a common pressure, or as recommended by standards, converted to base pressure before comparing the volumes measured. The conversion factor C_{pl} is used for converting the volume at operating pressure to a volume at base pressure, and is given by the following equation:

$$C_{pl} = 1/[1 - (F \times D_p)]$$

where:

- F_p is $1/[A + (D_p \times B)]$, namely the compressibility factor; calculated using constants A and B obtained from API Manual of Petroleum Measurement Standards, Chapter 11.2.2M
- D_p is the difference between the operating pressure (e.g. P_{FD} or P_{MM}) and the equilibrium vapour pressure (P_e) of LPG at operating temperature (T_{FD} or T_{MM})

B.3.1 How to Use the API Manual of Petroleum Measurement Standards

To calculate C_{pl}, use the temperature of LPG metered (T_{MM}) and the density of LPG at 15°C, to obtain the constants A and B from Chapter 11.2.2M. Then obtain the pressure difference (D_p) by taking the difference between the pressure of LPG metered at operating conditions (P_{MM}), and the equilibrium vapour pressure (P_e).

The equilibrium vapour pressure (P_e) can be obtained either by using the LPG hydrometer pressure vessel fitted with a pressure gauge or by reading the vapour pressure of LPG in the supply tank. Now insert the values obtained into the above equations to calculate C_{pl}.

To assist users, approximate tables (Tables B.1 to B.4) have been generated with values of the conversion factor (C_{pl}) for various values of LPG density at different conditions.

Note: The shaded areas represent an effect less than 0.1% which is considered to be insignificant and the value of C_{pl} may be taken as equal to unity.

B.3.2 How to Use Tables B.1 to B.4

Consider that the temperature of LPG at the meter is 17 °C, at a pressure of 1 150 kPa, and using the hydrometer pressure vessel the density of LPG at 15 °C was calculated to be 520 kg/m^3, and the equilibrium vapour pressure (P_e) of LPG at approximately 17°C was 550 kPa.

From this data the pressure difference (D_p) is 600 kPa (namely 1 150 kPa – 550 kPa), and for LPG temperature in the range 10 °C to 20 °C, Table B.2 is used to obtain the value for C_{pl} = 1.0028 (outlined in black).

Table B.1. Conversion factors, C_{pl}, for LPG at 5 °C (±5 °C)

D_p (kPa)	LPG density (kg/m^3) at 15 °C					
	510	520	530	540	550	560
100	1.000 4	1.000 4	1.000 4	1.000 3	1.000 3	1.000 3
200	1.000 8	1.000 8	1.000 7	1.000 7	1.000 6	1.000 6
300	1.001 3	1.001 2	1.001 1	1.001 0	1.000 9	1.000 8
400	1.001 7	1.001 5	1.001 5	1.001 3	1.001 2	1.001 1
500	1.002 1	1.002 0	1.001 8	1.001 6	1.001 5	1.001 4
600	1.002 5	1.002 3	1.002 1	1.002 0	1.001 8	1.001 7
700	1.002 9	1.002 7	1.002 5	1.002 3	1.002 1	1.001 9
800	1.003 3	1.003 1	1.002 8	1.002 6	1.002 4	1.002 2

Note: D_p is the pressure difference between the operating pressure at the meter (P_{MM}) and the equilibrium vapour pressure (P_e) of LPG at the operating temperature.

Table B.2. Conversion factors, C_{pl}, for LPG at 15 °C (±5 °C)

D_p (kPa)	LPG density (kg/m^3) at 15 °C					
	510	520	530	540	550	560
100	1.000 5	1.000 5	1.000 4	1.000 4	1.000 4	1.000 3
200	1.001 0	1.000 9	1.000 8	1.000 8	1.000 7	1.000 7
300	1.001 5	1.001 4	1.001 3	1.001 2	1.001 1	1.001 0
400	1.002 0	1.001 8	1.001 7	1.001 5	1.001 4	1.001 3
500	1.002 5	1.002 3	1.002 1	1.001 9	1.001 7	1.001 6
600	1.003 0	1.002 8	1.002 5	1.002 3	1.002 1	1.001 9
700	1.003 5	1.003 2	1.002 9	1.002 7	1.002 5	1.002 3
800	1.004 0	1.003 7	1.003 3	1.003 1	1.002 8	1.002 6

Table B.3. Conversion factors, C_{pl}, for LPG at 25 °C (±5 °C)

D_p (kPa)	LPG density (kg/m^3) at 15 °C					
	510	520	530	540	550	560
100	1.000 6	1.000 6	1.000 5	1.000 5	1.000 4	1.000 4
200	1.001 3	1.001 1	1.001 0	1.000 9	1.000 8	1.000 8
300	1.001 9	1.001 7	1.001 5	1.001 4	1.001 3	1.001 1
400	1.002 5	1.002 3	1.002 0	1.001 8	1.001 7	1.001 5
500	1.003 1	1.002 8	1.002 5	1.002 3	1.002 1	1.001 9
600	1.003 7	1.003 4	1.003 0	1.002 7	1.002 5	1.002 3
700	1.004 3	1.003 9	1.003 5	1.003 2	1.002 9	1.002 7
800	1.004 9	1.004 5	1.004 0	1.003 7	1.003 3	1.003 0

Table B.4. Conversion factors, C_{pl}, for LPG at 35 °C (±5 °C)

D_p (kPa)	LPG density (kg/m^3) at 15 °C					
	510	520	530	540	550	560
100	1.000 8	1.000 7	1.000 6	1.000 6	1.000 5	1.000 5
200	1.001 6	1.001 4	1.001 3	1.001 1	1.001 0	1.000 9
300	1.002 4	1.002 1	1.001 9	1.001 7	1.001 5	1.001 4
400	1.003 2	1.002 8	1.002 5	1.002 3	1.002 0	1.001 8
500	1.003 9	1.003 5	1.003 1	1.002 8	1.002 5	1.002 3
600	1.004 7	1.004 2	1.003 7	1.003 4	1.003 0	1.002 7
700	1.005 5	1.004 9	1.004 4	1.003 9	1.003 5	1.003 2
800	1.006 2	1.005 5	1.005 0	1.004 5	1.004 0	1.003 6

Note: D_p is the pressure difference between the operating pressure at the meter (P_{MM}) and the equilibrium vapour pressure (P_e) of LPG at the operating temperature.