Chapter 7

The Test

Objectives

Upon completion of this chapter, you should be able to:

1. Understand the purpose of testing the performance of LPG liquid-measuring systems and the reasons for conducting a variety of performance tests.

2. Understand special factors associated with testing LPG liquid-measuring systems in the field.

3. Learn to make pre-test determinations as specified in the EPO's for LPG motor-fuel devices and other LPG liquid-measuring devices.

4. Describe procedures for conducting performance tests specified in the EPO's.

5. Analyze and interpret test results, as appropriate.

Introduction

An LPG liquid-measuring device that conforms with all of the specifications and requirements set forth in Handbook 44 relating to its design, installation, maintenance, and use may not meet the accuracy and repeatability requirements specified in NIST Handbook 44. The reason for this is that the meter--being a mechanical device with moving parts--is subject to wear, and this wear will eventually have an effect on accuracy. As a result, the condition of the meter and associated components like the register, vapor eliminator, etc., are important factors that must be determined.

Thorough inspection may give some indication of the condition of the system you are examining, but the results will be usually be based on observations made while the system is not in operation and so may be misleading. For example, a metering system that is clean and, to all outward appearances, well maintained, may be badly worn and in need of adjustment or reconditioning. The only way to determine the condition of the equipment--and thereby to determine how accurate it is likely to be when used for deliveries of LPG with any degree of confidence–is to test its performance under conditions that approximate actual conditions of use. This is the purpose of the Test section of the examination procedure.

The Test section is comprised of several separate tests, each of which has a specific testing objective. Some of these tests are intended to determine the accuracy of the system over the range of operating conditions for which it was designed (and, presumably, is used). Others are intended to test specific elements of the system. You should understand not only how to perform these tests, but also the reasons for performing them.

In addition, you will learn that the results of these performance tests can often provide information that is useful to the operator and to servicepersons in making needed repairs, even on equipment that is technically in compliance with weights and measures requirements at the time of the examination. Thus, you should understand how to interpret the results you obtain and inform the operator of their significance.

This chapter is intended as an introduction to the procedures that you will review and practice in the field. We will follow the NIST Examination Procedure Outlines (EPO's) for LPG motor-fuel and liquid-measuring devices, reviewing relevant requirements and specifications from Handbook 44. The differences between the procedures for these two different types of devices are relatively few, and will be noted as we proceed. Your instructor will describe policies and procedures employed by your jurisdiction that differ from those outlined in the EPO's.

Preparation for Testing

Prior to beginning the Test you will have arranged your safety gear and set up your test equipment, as described in Chapters 4 and 5. You should also prepare your report form by recording certain basic information about the device you are going to be testing. This basic information includes:

- the date of the test;
- the name and complete address of the operator of the device, the make and model, size, and serial number of the meter (from the meter identification plate);
- the maximum and minimum discharge rates that are marked on the meter;
- the accessory devices that are part of the system (register, ticket printer, thermometer well, automatic temperature compensator, etc.);
- the values currently registered on each of the system's totalizers; and
- if the device is equipped with an audit trail, the current audit trail values and information.

This information is important for recordkeeping purposes, and some of it--the maximum and minimum discharge rates and the existence of a temperature compensator--is necessary for determining specific test factors, as you will see below.

Record totalizer readings before the Test begins and again at its conclusion in order to determine the total quantity of product metered during the Test. Operators must be furnished with this data so they can reconcile inventory figures since product dispensed during the Test will have been recorded on the totalizer as delivered even though it has all been returned to the operator's tank. Recording the beginning and ending totalizer readings simplifies the calculation of the total amount dispensed since it saves adding indicated quantities for several test drafts. If the register is of the computing type and has a money-value totalizer, you should record this value as well. It is good practice to record this information before you begin other pre-test activities so that it will be available and will not be overlooked while you are concentrating on other tasks.

Note how this information is recorded on the top portion of the report form shown in Figure 7-11. This report form will be used for all examples in this chapter. If your jurisdiction uses another report form, your instructor will explain to you where and how information should be recorded.

Pre-Test Determinations

Before you begin the Test you must make several specific determinations relating to applicable tolerances and other test factors. These "pre-test determinations" are outlined in a separate section of the EPO's that precedes the Test and which is reproduced in Figure 7-1. To make these determinations, you will need to refer to several items of information about the system and the type of examination you are conducting.

1.	Determine that the test liquid is similar in character to the liquid to be measured commercially	N.1.
2.	Tolerances.	
	Applicable requirements..	G.-T., T.1.
	Tolerance values..	T.2.
	Repeatability..	T.3.
	Automatic Temperature-Compensating System.........................	T.4.

Figure 7-1. Pre-Test Determinations Portion of EPO's

You will need to know:

- the identity of the liquid product that is normally dispensed by the system and the identity of the liquid in the system at the time of the Test (if different);
- how long the system has been in service since its installation or since it was last adjusted; and
- the maximum discharge rate of the system (see above).

Again, recording this information before you begin to make pre-test determinations will make the procedure most efficient and organized.

Test Liquid

You must first determine that the physical properties of the liquid product in the system are the same, or very nearly the same, as the physical properties of the product that is metered by the system during its normal service. Metering systems are generally calibrated for the product that they will be used to measure and should be expected to perform within tolerances when metering that product. However, different LPG products have different properties, depending upon their composition and grade, and some of these differences can affect the performance of the system.

Of particular importance for measurement accuracy is the rate at which the volume of the liquid expands or contracts in response to changes in temperature -- its coefficient of expansion. Even the variation that exists for different grades of the same generic product can make a significant difference (remember that commercial propane is a mixture of one or more hydrocarbons with propane and that the composition may vary even from one shipment to the next from the same supplier).

The coefficient of expansion of the product is especially important if the system is equipped with an automatic temperature compensator (ATC) since this device is also calibrated for a specific product and may cause inaccurate registration if a different product is used.

Another important factor is the tendency of the product to vaporize with changes in pressure at atmospheric temperatures. Propane, which has a boiling point of -44 °F, will tend to vaporize readily when pressure inside the system falls even a small amount (commercial propane, containing up to 7 percent ethane, has a boiling point well below -44° F). Butane, on the other hand, with a boiling point of +32 °F, will not vaporize as readily with relatively small changes in system pressure.

Because the ability of the system to effectively exclude vapor is essential for accurate measurement of product delivered, a test of a system that normally is used to dispense *propane* using *butan*e as the test liquid may provide results that do not reflect the performance of the system as it is used in its commercial service--the objective of these test procedures.

You should question the operator to determine the identity of the product in the system and record this information on your test report (see Figure 7-11.). In addition to the name of the product, you should also ascertain and record its specific gravity since you will use this value to make temperature corrections during the course of the test.

You should also ask whether or not the product in the system is the same as that normally dispensed. If not, you should note the product normally dispensed on your test report. Consult your supervisor if the properties of the liquid in the system (especially its specific gravity) are significantly different from those of the product normally dispensed.

Tolerances

It is recognized that the measuring device being tested is not capable of errorless performance under all operating conditions that may occur in the field. For this reason tolerances are established to fix the acceptable range of inaccuracy for weighing and measuring devices in commercial service. Tolerances are designed to permit only measurement errors small enough not to cause serious economic injury to either buyer or seller. At the same time, the tolerances that apply to a particular device must not be so stringent as to make the costs of manufacturing and maintaining equipment unreasonably high since these costs are usually passed on to the consumer. The tolerances established by code or regulation and enforced by weights and measures officials are generally considered as minimum standards by meter manufacturers; users can, and often do, establish performance standards that are more stringent.

Handbook 44 includes tolerances for LPG liquid-measuring devices. The applicable tolerance is determined by three factors:

- the length of time the device has been in service,
- the type of test that is being performed, and
- the size of the test draft.

For LPG liquid-measuring equipment--as for all mechanical devices whose performance can be affected as a result of extended use--Handbook 44 establishes two sets of tolerances:

- Acceptance Tolerances - Acceptance tolerances shall apply to:

  (a) equipment to be put into commercial use for the first time;

  (b) equipment that has been placed in commercial service within the preceding 30 days and is being officially tested for the first time;

  (c) equipment that has been returned to commercial service following official rejection for failure to conform to performance requirements and is being officially tested for the first time within 30 days after corrective service;

  (d) equipment that is being officially tested for the first time within 30 days after major reconditioning or overhaul; and

  (e) equipment undergoing type evaluation.

  (Amended 1989)

- Maintenance tolerances shall apply to equipment that has been in actual use, except as stated above.

On normal tests (see Figure 7-2.), the acceptance tolerance is less than the value of the applicable maintenance tolerance. The maintenance tolerance, therefore, allows a limited degree of deterioration in performance and generally assures a reasonable period of use before the system must be adjusted.

N.4.1. Normal Tests. - The "normal" test of a device shall be made at the maximum discharge flow rate developed under the conditions of the installation. Any additional tests conducted at flow rates down to and including one-half the sum of the maximum discharge flow rate and the rated minimum discharge flow rate shall be considered normal tests.
(Amended 1998)

N.4.1.1. Automatic Temperature Compensation. - On devices equipped with automatic temperature compensating systems, normal tests shall be conducted as follows:

(a) by comparing the compensated volume indicated or recorded to the actual delivered volume corrected to 15 °C (60 °F); and,
(b) with the temperature compensating system deactivated, comparing the uncompensated volume indicated or recorded to the actual delivered volume.

The first test shall be performed with the automatic temperature-compensating system operating in the "as found" condition. On devices that indicate or record both the compensated and uncompensated volume for each delivery, the tests in (a) and (b) may be performed as a single test.
(Amended 1987)

N.4.1.2. Repeatability Tests. - Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors, such as temperature pressure and flow rate, are reduced to the extent that they will not affect the results obtained.
(Added 2001)

N.4.2. Special Tests. - "Special" tests, to develop the operating characteristics of a device and any special elements and accessories attached to or associated with the device, shall be made as circumstances require. Any test except as set forth in N.4.1. shall be considered a special test.

Figure 7-2. LPG & AA/LMD Code, Paragraphs N.4.1. and N.4.2.

Handbook 44 also establishes two different classes of tests, "normal" tests and "special" tests. They are described in paragraphs N.4.1. and N.4.2. of the LPG & AA/LMD Code (see Figure 7-2.). We will look more closely at these two tests later in this chapter when we discuss specific procedures. For now, you should simply consider that a normal test is intended to test performance under conditions that approximate as closely as possible those that are most usual for the system, that is, conditions that are "normal." Special tests, on the other hand, are used to assess the performance of the system under reduced or other flow conditions for which the device was designed and that may occur in everyday use.

The applicable tolerance values for any given test are based upon the indicated quantity of product delivered, that is, usually the size of the test draft. In accordance with paragraph N.3., the test draft "should be equal to at least the amount delivered by the device in 1 minute at its normal discharge rate." This is intended to assure that the system reaches and maintains a "steady-state" condition--that is, that it operates at a steady speed, without accelerating or decelerating--for a sufficient portion of the delivery to reduce to a minimum the inertial and other effects associated with starting and stopping the device.

The test draft will usually be equivalent to the nearest prover size whose nominal capacity equals or exceeds the number of gallons that can be delivered by the system in one minute at its maximum discharge rate. For most LPG motor-fuel devices, test drafts of 25 gallons will be sufficient; for most other LPG liquid-measuring devices that are regularly tested by weights and measures jurisdictions, 50- or 100-gallon test drafts are used. With these items of information, the applicable tolerances are readily determined using the formulas in T.2. of the LPG & AA/LMD Code (see Figure 7-4.).

N.3. Test Drafts. - Test drafts should be equal to at least the amount delivered by the device in 1 minute at its normal discharge rate.
(Amended 1982)

Figure 7-3. LPG & AA Code Paragraph N.3.

T.2. Tolerance Values. - The maintenance and acceptance tolerances for normal and special tests shall be as shown in Table T.2.
(Amended 2003)

Table T.2. Accuracy Classes and Tolerances for LPG and Anhydrous Ammonia Liquid-Measuring Devices

Accuracy Class	Application	Acceptance Tolerance	Maintenance Tolerance	Special Test Tolerance
1.0	Anhydrous ammonia, LPG (including vehicle tank meters)	0.6 %	1.0 %	1.0 %

Figure 7-4. LPG & AA Code Paragraph T.2.

G-S.5.4. Repeatability of Indications. - A device shall be capable of repeating, within prescribed tolerances, its indications and recorded representations. This requirement shall be met irrespective of repeated manipulation of any element of the device in a manner approximating normal usage (including displacement of the indicating elements to the full extent allowed by the construction of the device and repeated operation of a locking or relieving mechanism) and of the repeated performance of steps or operations that are embraced in the testing procedure.

N.4.1.2. Repeatability Tests. - Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors such as, temperature pressure and flow rate are reduced to the extent that they will not affect the results obtained.
(Added 2001)

T.3. Repeatability. - When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 percent of the absolute value of the maintenance tolerance and the results of each test shall be within applicable tolerance. This tolerance does not apply to the test of the automatic temperature compensating system. See also N.4.1.2.
(Added 1992) (Amended 1997 and 2001)

Figure 7-5. General Code Paragraph G-S.5.4. and LPG and AA/LMD Code Paragraphs N.4.1.2. and T.3.

In order to comply with Handbook 44, a device must be capable of repeating within prescribed tolerances its indications and recorded representations. Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size. Repeatability tests must also be conducted at approximately the same flow rate, and differences in other conditions such as temperature and pressure must be reduced to the extent that they will not affect the results of the tests. Reducing these variations in the test conditions helps to ensure that the results obtained reflect the ability of the device to deliver repeatable results and that device performance is not influenced by these other factors. The range of test results shall not exceed 40 percent of the absolute value of the maintenance tolerance and the results of each test shall be within applicable tolerance.

Consider the example of two 100-gallon normal test drafts run at approximately the same flow rate. If maintenance tolerance applies, the tolerance for each individual draft is +/- 1.0 percent or, in this example, +/- 1 gallon (231 cubic inches); thus, permissible indications range from +1 gallon to -1 gallon. The absolute value of a number is equal to that number without the “+” or “-” signs; the absolute value of maintenance tolerance in this case is 1 gallon. Thus, the repeatability tolerance is 40 percent of the absolute value of maintenance tolerance or 40 percent of 1 gallon; 40 percent of 1 gallon is 0.4 gallon or 92.4 cubic inches.

There are two methods for arriving at this calculation as outlined below.

Method 1:

40 % x Maintenance Tolerance in % =

40 % x 1 % =

0.4 x 0.01 =

0.004 = 0.4 %

0.4 % x indicated gallons = 0.004 x 100 gallons = 0.4 gallons = 92.4 cubic inches

Method 2:

40 % x Maintenance Tolerance in gallons =

0.4 x 1 gallon =

0.4 gallons = 92.4 cubic inches

If the result of the first test is -110 cubic inches and the result of the second test is +90 cubic inches, each individual result is within the plus or minus 231 cubic inches tolerance permitted for individual test drafts. However, the results have a range of 200 cubic inches (-110 to +90 cubic inches), which exceeds the repeatability tolerance of 92.4 cubic inches.

When testing a device with an automatic temperature compensating (ATC) system, the difference between the meter error for results determined with and without the ATC activated shall not exceed the limits specified in paragraph T.4. (see Figure 7-6.). Different tolerances are specified for mechanical ATC's and for electronic ATC's. The flow rates of the ATC and non-ATC tests should be approximately equal.

T.4. Automatic Temperature-Compensating Systems. - The difference between the meter error (expressed as a percentage) for results determined with and without the automatic temperature-compensating system activated shall not exceed:

(a) 1.0 percent for mechanical automatic temperature compensating systems; and

(b) 0.5 percent for electronic automatic temperature compensating systems.

The delivered quantities for each test shall be approximately the same size. The results of each test shall be within the applicable acceptance or maintenance tolerance.
(Added 1991; Amended 1992, 1996, and 1997)

Figure 7-6. LPG & AA Code Paragraph T.4.

Consider the example of a 100-gallon test draft run on a system equipped with an electronic ATC under maintenance tolerance. If a normal test run with the ATC activated results in an error of +60 cubic inches and a normal test run with the ATC deactivated results in an error of -70 cubic inches, the range between the results of the two tests is 130 cubic inches (from -70 to +60 cubic inches).

As calculated in the previous example, the maintenance tolerance for a 100-gallon normal test draft is 1 gallon or 92.4 cubic inches. For a 100-gallon draft, the Automatic Temperature-Compensating System Tolerance as specified in paragraph T.4. is 0.5 percent x 100 gallons, which is 0.5 gallons or 115.5 cubic inches.

Thus, although the individual test results (+60 and -70 cubic inches) are within the permissible maintenance tolerance of 1 gallon or 231 cubic inches, the difference between the two results, 130 cubic inches, exceeds the tolerance of 0.5 percent (115.5 cubic inches) permitted for a 100-gallon test draft.

An alternative way to determine compliance with paragraph T.4. is to determine the meter error in percent for each run and compare the difference with the tolerance. In the example above, the run with the ATC activated resulted in an error of +0.26 % (+60 cubic inches = +0.26 gallons or 0.26 % of 100 gallons); the run with the ATC deactivated resulted in an error of - 0.31 % (-70 cubic inches = -0.30 gallons or 0.30 % of 100 gallons). The difference in percent of the ATC and non-ATC runs is 0.56 percent, which exceeds the permissible 0.5 percent tolerance.

When you have completed the pre-test determinations portion of the EPO, you are ready to proceed with the Test.

The Test

The Test portion of an official field examination, as set forth in the EPO's, can be summarized as follows:

- At least three test drafts are drawn and recorded. Two of these are made at the system's maximum discharge rate; if the system is equipped with an automatic temperature compensator, one draft is made with the ATC activated, the other with the ATC inactivated. Both of these tests are considered normal tests. A third draft is drawn at a rate of flow that is at or near the minimum discharge rate recommended by the manufacturer of the meter. This is considered a special test because it is not made at the maximum discharge rate.

- Registration errors are recorded for each draft, based upon prover readings that have been corrected for expansion of the prover due to pressurization, thermal expansion or contraction of the prover, and for the temperature difference between product at the meter and at the prover. On a temperature-compensated test, the prover reading is corrected to reflect the volume of the liquid at 60 °F. These errors are compared to the applicable tolerances to determine conformance with performance requirements.

- All primary indicating and recording elements are checked for comparability of indications, and computing type devices are tested for agreement between indicated and mathematically computed money values.

Test Notes

Before looking at the Test procedures in detail, let us turn our attention briefly to several steps that are repeated for each test draft. These are listed together at the beginning of the Test section of the EPO's, where they are designated as "Test Notes" (see Figure 7-7.).

Test Notes:

1. Wet prover (fill to nominal capacity). Allow 30-second drain period each time prover is emptied.	
2. Read temperature and pressure of product in prover immediately following each test draft and make appropriate corrections to test results ...	N.5.
3. If dispenser is equipped with a recording element, print ticket after each test run	G-S.5.2.2., G-S.5.6., S.1.1.6., UR.2.5., UR.2.6.
4. If computing type, check computation	G-S.5.5., S.1.1.5., S.1.5.2.
5. To determine proper operation of totalizers, observe and record the totalizer indication before and after all test drafts.	

Figure 7-7. Test Notes from EPO No. 27.

The first of these steps involves assuring the correct condition of the prover.

Wet Condition

As you have learned, the prover must be "wet" condition before the first official test draft, and this condition must be maintained between subsequent test drafts by following the evacuation, draining, and zeroing procedures described in Chapter 5. Unlike tests of liquid-measuring devices, which dispense products at atmospheric pressure, this wetting procedure must be conducted for each meter that is tested. This helps to ensure equalization of pressure between the prover and the system under test. Since loss of this wet condition can have a significant effect on test results, it is especially important that the drain time be strictly observed. If it is exceeded by more than a few seconds, the prover should be re-wetted before another official test draft is drawn. In addition, if there is a long period of time between test drafts--a lunch break or a prolonged time for meter adjustment or repair--the prover should be re-wetted before proceeding with further test drafts.

The second step is to read and record the temperature and pressure of product in the prover and the pressure at the meter immediately after the delivery has been halted and before the prover is evacuated. The temperature and pressure readings at the prover are needed to adjust the prover reading for expansion or contraction of the prover itself due to pressurization and temperature and for thermal expansion or contraction of the product due to any temperature difference between the system and the prover (we will cover the procedure for calculating these corrections shortly).

The system pressure reading will be compared to the pressure observed at the prover to determine the difference between the pressure gauges. Since the pressure inside the system and inside the prover should be in equilibrium during a delivery or a test draft, a significant difference (more than 5 psi) between these readings will probably indicate an obstruction somewhere in the circuit that is restricting flow. If this is the case, excessive condensation in the region ahead of the restriction may adversely affect test results. This condition should be monitored during each normal test draft.

If the system you are examining is equipped with a printer, you should print a ticket at the conclusion of each test draft. Several requirements relating to the printed ticket were discussed in the last chapter. In addition, the following paragraphs from the General Code establish requirements for the printed ticket, which should be checked during the Test.

G-S.5.6. Recorded Representations. - Insofar as they are appropriate, the requirements for indicating and recording elements shall be applicable also to recorded representations. All recorded values shall be printed digitally.
(Amended 1975) (Made retroactive 1990)

G-S.5.2.2. Digital Indication and Representation. - Digital elements shall be so designed that:

(a) All digital values of like value in a system agree with one another.

(b) A digital value coincides with its associated analog value to the nearest minimum graduation.

(c) A digital value "rounds off" to the nearest minimum unit that can be indicated or recorded.

(d) A digital zero indication includes the display of a zero for all places that are displayed to the right of the decimal point and at least one place to the left. When no decimal values are displayed, a zero shall be displayed for each place of the displayed scale division.

[Nonretroactive as of January 1, 1986.] (Amended 1973 and 1985)

Figure 7-8. General Code, Paragraphs G-S.5.6. and G-S.5.2.2.

In summary, you should check the printed ticket to determine the following:

- Values are printed digitally. Printed representations of a dial face or some similar analog representation are not acceptable (see G-S.5.6., above).

- A printer that is returnable to zero has been properly reset and it agrees with the register. The printed quantity value should agree exactly with that indicated on a digital register, and with that shown on an analog register to the nearest minimum graduation (see G-S.5.2.2., above). For money-value agreement, see below.

- The device is of the computing type, it displays the total computed price and the total volume of the delivery in terms of gallons (see S.1.1.6., discussed in the last chapter).

- All recorded representations are readable (see G-S.5.1., discussed in the last chapter).

All tickets printed for test purposes should be returned to the operator at the conclusion of the examination so that he or she can record control numbers on the tickets and reconcile ticket inventory. You should write "void" or "test" on each ticket and retain a carbon copy of this information, if possible, for your records; in some cases you may also be asked to initial the ticket.

Price Computations

All money values indicated or recorded on any digital computing type device, or on any retail analog computing device, must meet certain requirements for agreement with the price computed mathematically, that is, with the value produced by multiplying the unit price by the quantity. The applicable paragraphs of the General and LPG & AA/LMD Codes are quoted in Figure 7-9.

G-S.5.5. Money Values, Mathematical Agreement. - Any recorded money value and any digital money-value indication on a computing-type weighing or measuring device used in retail trade shall be in mathematical agreement with its associated quantity representation or indication to the nearest one cent of money value. This does not apply to auxiliary digital indications intended for the operator's use only, when these indications are obtained from existing analog customer indications that meet this requirement.
(Amended 1973)

S.1.1.5. Money Values--Mathematical Agreement. - Any digital money-value indication and any recorded money value on a computing-type device shall be in mathematical agreement with its associated quantity indication or representation to within one cent of money value; except that a stationary retail computing-type device must compute and indicate to the nearest one cent of money value (see Section 1.10., G-S.5.5.).
(Amended 1984, 1988)

S.1.5. For Stationary Retail Devices.

S.1.5.2. Money-Value Computations. - A computing device shall compute the total sales price at any single-purchase unit price (excluding fleet sales and other price contract sales) for which the product is offered for sale at any delivery possible within either the measurement range of the device or the range of the computing elements, whichever is less. The analog money value indication shall not differ from the mathematically computed money value (quantity x unit price = sales price), for any delivered quantity, by an amount greater than the values shown in Table 1.
(Amended 1995)

**Figure 7-9. General Code, Paragraph G-S.5.5;
LPG & AA/LMD Code, Paragraphs S.1.1.5. and S.1.5.2.**

Table 1. Money-Value Divisions and Maximum Allowable Variations for Money-Value Computations on Mechanical Analog Computers				
Unit Price		Money Value Division	Maximum Allowable Variation	
From	To and including		Design Test	Field Test
0	0.25/liter or $1.00/gallon	1¢	± 1¢	± 1¢
0.25/liter or $1.00/gallon	0.75/liter or $3.00/gallon	1¢ or 2¢	± 1¢	± 2¢
0.75/liter or $3.00/gallon	2.50/liter or $10.00/gallon	1¢ or 2¢	± 1¢	± 2¢
0.75/liter or $3.00/gallon	2.50/liter or $10.00/gallon	5¢	± 2 1/2¢	± 5¢

Figure 7-10. LPG & AA/LMD Code, Table 1.

Following the first test draft, you should check all indicated and recorded money values to determine whether or not they are in conformance with these requirements.

In summary:

- For a digital device, the indicated or recorded money value must agree with the mathematically computed price to within 1 cent; a stationary retail device must be to the nearest 1 cent (see G-S.5.5. and S.1.1.5., Figure 7-9.).

- For example, consider a delivery of 152.7 gal of product at a unit price of $0.84. The mathematically computed price is $128.268. To conform with the requirement, a stationary retail device would have to indicate $128.27; any other LPG device could read either $128.27, $128.26, or $128.28.

- For a retail analog device, the indicated money value must not differ from the mathematically computed money value by an amount more than that shown for the given unit price and type of test in Table 1 of the LPG & AA/LMD Code (reproduced in Figure 7-10.; see S.1.5.2. in Figure 7-9.).

If the system you are examining is equipped with a computing type register and/or printer you should check money-value indications and recorded representations after each test draft to determine if the requirements described in Table 1 are being met consistently.

Finally, you should observe and record totalizer readings after each test draft. Subtracting the newly recorded value from that recorded for the previous draft will produce a value that you can compare with the register reading. If these values do not agree, there is a problem somewhere in the indicating mechanism.

The First Test Draft

The first test of the system establishes baseline results that are needed to analyze and evaluate subsequent tests. It should approximate as closely as possible the conditions of service that occur in most deliveries: the draft is drawn at the system's full flow rate, and if the system is equipped with an automatic temperature compensator (ATC), this device is left activated during the first test draft.

We have covered the procedure for drawing a test draft and reading indications on the register, prover gauge, thermometers, and pressure gauges in Chapter 5. Before turning to the subject of temperature and pressure corrections, however, a couple of notes on the delivery procedure are in order. You should time the first test draft to determine the actual maximum discharge rate of the system. Time the delivery of 10 gallons of product (but neither the first nor the last 10 gallons of the run). (Note that for smaller test drafts, such as when a 25-gallon prover is used, these quantities are reduced accordingly.) Divide 600 by the observed time in seconds. The result will be the discharge rate in gallons per minute. For example, if you determine that it took 10 seconds for the delivery of 10 gallons of product, then the discharge rate is 600/10 = 60 gpm. This rate should not exceed the maximum discharge rate marked on the meter identification plate. You should mark this amount on your report for future reference.

If the system is not equipped with an ATC, you should observe and record the temperature of product at the meter twice during the delivery: when the register indicates approximately one-third and two-thirds of the nominal capacity of the prover. Thus, for a 100-gallon draft, meter temperature should be recorded at about 35 gallons delivered and again at about 70 gallons. Record the temperature each time to the nearest one-half degree.

The reason for multiple temperature readings is that the temperature of product passing through the meter may change by as much as one or two degrees over the course of the delivery, depending upon the ambient temperature, the flow rate, the amount of time that has passed since the last delivery, the amount of time that the pump is activated before the delivery begins (product circulating through the by-pass circuit is likely to be heated slightly by friction), etc. Because the meter temperature is used as the basis for adjusting the prover reading to reflect temperature change, and since the coefficient of expansion of LPG products is so high, the value used should reflect an average of readings taken at evenly spaced intervals over the course of the delivery.

If the system <u>does</u> have an ATC, it should be operative during the first test draft. Since in this case the registered volume will be assumed to have been corrected to 60 °F, the actual temperature at the meter is irrelevant to the temperature correction. Meter temperature on a compensated draft should be recorded as 60 °F. See Figure 7-11. Sample Report Form, First Test Draft on the following page.

DATE *AUGUST 15, 1998*	DEPARTMENT HEADING LPG METER TEST REPORT	TEST NO *5698*	TRUCK ID *AR 364*
NAME *PROPANE, INCORPORATED*		INSPECTOR: *LOU FISCHER*	
ADDRESS *123 MAIN STREET* STATE: *MD* ZIP: *01234*		OWNER: *S.W. STRATTON*	
MAKE OF METER: *LIQUIDMETER* MODEL: *8979* SN: *N1160*		REGISTER MODEL: *REGITRUE MODEL 124* SERIAL NUMBER: *AB142*	
METER SIZE (INCHES): *2.0* IN	TOTALIZER FINISH:		
FLOW RATE: MIN *20 GPM* MAX *100 GPM*	TOTALIZER START: *79848*	PRODUCT: *LPG/PROPANE*	
THERMOMETER WELL ☒ PRINTER ☒ TEMPERATURE COMPENSATOR: ☐ ELEC ☒ MECH	TOTAL PRODUCT: *RETURNED TO STORAGE*	SPECIFIC GRAVITY: *0.505*	
TOLERANCE APPLIED: ACCEPTANCE ☒ MAINTENANCE ☐		SECURITY SEALS INTACT AS FOUND? YES ☒ NO ☐	

Test Data	1st run	2nd run	3rd run	4th run
1. TYPE OF TEST RUN	NORMAL ✓ SPEC___ ATC ✓	NORMAL___ SPEC___ ATC ___	NORMAL___ SPEC___ ATC ___	NORMAL___ SPEC___ ATC ___
2. FLOW RATE	*98* GAL/MIN	GAL/MIN	GAL/MIN	GAL/MIN
3. METER TEMP (1/3 PROVER CAP)	*60* °F	°F	°F	°F
4. METER TEMP (2/3 PROVER CAP)	*60* °F	°F	°F	°F
5. TANK PRESSURE	*120* PSI	PSI	PSI	PSI
6. PROVER PRESSURE	*118* PSI	PSI	PSI	PSI
7. PROVER TEMPERATURE	*68.0* °F	°F	°F	°F
8. PROVER READING TO 0.05 GAL	*98.15* GAL	GAL	GAL	GAL
9. METER READING	*97.00* GAL	GAL	GAL	GAL
USE FOR UNCOMPENSATED RUN				
10. a. AVG METER TEMP (3 + 4) ÷ 2	°F	°F	°F	°F
b. TEMP DIFFERENCE (10a - 7)	°F	°F	°F	°F
c. TEMP CORR FACTOR (TABLE 2)	GAL/°F	GAL/°F	GAL/°F	GAL/°F
d. TEMP DIFF CORR (10b x 10c)	GAL	GAL	GAL	GAL
11. TEMP CORRECTED PROVER READING (10d + 8)	GAL	GAL	GAL	GAL
USE FOR COMPENSATED RUN				
10. VOLUME CORRECTION FACTOR AT PROVER TEMPERATURE (TABLE 4)	GAL	GAL	GAL	GAL
11. TEMP CORRECTED PROVER READING (10 X 8)	GAL	GAL	GAL	GAL
USE FOR EITHER RUN				
12. CORR FOR PROVER PRESSURE (TABLE 1)	GAL	GAL	GAL	GAL
13. CORR FOR PROVER TEMP (TABLE 3)	GAL	GAL	GAL	GAL
14. CORRECTED PROVER READING (11+12+13)	GAL	GAL	GAL	GAL
15. METER READING (ROW 9)	GAL	GAL	GAL	GAL
16. NET METER ERROR (14 - 15)	GAL	GAL	GAL	GAL
17. PERCENT ERROR (ROW 16 ÷15) X 100	%	%	%	%
18. TOLERANCE CALCULATION (ROW 15 X %TOL)	GAL	GAL	GAL	GAL
19. DIFFERENCE BETWEEN ATC AND NON- ATC TEST RUN(S): (% ERROR ATC - % ERROR NON-ATC) =				
REMARKS:				
ACTION TAKEN: ☐ APPROVED ☐ REJECTED ☐ CONDEMNED				(FORM REV 5/31/98)

Figure 7-11. Sample Report Form, First Test Draft.

By the end of the first test, you should have recorded the following items of data:

- the actual discharge rate;
- the temperature of product at the meter after intervals corresponding to about one-third and two-thirds of the nominal capacity of the prover;
- the temperature at the prover immediately following product delivery;
- the pressure in the metering system tank and at the prover immediately after delivery has been completed;
- the prover reading to the nearest 0.05 gal; and
- the register reading to the nearest one-tenth of the value of the smallest graduated quantity interval (that is, to the nearest 0.1 gal if the smallest unit is gallons; to the nearest 0.01 gal if the smallest unit is tenths of a gallon).

These items of information are recorded on the sample report form shown in Figure 7-11. Note also the basic device information and pre-test determinations that are recorded on the top portion of the form. Before proceeding further, review the recorded test data and look for apparent anomalies. When satisfied that the test data are valid, proceed to make the appropriate corrections to the prover reading for temperature and pressure effects. For the first test draft, there are three corrections:

- for change in product volume between the meter and the prover resulting from temperature difference in the product;
- for the expansion or contraction of the prover container caused by pressure;
- for thermal expansion or contraction of the prover caused by temperature.

To make the appropriate correction in each case, you will need to refer to tables that furnish correction factors or values for specific conditions.

Temperature Correction

One set of tables (Table 4, included in Appendix B) is used to correct the volume of an LPG product at any given temperature to its volume at 60 °F. The tables are used to correct prover volume readings to 60° F after <u>compensated</u> test runs (that is, when the ATC is activated). They are reprinted from API Standard: 2540, “Petroleum Measurement Tables,” Table 24, Volume Reduction to 60 °F (see below).

Another table (Table 2 in Appendix B and on the report form) gives volume correction values for each degree of difference in temperature between the metering system storage tank and the prover. These are used for <u>uncompensated</u> test drafts (see section on “Uncompensated Drafts” later in this chapter).

You will also need to use the pressure correction table that was prepared when the prover was calibrated. As you learned in Chapter 5, the response of a particular prover to pressurization may be unique to that prover and not predictable from its material or design. Accordingly, you should only use the table that was prepared for the prover you are using. Pressure correction tables used with examples later in this chapter are samples, and should not be used in the field.

Another table also accompanies the prover and shows correction values for thermal expansion or contraction for the material of which the prover container is made. Examples below use a table that is appropriate for a 100-gal prover constructed of low-carbon steel only. A copy of this table is included in Appendix B (designated Table 3 in the appendix and on the report form). If the prover you use has a different nominal capacity or is made of another material (stainless steel, for example), you will need a table with appropriate values; or you can use the coefficient of expansion that is marked on the prover.

These are the tables you will use to make correction to the prover volume. The correction procedure depends upon whether you are performing a compensated or an uncompensated test run. Let us follow the complete prover correction procedure for a compensated draft first.

Temperature-Compensated Draft

If the ATC is activated during the first test, the volume registered by the metering system will presumably have been corrected to its volume at 60 °F. To make the prover reading comparable, we must also correct it to 60 °F. This is accomplished by multiplying the prover reading by a volume correction factor that can be found in Table 4 in Appendix B. The appropriate page of this table for our example is reproduced in Figure 7-12.

Observed Temperature °F	**Specific Gravity 60/60°F**		
	0.500	**0.505**	**0.510**
	Factor for Reducing Volume to 60°F		
50	1.017	1.017	1.016
51	1.015	1.015	1.014
52	1.014	1.013	1.012
53	1.012	1.012	1.011
54	1.010	1.010	1.009
55	1.009	1.008	1.008
56	1.007	1.007	1.006
57	1.005	1.005	1.005
58	1.003	1.003	1.003
59	1.002	1.002	1.002
60	1.000	1.000	1.000
61	0.998	0.998	0.998
62	0.997	0.997	0.997
63	0.995	0.995	0.995
64	0.993	0.993	0.994
65	0.991	0.992	0.992
66	0.990	0.990	0.990

Observed Temperature °F	Specific Gravity 60/60°F		
	0.500	**0.505**	**0.510**
	Factor for Reducing Volume to 60°F		
67	0.988	0.988	0.989
68	0.986	0.986	0.987
69	0.985	0.985	0.985
70	0.983	0.983	0.984

Figure 7-12. Excerpt from Table 4 (ASTM 24)

The appropriate correction factor is determined by finding the prover temperature in the left-hand column and reading the value in that row under the specific gravity of the product being metered. The first two pages of Table 4 include correction factors for standard grades of commercial propane, which have specific gravities between 0.500 and 0.510. The last four pages have factors appropriate for butane products; the specific gravity for commercial butane is generally around 0.580.

If the specific gravity of the product in the system you are testing is between two of the values shown across the top row of the table, use the value that is closest to it.

We do not need the meter temperature for this determination since the meter registration is already assumed to be corrected to 60 °F. Let us use the sample data recorded on the test form in Figure 7-11. The prover temperature was recorded as 68.0 °F, and a specific gravity of 0.505 was recorded for the product in the system.

We find the prover temperature (68.0 °F) in the left-hand column of the page from Table 4 reproduced in Figure 7-12. and read the corresponding value in the column headed by 0.505. This corresponding value, 0.986, is multiplied by the prover volume reading (not the temperature) to produce the corrected reading. In our example, 98.15 gallons (the prover reading) is multiplied by 0.986 to give a corrected prover reading of 96.78 gallons. This is the volume that the liquid inside the prover would occupy if the temperature of the liquid were at 60 °F. The recording and computation of these values is shown in Figure 7-13. (note that for a compensated run we disregard the first lines 10 and 11 on the form and make the correction on the corresponding lines labeled “Use for Compensated Run”).

DATE *AUGUST 15, 1998*	DEPARTMENT HEADING LPG METER TEST REPORT	TEST NO *5698*	TRUCK ID *AR 364*
NAME *PROPANE, INCORPORATED*		INSPECTOR: *LOU FISCHER*	
ADDRESS *123 MAIN STREET* STATE: *MD* ZIP: *01234*		OWNER: *S.W. STRATTON*	
MAKE OF METER: *LIQUIDMETER* MODEL: *8979* SN: *N1160*		REGISTER MODEL: *REGITRUE MODEL 124*	
METER SIZE (INCHES): *2.0* IN	TOTALIZER FINISH:	SERIAL NUMBER: *AB142*	
FLOW RATE: MIN *20 GPM* MAX *100 GPM*	TOTALIZER START: *79848*	PRODUCT: *LPG/PROPANE*	
THERMOMETER WE LL ☒ PRINTER ☒ TEMPERATURE COMPENSATOR: ☐ ELEC ☒ MECH	TOTAL PRODUCT: *RETURNED TO STORAGE*	SPECIFIC GRAVITY: *0.505*	
TOLERANCE APPLIED: ACCEPTANCE ☒ MAINTENANCE ☐		SECURITY SEALS INTACT AS FOUND? YES ☒ NO ☐	

Test Data	1st run	2nd run	3rd run	4th run
1. TYPE OF TEST RUN	NORMAL ✓ SPEC___ ATC ✓	NORMAL___ SPEC___ ATC ___	NORMAL___ SPEC___ ATC ___	NORMAL___ SPEC___ ATC ___
2. FLOW RATE	*98* GAL/MIN	GAL/MIN	GAL/MIN	GAL/MIN
3. METER TEMP (1/3 PROVER CAP)	*60* °F	°F	°F	°F
4. METER TEMP (2/3 PROVER CAP)	*60* °F	°F	°F	°F
5. TANK PRESSURE	*120* PSI	PSI	PSI	PSI
6. PROVER PRESSURE	*118* PSI	PSI	PSI	PSI
7. PROVER TEMPERATURE	*68.0* °F	°F	°F	°F
8. PROVER READING TO 0.05 GAL	*98.15* GAL	GAL	GAL	GAL
9. METER READING	*97.00* GAL	GAL	GAL	GAL
USE FOR UNCOMPENSATED RUN				
10. a. AVG METER TEMP (3 + 4) ÷ 2	----- °F	°F	°F	°F
b. TEMP DIFFERENCE (10a - 7)	----- °F	°F	°F	°F
c. TEMP CORR FACTOR (TABLE 2)	----- GAL/°F	GAL/°F	GAL/°F	GAL/°F
d. TEMP DIFF CORR (10b x 10c)	----- GAL	GAL	GAL	GAL
11. TEMP CORRECTED PROVER READING (10d + 8)	----- GAL	GAL	GAL	GAL
USE FOR COMPENSATED RUN				
10. VOLUME CORRECTION FACTOR AT PROVER TEMPERATURE (TABLE 4)	*0.986* GAL	GAL	GAL	GAL
11. TEMP CORRECTED PROVER READING (10 X 8)	*96.78* GAL	GAL	GAL	GAL
USE FOR EITHER RUN				
12. CORR FOR PROVER PRESSURE (TABLE 1)	*+0.02* GAL	GAL	GAL	GAL
13. CORR FOR PROVER TEMP (TABLE 3)	*+0.02* GAL	GAL	GAL	GAL
14. CORRECTED PROVER READING (11+12+13)	*96.82* GAL	GAL	GAL	GAL
15. METER READING (ROW 9)	*97.00* GAL	GAL	GAL	GAL
16. NET METER ERROR (14 - 15)	*-0.18* GAL	GAL	GAL	GAL
17. PERCENT ERROR (ROW 16 ÷15) X 100	*-0.19* %	%	%	%
18. TOLERANCE CALCULATION (ROW 15 X %TOL)	*+/- 0.97* GAL	GAL	GAL	GAL
19. DIFFERENCE BETWEEN ATC AND NON- ATC TEST RUN(S): (% ERROR ATC - % ERROR NON-ATC) = *-0.19* % TO				
REMARKS:				
ACTION TAKEN: ☐ APPROVED ☐ REJECTED ☐ CONDEMNED(FORM REV 5/31/98)				

Figure 7-13. Sample Report Form, First Test Draft -- Calculation of Results.

Figure 7-13. also shows the appropriate corrections for prover pressure and temperature (lines 12 and 13). The first of these steps involves a correction for expansion of the prover from its calibrated capacity due to its pressurization. For this value, we consult the pressure correction table that was prepared for this prover. A sample of such a table is shown in Figure 7-14. (remember that you must use the table that was prepared for the prover you are using in the field).

Pressure Corrections to indicated Volume of LP Gas Meter Prover		
If gauge pressure is:	**Add to prover gauge reading:**	
psi	**cubic inches**	**gallons**
50	- 12	- .05
60	- 10	- .04
70	- 8	- .03
80	- 5	- .02
90	- 2	- .01
100	0	0
110	+ 2	+ .01
120	+ 5	+ .02
130	+ 8	+ .03
140	+ 10	+ .04
150	+ 12	+ .05
160	+ 15	+ .06
170	+ 18	+ .08
180	+ 20	+ .09
190	+ 22	+ .10
200	+ 25	+ .11

Figure 7-14. Sample prover pressure correction table.

According to the sample table, if the prover pressure gauge reading is 118 psi, as in our example, the pressure correction to the nearest 10 psi will be +0.02 gal (if the pressure is exactly between two successive values on the table, use the higher value). Adding this value to the prover reading will offset the expansion in volume that has occurred as a result of being pressurized.

Finally, we must correct the prover reading for the expansion or contraction of the prover from its calibrated capacity as a result of the effects of ambient temperature and delivered product temperature on the metal of the prover. For this we must use a table similar to that shown in Figure 7-15 (this table is also included in Appendix B as Table 3 and is appropriate for low-carbon steel provers only; see Chapter 5).

Prover	Prover Correction	
° F	cubic inches	gallons
- 20	- 34	- 0.15
- 15	- 32	- 0.14
- 10	- 30	- 0.13
- 5	- 28	- 0.12
0	- 26	- 0.11
5	- 24	- 0.10
10	- 21	- 0.09
15	- 19	- 0.08
20	- 17	- 0.07
25	- 15	- 0.07
30	- 13	- 0.06
35	- 11	- 0.05
40	- 9	- 0.04
45	- 6	- 0.03
50	- 4	- 0.02
55	- 2	- 0.01
60	0	0
65	2	+0.01
70	4	+0.02
75	6	+0.03
80	9	+0.04
85	11	+0.05
90	13	+0.06
95	15	+0.07
100	17	+0.07
105	19	+0.08
110	21	+0.09
115	24	+0.1
120	26	+0.11

Figure 7-15. Table 3. Volume corrections for thermal expansion or contraction of a 100-gal low-carbon steel LPG Prover.

The nearest temperature in the left-hand column to the recorded prover temperature of 68.0 °F is 70 °F. Opposite this temperature we find a correction in decimal gallons of +0.02 gal. Adding this value to the prover reading will offset the expansion in the prover that has occurred as a result of ambient product temperature above the prover's calibration temperature of 60 °F.

When the prover reading has been corrected for temperature and pressure (see Figure 7-13., lines 12-14), it is comparable to the meter reading. Subtracting the meter reading (line 15) from the corrected prover reading (line 14) gives the net meter error for this first test. If the value is a positive number, the system is underregistering (registering less product than is actually delivered); if the error is a negative number -- as in our example -- the system is overregistering (registering more product than it actually delivers).

As you can see on the sample report form (Figure 7-13), the error is computed first in decimal gallons, since the register and prover readings were recorded in these units. The applicable tolerances are often expressed in cubic inches, so the meter error must be converted to cubic inches before it can be compared. This is easily done by multiplying the net meter error in decimal gallons by 231; the result is the error for the test in cubic inches. Referring again to our example, the meter error is -0.18 gal x 231 = -41.58 cubic inches. This value is then rounded to the nearest whole cubic inch (-42 cubic inches in our example) and recorded on the report form.

The indicated delivery was 97.00 gallons. Since this is a normal test and maintenance tolerance applies, the applicable tolerance is 1 percent of the test draft or 1 percent of 97.00 gallons; thus, the tolerance is plus or minus 0.97 gallons or 224 cubic inches (0.97 x 231). Thus, this meter is well within tolerance on this first test draft.

If the meter error for this or any other test is within 10 percent of the applicable tolerance for that test, either plus or minus, the test should be repeated to confirm the results. In our example, 10 percent of the applicable tolerance would be 22.4 cubic inches, which we can round to 22 cubic inches. Adding and subtracting this value from the tolerance value gives a range of values that would indicate the need to repeat the test. Thus, if the meter error had been within the range -202 cubic inches or within the range of +202 cubic inches, a repeat test would have been indicated.

Likewise, if the meter error for this or any other test exceeds the tolerances, the test should be repeated to confirm the results.

This is especially important for performance tests of LPG metering systems because the test procedure is especially sensitive: it involves not just two readings (one from the measuring device and one from the proving device), but as many as seven, all but one of which (system pressure) are used to make corrections that can have a significant effect on the outcome. Since each reading has some margin of inaccuracy, the probability of some degree of error in the procedure is higher than on tests of many other devices.

Another significant factor, especially in the case of the first draft drawn, is often temperature differential between the prover and the metering system.

If a repeated test produces a meter error value that agrees with its predecessor to within 10 percent of the applicable tolerance, an average of the two should used as the final result for that test. If results still do not agree within this guideline, the test should be repeated again.

Uncompensated Draft

If you are testing a system that is not equipped with an automatic temperature compensator, or if the ATC has been deactivated (see below) and if product in the prover at the time when it is read is at a different temperature than it was when it passed through the meter--as is often the case–, the prover reading will have to be corrected to reflect the effect of this difference on the volume; if product in the prover is warmer than it was at the meter, an amount will have to be subtracted from the prover reading to compensate for the expansion that has taken place since the liquid was metered; if the product is cooler at the prover than it was at the meter, an amount will have to be added to the prover reading to compensate for the contraction that has occurred. In either case, the amount of the correction will depend upon the specific gravity of the product and the temperature difference between the prover and the meter. Since in our example, the first test draft was compensated, let us turn to the second test draft to see how the correction is made for an uncompensated run.

The Second Test Draft

The second test draft is also performed at the metering system's maximum discharge rate and so should confirm the results of the first draft. The second test draft is always uncompensated. If the metering system is not equipped with an ATC, the first and second drafts will be thus be conducted under the same operating conditions, and results should be quite similar. However, if the system is equipped with an ATC, this device is deactivated for the second test. If the ATC is functioning correctly, results from a compensated and an uncompensated test run should be quite close; if they are not, a malfunction of the ATC may be indicated. An uncompensated draft is performed in the same manner as a compensated draft, except that meter temperatures are recorded during the draft, as described above. If the first test draft was compensated, you should have the operator deactivate the ATC for the second draft. Sample data for a second test draft are given in Figure 7-16.

DATE *AUGUST 15, 1998*	DEPARTMENT HEADING LPG METER TEST REPORT	TEST NO *5698*	TRUCK ID *AR 364*
NAME *PROPANE, INCORPORATED*		INSPECTOR: *LOU FISCHER*	
ADDRESS *123 MAIN STREET* STATE: *MD* ZIP: *01234*		OWNER: *S.W. STRATTON*	
MAKE OF METER: *LIQUIDMETER* MODEL: *8979* SN: *N1160*		REGISTER MODEL: *REGITRUE MODEL 124*	
METER SIZE (INCHES): *2.0* IN	TOTALIZER FINISH:	SERIAL NUMBER: *AB142*	
FLOW RATE: MIN *20 GPM* MAX *100 GPM*	TOTALIZER START: *79848*	PRODUCT: *LPG/PROPANE*	
THERMOMETER WE LL ☒ PRINTER ☒ TEMPERATURE COMPENSATOR: ☐ ELEC ☒ MECH	TOTAL PRODUCT: *RETURNED TO STORAGE*	SPECIFIC GRAVITY: *0.505*	
TOLERANCE APPLIED: ACCEPTANCE ☒ MAINTENANCE ☐		SECURITY SEALS INTACT AS FOUND? YES ☒ NO ☐	

Test Data	1st run	2nd run	3rd run	4th run
1. TYPE OF TEST RUN	NORMAL ✓ SPEC___ ATC ✓	NORMAL ✓ SPEC___ ATC___	NORMAL___ SPEC___ ATC___	NORMAL___ SPEC___ ATC___
2. FLOW RATE	*98* GAL/MIN	*98* GAL/MIN	GAL/MIN	GAL/MIN
3. METER TEMP (1/3 PROVER CAP)	*60* °F	*66.0* °F	°F	°F
4. METER TEMP (2/3 PROVER CAP)	*60* °F	*66.5* °F	°F	°F
5. TANK PRESSURE	*120* PSI	*119* PSI	PSI	PSI
6. PROVER PRESSURE	*118* PSI	*117* PSI	PSI	PSI
7. PROVER TEMPERATURE	*68.0* °F	*67.0* °F	°F	°F
8. PROVER READING TO 0.05 GAL	*98.15* GAL	*98.90* GAL	GAL	GAL
9. METER READING	*97.00* GAL	*99.00* GAL	GAL	GAL
USE FOR UNCOMPENSATED RUN				
10. a. AVG METER TEMP (3 + 4) ÷ 2	----- °F	*66.25* °F	°F	°F
b. TEMP DIFFERENCE (10a - 7)	----- °F	*-0.75* °F	°F	°F
c. TEMP CORR FACTOR (TABLE 2)	----- GAL/°F	*0.170* GAL/°F	GAL/°F	GAL/°F
d. TEMP DIFF CORR (10b x 10c)	----- GAL	-0.13 GAL	GAL	GAL
11. TEMP CORRECTED PROVER READING (10d + 8)	----- GAL	*98.77* GAL	GAL	GAL
USE FOR COMPENSATED RUN				
10. VOLUME CORRECTION FACTOR AT PROVER TEMPERATURE (TABLE 4)	*0.986* GAL	----- GAL	GAL	GAL
11. TEMP CORRECTED PROVER READING (10 X 8)	*96.78* GAL	----- GAL	GAL	GAL
USE FOR EITHER RUN				
12. CORR FOR PROVER PRESSURE (TABLE 1)	*+0.02* GAL	*+ 0.02* GAL	GAL	GAL
13. CORR FOR PROVER TEMP (TABLE 3)	*+0.02* GAL	*+ 0.01* GAL	GAL	GAL
14. CORRECTED PROVER READING (11+12+13)	*96.82* GAL	*98.80* GAL	GAL	GAL
15. METER READING (ROW 9)	*97.00* GAL	*99.00* GAL	GAL	GAL
16. NET METER ERROR (14 - 15)	*-0.18* GAL	*- 0.20* GAL	GAL	GAL
17. PERCENT ERROR (ROW 16 ÷15) X 100	*-0.19* %	*- 0.2* %	%	%
18. TOLERANCE CALCULATION (ROW 15 X %TOL)	*+/- 0.97* GAL	*+/- 0.99* GAL	GAL	GAL
19. DIFFERENCE BETWEEN ATC AND NON- ATC TEST RUN(S): (% ERROR ATC - % ERROR NON-ATC) = *0.19 % TO -0.2% = 0.01 %*				
REMARKS:				
ACTION TAKEN: ☐ APPROVED ☐ REJECTED ☐ CONDEMNED				(FORM REV 5/31/98)

Figure 7-16. Sample Report Form, Second Test Draft and Calculation of Results.

As before, you should first review the test data for anomalies. Temperatures recorded at the meter may differ slightly from the first to the second reading, but should not vary by more than 1 or 2 °F. Nor should there be a difference of more than one or two degrees between the meter temperature and the prover temperature. If readings significantly outside these guidelines are observed, the cause should be determined and corrected, and the test repeated. When satisfied that the data are valid, you can proceed to perform the temperature correction.

The first step is to determine the difference between the average meter temperature and the temperature of liquid in the prover. This calculation is performed on lines 10a and 10b of the report form (see Figure 7-16.). The correction factor is then determined from Table 2 (Appendix B), which gives temperature correction factors for a 100-gallon prover.

This table is reproduced in Figure 7-17. It includes correction factors for propane products. The factor is based upon the prover temperature. Returning to our example, the average meter temperature was 66.25 °F. Subtracting this from the prover temperature (67.0 °F) gives a temperature difference of -0.75 °F (line 10b). The correction factor for decimal gallons from Table 2 for product with a specific gravity of 0.505 at the temperature that is closest to the actual prover temperature is 0.170.

Temperature of Liquid in Prover °F	**100-Gallon Correction Per °F Difference between Meter Temperature and Prover Temperature**	
	Propane Specific Gravity 60/60°F 0.505*	
	cu in/°F	**gal/°F**
-20 to -10	33.9	0.147
Over -10 to 0	34.1	0.148
Over 0 to 10	34.6	0.150
Over 10 to 20	35.7	0.154
Over 20 to 30	36.6	0.159
Over 30 to 40	37.0	0.160
Over 40 to 50	37.7	0.163
Over 50 to 70	39.3	0.170
Over 70 to 80	39.3	0.170
Over 80 to 90	39.7	0.172
Over 90 to 100	40.6	0.176
Over 100 to 110	41.3	0.179
Over 110 to 120	42.0	0.182

* Approximate specific gravity for a commercial LPG product

Note: The appropriate correction factor should be multiplied by the number of degrees difference between the meter and prover temperatures. If the temperature at the meter is *higher* than the temperature of the prover, the correction should be *added* to the prover gauge reading to compensate for the contraction of the liquid that has taken place after it was measured by the meter. If the temperature at the meter is *lower* than the temperature of the prover, the correction should be *subtracted* from the prover gauge reading to compensate for the expansion of the liquid that has taken place after it was measured by the meter.

Figure 7-17. Table 2. Temperature Corrections to Indicated Volume of a 100-Gallon LPG Prover (From Appendix B)

This factor is the appropriate correction per degree of temperature difference. To arrive at the total correction, we must multiply it by the temperature difference (-0.75 °F). The result (-0.13 gal) is then added to the prover reading. This has the effect, as you can see by comparing lines 8 and 11 on the sample report form, of reducing the prover reading to compensate for expansion of product after it passed through the meter.

If you are using a prover with a nominal capacity other than 100 gallons, the correction (line 10d) must first be multiplied by the capacity of the prover divided by 100. For example, if we had been using a 50-gallon prover instead of a 100-gallon prover for our test draft, we would have to multiply the correction (-0.13 gal) by 0.5 (50/100) to obtain the proper correction, -0.065.

The corrections for prover expansion due to pressurization and thermal expansion or contraction (lines 12 and 13) are performed in exactly the same way as for the first test draft. Note that in the sample, the correction for prover temperature is smaller than for the first test draft. This is because the prover temperature dropped 1 °F between the first and second drafts.

The corrected prover reading for this draft is then 98.80 gallons, which will produce a net meter error of -0.20 gallons or -46.20 cubic inches, which is rounded to -46 cubic inches. Since the applicable tolerance is ±0.99 gallons (1 % of 99.00 gallons: 99.00 x 0.01) or ±229 cubic inches (0.99 gallons x 231), this system is well within tolerance on the second test draft also. The fact that meter errors for both the compensated and the uncompensated drafts are so close indicates that the ATC is functioning properly in this example.

In the case of a system that is equipped with an ATC, if the meter errors for the compensated and uncompensated runs are substantially different, this difference may be attributable to malfunction or improper adjustment of the ATC. However, other factors may be responsible for divergent results. As noted earlier in this chapter, the difference between the meter error for results determined with and without the automatic temperature-compensating system activated shall not exceed the values specified in paragraph T.4. of Handbook 44.

You must understand that interpreting test data in this way can be useful, but that it is based upon experience and probability and is, therefore, never certain. As you gain experience with different types of metering equipment, you will develop the ability to interpret test results with considerable skill and accuracy. However, diagnosing meter problems usually cannot be based on performance data alone. The specific cause and remedy should always be determined by a qualified serviceperson. The data obtained from the tests can be very useful in doing this, but you should use it to inform the operator of the condition of the equipment, rather than taking on the role of troubleshooter or serviceperson.

Special Test

The third test draft of an LPG liquid-measuring system is a Special Test. It is customarily referred to as a "slow-flow" test because the test draft is drawn at a flow rate that is at or near the minimum discharge rate recommended by the manufacturer (see below). Tolerances set forth in the LPG & AA/LMD Code for special tests are the same as maintenance tolerance values for Normal Tests (1 percent of the test draft). If the system is equipped with an ATC, the device is left deactivated for the Special Test. Temperature and pressure correction computations are the same as those for an uncompensated Normal Test.

In fact, the only difference in procedure between the Special Test and the Normal Test involves maintaining a low discharge rate during the delivery. The appropriate rate depends upon the class of device (motor-fuel, other retail, or wholesale), and is specified in subsection N.4.2. of the LPG & AA/LMD Code, which is reproduced in Figure 7-18.

N.4.2. Special Tests. - "Special" tests, to develop the operating characteristics of a device and any special elements and accessories attached to or associated with the device, shall be made as circumstances require. Any test except as set forth in N.4.1. shall be considered a special test.

N.4.2.1. For Motor-Fuel Devices. - A motor-fuel device shall be so tested at a minimum discharge rate of:

(a) 20 L (5 gal) per minute, or

(b) the minimum discharge rate marked on the device, whichever is less.

N.4.2.2. For Other Retail Devices. - A retail device other than a motor-fuel device shall be tested at a minimum discharge rate of:

(a) the minimum discharge rate that can be developed under the conditions of installation, or

(b) the minimum discharge rate marked on the device, whichever is greater.
(Amended 1973)

N.4.2.3. For Wholesale Devices. - A wholesale device shall be so tested at a minimum discharge rate of:

(a) 40 L (10 gal) per minute for a device with a rated maximum discharge less than 180 L (50 gal) per minute.

(b) 20 percent of the marked maximum discharge rate for a device with a rated maximum discharge of 180 L (50 gal) per minute or more, or

(c) the minimum discharge rate marked on the device, whichever is least.
(Amended 1987)

Figure 7-18. LPG & AA/LMD Code, Subsection N.4.2.

In the case of a retail device other than a motor-fuel device, you will have to ascertain from the operator the minimum rate that can be developed by the system. For all other classes, the appropriate discharge rate can be determined by referring to the minimum discharge rate marked on the device and comparing it with the specifications of subsection N.4.2. Record the appropriate rate on your report form.

The delivery of the test draft will have to be monitored with a watch that displays seconds or, preferably, with a stopwatch. The discharge rate should be controlled by manipulating the prover inlet valve. The system pump speed should not be lowered for this purpose unless absolutely necessary. If the pump speed must be lowered in order to obtain the desired flow rate, this should be noted on the test report. Experience with your prover will allow you to make a preliminary setting of the valve to reduce the discharge rate substantially without restricting it below the specified rate (excessive restriction at the beginning of the delivery may adversely affect test results, even if adjustments are made quickly).

After the meter has gotten up to speed (usually after about 5 gallons), time the delivery of the next 5 gallons by monitoring the register. Dividing the number of elapsed seconds for delivery of this amount into 300 will give you the actual delivery rate. If "trimming" the flow rate is necessary, as it probably will be, make an approximate (but again conservative) adjustment at the inlet valve and time another 5 gallons. Make any necessary correction based upon your computation of the actual discharge rate and continue to fine-tune the discharge rate in this way until it is near to the specified rate.

Keep in mind that the average delivery rate for the draft should be as close as possible to the specified rate (if you have a stopwatch that times laps, you can determine the actual discharge rate for the entire delivery at the same time). If you are not able to attain the specified rate exactly, you should make sure that any overall error is in the direction of a rate higher than the minimum discharge rate specified for the meter.

Temperature, pressure, prover, and meter readings are observed and recorded as for a the first and second test drafts. It may take some practice and experience before you become proficient at performing all of these procedures for the Special Test, since you will be monitoring the discharge rate at the same time as meter temperature, etc.

The primary purpose of a slow-flow test is to determine the condition of the meter. Figure 7-19 illustrates the type of results you may obtain and their significance. The curves describe the performance of a typical metering system in various conditions of wear over the range of discharge rates at which it operates. The curve marked "a" represents the expected performance of a meter that is new or that has recently been reconditioned and readjusted. You can see that the performance at full rated flow and at 20 percent of full rated flow is virtually identical. At these rates the system "gives" very slightly; that is, it delivers slightly more product than it registers.

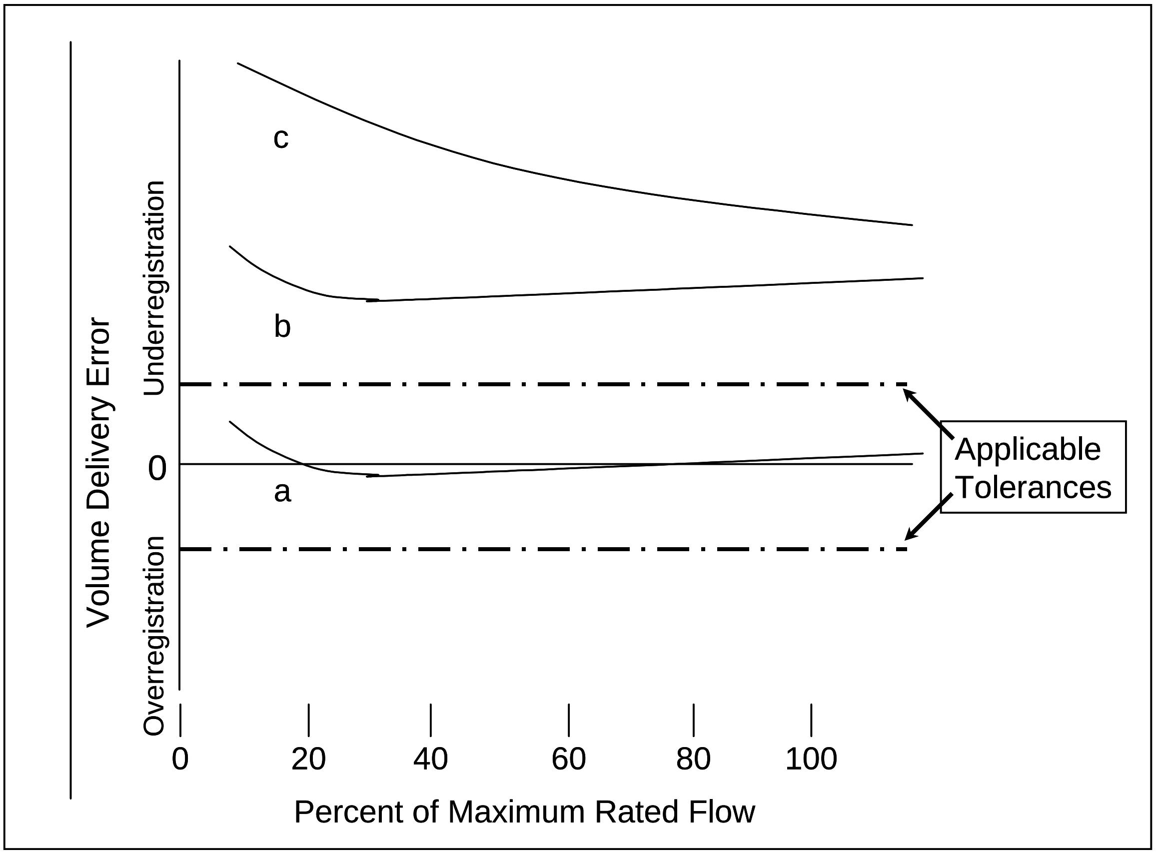

Figure 7-19. Typical Meter Performance Curve

You will see why we use the term "gives" rather than "underregisters" if you compare the curve marked "b", which depicts the performances that may be expected of a meter that has been in service for some time since its last adjustment. As you can see, it is out of tolerance at both ends of its rated discharge range, and underregisters at all delivery rates. However, its performance at full flow and at 20 percent of full rated flow are still virtually identical, and the shape of the curve is nearly the same as that of "a". As was the case for the newly adjusted meter described by curve "a", this meter "gives" slightly more at both ends of its range than at intermediate rates, but gives about the same amount of product at slow flow as at maximum flow.

This kind of performance indicate that the system's registration simply needs to be readjusted to bring it as close as possible to zero error. This can usually be accomplished by manipulating the adjustment mechanism between the meter and register and does not require dismantling and reconditioning the meter. The effect of the adjustment will be to "lower" the performance curve so that it is situated approximately where "a" is with respect to the zero-error line.

Curve "c", depicts the performance of a meter that is badly worn. Not only does it underregister rather severely at all flow rates, but it "gives" substantially more at slow rates of flow than it des at its maximum rate. It is this characteristic of the performance curve that indicates the meter is badly worn, not merely the fact that it underregisters.

As a meter wears, the clearances between the segmenting elements and the walls of the meter chamber tend to wide (see Chapter 3 to review the operation of the meter). This results in more product slippage (and hence underregistration) at all discharge rates. However, at relatively low flow rates, the rate of slippage is markedly higher because of the low flow rate. Simply readjustment a meter that is this badly worn will not remedy the situation, even if it brings registration temporarily within tolerance, since the condition will continue to deteriorate rapidly and the system will very quickly be out of tolerance again. The only adequate remedy is to recondition or overhaul the meter, replacing badly worn components and adjusting others.

You can see how the results of the Special Test, conducted at a slow flow rate, when compared with the results of the Normal Test, can indicate the condition of the meter: they represent the critical points on a performance curve like those we have been looking at – their relative positions on the curve indicate the extent of wear. In general, the greater the difference between meter errors observed for the Normal and Special Tests, the stronger the indication that the meter chamber is worn and in need of reconditioning.

The performance curves shown in Figure 7-19 are somewhat idealized. In practice it is normal for a meter to give slightly more product at its specified slow-flow rate, even if it is in good condition. However, if the meter error recorded for a slow-flow test indicates less "give" than was observed for delivery at the system's maximum discharge rate, you may have reason to be suspicious of the results.

Throttling at the prover inlet valve to obtain the specified low flow rate may results in production of vapor in the prover, which will have the effect of offsetting the increased slippage of product, even to the point of indicating relative overregistration. This might happen, for example, if the system is not equipped with an external pump bypass circuit, or if the bypass circuit has been shut or throttled because of a worn pump. If this occurs, you should repeat the Special Test at a discharge rate somewhat higher than the specified, or at a lower pumping speed, and compare the results to those for the earlier test. The operator should be informed that the system is not capable of registering accurately at the lower rate, and that steps should be taken to correct this condition. A notation to that effect should also be made on your test report.

After some experience with different makes and models of metering equipment, you will develop the ability to judge whether the degree of difference observed in results between a given set of Normal and Special Tests suggests wear that is sufficient to require that the meter be reconditioned. Because such repair is costly to the operator, you should check borderline results with the manufacturer or a qualified serviceperson.

It is mostly likely that a meter that is badly worn will be out of tolerance on the Special Test and possibly on the Normal Test as well. However, that the tolerances apply individually to results of the separate tests. It is therefore possible that a badly worn meter could be technically in conformance with performance requirements. For example, if the operator of a device like the one whose performance is depicted by curve "c" were to attempt to remedy the out-of-tolerance condition by readjusting, the effect might be to lower the curve as shown in Figure 7-20. Although this has the desired effect of brining the meter technically within tolerances, it is not an adequate remedy.

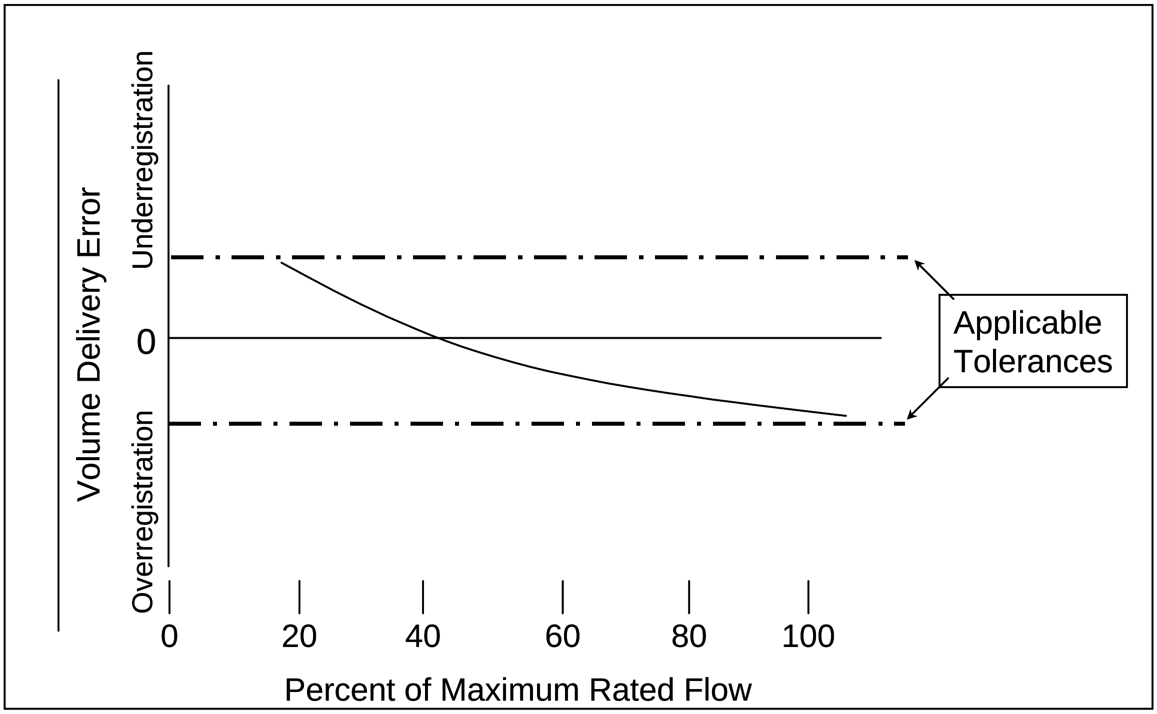

Figure 7-20. Adjustment of a Badly Worn Meter.

Because replacement or reconditioning is considerably more expensive than readjusting the meter, and usually means taking the system out of service for a period of time, the operator may prefer to attempt a remedy such as this. In the long run, he or she will probably simply be incurring further expense to have the system repaired correctly, but may argue that the meter is technically in compliance with weights and measures regulations. In such a situation, you may determine that the system does not conform with the requirements of the General code (paragraph G-UR.4.1., discussed in Chapter 6) that the equipment be “maintained in a proper operating condition.” To save yourself and the operator considerable time and expense, you should inform him or her of this requirement when results of the special Test strongly suggest that the meter is badly worn even though it is within tolerances.

In general, if the range of errors observed in the Normal and Special Tests approaches or exceeds the sum of the applicable tolerances for underregistration and overregistration, the meter is badly worn and replacement ore reconditioning is in order. In some cases, a recommendation that the meter be reconditioned may be appropriate even if the range of errors is somewhat smaller. This is especially true if the metering system is outside of one or more tolerances and will be rejected anyway on those grounds.

This situation is illustrated in the example we have been using. As the completed results for the Special Test show (Figure 7-21), the system is underregistering to a degree that exceeds the applicable tolerance (here, 0.97 gallons or 224 cubic inches). The range of meter errors between the second and third tests drafts is 483 cubic inches and indicates a considerable degree of meter wear. Even though the first and second tests drafts were well within tolerances, the system must be rejected and the operator should be informed that the meter is clearly in need of reconditioning.

Note that the three necessary corrections to the prover volume are determined and recorded in exactly the same manner as for the earlier uncompensated test draft.

DATE *AUGUST 15, 1998*	DEPARTMENT HEADING LPG METER TEST REPORT	TEST NO *5698*	TRUCK ID *AR 364*
NAME *PROPANE, INCORPORATED*		INSPECTOR: *LOU FISCHER*	
ADDRESS *123 MAIN STREET* STATE: *MD* ZIP: *01234*		OWNER: *S.W. STRATTON*	
MAKE OF METER: *LIQUIDMETER* MODEL: *8979* SN: *N1160*		REGISTER MODEL: *REGITRUE MODEL 124*	
METER SIZE (INCHES): *2.0* IN	TOTALIZER FINISH:	SERIAL NUMBER: *AB142*	
FLOW RATE: MIN *20 GPM* MAX *100 GPM*	TOTALIZER START: *79848*	PRODUCT: *LPG/PROPANE*	
THERMOMETER WE LL ☒ PRINTER ☒ TEMPERATURE COMPENSATOR: ☐ ELEC ☒ MECH	TOTAL PRODUCT: *RETURNED TO STORAGE*	SPECIFIC GRAVITY: *0.505*	
TOLERANCE APPLIED: ACCEPTANCE ☒ MAINTENANCE ☐		SECURITY SEALS INTACT AS FOUND? YES ☒ NO ☐	

Test Data	1st run	2nd run	3rd run	4th run
1. TYPE OF TEST RUN	NORMAL ✓ SPEC__ ATC ✓	NORMAL ✓ SPEC___ ATC___	NORMAL ___ SPEC✓ ATC___	NORMAL___ SPEC___ ATC ___
2. FLOW RATE	*98* GAL/MIN	*98* GAL/MIN	*23* GAL/MIN	GAL/MIN
3. METER TEMP (1/3 PROVER CAP)	*60* °F	*66.0* °F	*66.0* °F	°F
4. METER TEMP (2/3 PROVER CAP)	*60* °F	*66.5* °F	*67.0* °F	°F
5. TANK PRESSURE	*120* PSI	*119* PSI	*119* PSI	PSI
6. PROVER PRESSURE	*118* PSI	*117* PSI	*117* PSI	PSI
7. PROVER TEMPERATURE	*68.0* °F	*67.0* °F	*67.0* °F	°F
8. PROVER READING TO 0.05 GAL	*98.15* GAL	*98.90* GAL	*98.95* GAL	GAL
9. METER READING	*97.00* GAL	*99.00* GAL	*97.00* GAL	GAL
USE FOR UNCOMPENSATED RUN				
10. a. AVG METER TEMP (3 + 4) ÷ 2	----- °F	*66.25* °F	*66.5* °F	°F
b. TEMP DIFFERENCE (10a - 7)	----- °F	*-0.75* °F	*-0.5* °F	°F
c. TEMP CORR FACTOR (TABLE 2)	----- GAL/°F	*0.170* GAL/°F	*0.170* GAL/°F	GAL/°F
d. TEMP DIFF CORR (10b x 10c)	----- GAL	-0.13 GAL	-0.09 GAL	GAL
11. TEMP CORRECTED PROVER READING (10d + 8)	----- GAL	*98.77* GAL	*98.86* GAL	GAL
USE FOR COMPENSATED RUN				
10. VOLUME CORRECTION FACTOR AT PROVER TEMPERATURE (TABLE 4)	*0.986* GAL	----- GAL	----- GAL	GAL
11. TEMP CORRECTED PROVER READING (10 X 8)	*96.78* GAL	----- GAL	----- GAL	GAL
USE FOR EITHER RUN				
12. CORR FOR PROVER PRESSURE (TABLE 1)	*+0.02* GAL	*+ 0.02* GAL	*+ 0.02* GAL	GAL
13. CORR FOR PROVER TEMP (TABLE 3)	*+0.02* GAL	*+ 0.01* GAL	*+ 0.01* GAL	GAL
14. CORRECTED PROVER READING (11+12+13)	*96.82* GAL	*98.80* GAL	*98.89* GAL	GAL
15. METER READING (ROW 9)	*97.00* GAL	*99.00* GAL	*97.00* GAL	GAL
16. NET METER ERROR (14 - 15)	*-0.18* GAL	*- 0.20* GAL	*+1.89* GAL	GAL
17. PERCENT ERROR (ROW 16 ÷15) X 100	*-0.19* %	*- 0.2* %	*+1.95* %	%
18. TOLERANCE CALCULATION (ROW 15 X %TOL)	*+/- 0.97* GAL	*+/- 0.99* GAL	*+/- 0.97* GAL	GAL
19. DIFFERENCE BETWEEN ATC AND NON- ATC TEST RUN(S): (% ERROR ATC - % ERROR NON-ATC) = *0.19 % TO -0.2% = 0.01 %*				
REMARKS:				
ACTION TAKEN: ☐ APPROVED ☐ REJECTED ☐ CONDEMNED				(FORM REV 5/31/98)

Figure 7-21. Sample Report Form, Results of Special Tests.

Systems With Multiple Discharge Hoses

If you are testing a system with more than one discharge hose, you should follow the procedures described above using the hose that is used most frequently (if known). After you have completed these procedures, you should run additional normal tests using each additional hose.

Concluding the Test

When you are satisfied with the results for all performance tests specified in the EPO's, you should make sure that all product has been returned to the operator's tank and that you have taken a final totalizer reading. If an ATC has been deactivated, the operator should reactivate it and a new security seal should be installed (see Chapter 8). Then disconnect the prover from the system and, if no more tests are to be conducted that day, or if you are changing location, bleed the prover hoses. Only after the metering system and prover are secure should you proceed to the post-test tasks that are described in the next chapter.

Summary

The purpose of the Test component of a field examination is to determine whether the system being examined can perform within legal limits of inaccuracy (tolerances) under conditions that approximate, as nearly as possible, actual service conditions. The Test is comprised of several distinct procedures: some are designed to develop the operating characteristics of the system; others test for performance of specific elements or under specific conditions that may affect accuracy in commercial service. Before the Test is begun, a number of Pre-test Determinations must be performed to establish applicable tolerances and other test conditions. Guidelines for Test procedures are provided in the EPO's. The first official test draft is always made at the system's maximum discharge rate; if the system is equipped with an ATC, it is left activated for this draft. The second test draft is always uncompensated, and it performed at the system's maximum discharge rate.

Results of this draft should confirm those of the first test draft. The third test draft is a slow-flow test and is intended to indicate the condition of the meter. Comparison and interpretation of results obtained from various Test procedures can provide operators, servicepersons, and the weights and measures jurisdiction with important information regarding the current condition of the LPG liquid-measuring device(s) examined.