Chapter 5

Test Equipment, Report Forms, and Preliminaries to the Field Examination

Objectives

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

1. Identify and describe the use of items of test equipment employed in field examinations of LPG liquid-measuring systems.

2. Describe the setup, operation, and maintenance of an LPG liquid field standard prover.

3. Describe the steps in drawing an official test draft using an LPG liquid-field standard prover.

4. Understand the use of report forms and other official documentation.

Introduction

Safe, accurate, and efficient examinations of LPG liquid-measuring systems can only be performed if the inspector is equipped with the proper equipment and with the knowledge, skills, and experience necessary to use this equipment correctly. Because of the potentially hazardous nature of LPG, "quick fix" substitutions for items of proper equipment are not acceptable. If you begin an examination only to discover part way through that you do not have all the right equipment and have to return to your office to obtain it, you will end up wasting your own time and causing some hardship to the operator of the device, who has made arrangements for the equipment and an assistant to be available to you. You must be fully equipped to perform required procedures on the particular model or type of device that is scheduled for examination when you arrive at the site.

You are responsible for maintaining your test equipment in a safe and accurate condition. Field standard provers like those described in this chapter are precision measuring instruments designed for the conditions of field testing. However, they can be rendered imprecise by accidental damage, improper operation, or neglect of regular care and maintenance. This chapter presents an introduction to the basic equipment required for field examinations of LPG liquid-measuring systems. We will cover setup, use, and maintenance procedures that you will review and practice in Field Training. Your instructor will describe any additional equipment or procedures that are employed in your jurisdiction.

Basic Equipment

The following list includes the items of basic equipment required for an official field examination of any LPG liquid-measuring system:

- One or more dry chemical fire extinguishers, of the type described in Chapter 4.

- A first aid kit, supplied with the items recommended in Chapter 4.

- Protective gauntlet gloves and goggles, of the type and materials described in Chapter 4.

- A set of caution signs and markers, as described in Chapter 4.

- A calibrated field standard prover of the correct capacity for the type of metering equipment being examined (see below) and equipped with liquid intake and return and vapor return hoses with standard fittings.

- A heavy-duty 3-wire, 100-foot extension cord and a 3-prong receptacle adaptor to supply power for the prover return pump from a remote outlet. Size 10 neoprene-covered wire is specified.

- A heavy-duty grounding cable for grounding the prover.

- A complete set of adaptors to facilitate connections to various types of LPG liquid-measuring systems. You will probably need more fittings than those supplied by the manufacturer of the prover. A list of suggested fittings for non-standard connections is provided in Appendix B of this manual.

- A supply of matched and accurate liquid-in-glass thermometers, capable of registering temperatures from -30 °F to +130 °F in increments of 1 °F and at least 12 inches in length. (Matched thermometers are thermometers that read the same temperature. A 1 °F difference in readings can cause an error of as much as 40 cubic inches in the volume measurement of a 100-gallon test draft.) The thermometers should be accurate to within ±0.5 °F at +32 °F in cracked ice (that is, they should indicate a temperature of not more than +32.5 °F and not less than +31.5 °F when immersed in a container of cracked ice). Because these instruments are very fragile, you should have at least six of them at all times.

- A supply of ethylene glycol, to facilitate temperature transfer in thermometer wells. A bulb syringe should be used to fill the wells with this fluid.

- A can or stick of pipe joint compound, suitable for high-pressure liquid gas, to use in resealing pipe joints and fittings.

- A suitable set of hand tools, such as pipe and crescent wrenches, screwdrivers, etc., in an equipment box.

- A stop watch, preferably one with a lap timer, is necessary for timing flow rates, prover discharge and drainage, etc.

- Temperature and pressure correction tables designed for the prover you are using (see below).

- ASTM Temperature Table 24, used to calculate volume reduction to 60 °F for LPG products. (A copy of this table is included in Appendix B of this manual.)

- A copy of NIST Handbook 44, along with copies of any other codes or regulations applicable in your jurisdiction.

- A supply of official examination report forms used by your jurisdiction (see below).

- A supply of lead-and-wire seals, tags, stickers, and any other marking devices used by your jurisdiction.

You may find it useful to make up an equipment checklist, especially if different inspectors in your jurisdiction share test equipment.

LPG Field Standard Provers

The largest and most expensive item of test equipment you take into the field with you is the field standard prover. It is a precision volumetric field standard that provides a high degree of accuracy and reliability of measurement when operated and maintained correctly. Before we take a closer look at a modern LPG liquid prover, let us consider briefly the two basic methods of measurement that have been used in proving LPG liquid-measuring equipment.

Methods of Proving LPG Liquid-Measuring Systems

One of these is the gravimetric method. This type of measurement is based upon the fact that the volume of a known weight of a liquid at any given temperature and pressure can be calculated if its specific gravity is also known (the specific gravity of a liquid is the ratio of its density to that of water; see below). Therefore, if a container is filled with LPG and weighed, and the temperature and pressure of the liquid in the container are measured, it should be possible to determine from the observed weight (after subtracting the weight of the container), the volume that it contains. This could then be compared to the quantity registered by the metering device to determine the accuracy of the metering system.

The alternative method is volumetric proving. In this method, a standard volumetric measure is used to compare the volume actually delivered with the volume indicated by the measuring device. This description of both these methods is somewhat simplified. In the case of the volumetric method, the quantity indicated by the prover must be corrected to reflect changes in temperature and pressure between the metered liquid and liquid in the prover. Corrections must also be made for the effects of temperature and pressure on the volume of the prover. This might appear to make the gravimetric method preferable, but in fact the opposite is the case, since for the gravimetric method an accurate specific gravity of the product is a necessity, and this is not easily determined in the field. This, along with the uncertainties introduced by the use of a weighing scale, significantly reduces the

accuracy of the test. The volumetric method is in fact less complicated and more accurate for use in the field, and also approximates more closely the actual service conditions of a commercial delivery. For these reasons it is the recommended method, and the only one presented in this training manual.

Design and Operation of an LPG Prover

An LPG field standard volumetric prover should be designed and constructed according to general specifications that are provided by the Weights and Measures Division (WMD) of the National Institute of Standards and Technology. Any prover used for weights and measures field examinations should be calibrated according to Recommended Standard Operations Procedure No. 21 in NIST Handbook 145, "Handbook for the Quality Assurance of Metrological Measurements," or according to the procedures prescribed by your jurisdiction. Its accuracy should be re-certified periodically either by the National Institute of Standards and Technology, a State metrology laboratory, or a laboratory licensed by the State.

Before taking up details of the setup and operation of an LPG liquid prover, let us take an overview. Figure 5-1 is a simplified illustration of a prover connected to a metering system. There are three basic connections: a supply line from the system to the prover (actually the system discharge line or hose), a liquid return line from the prover back to the system storage tank, and a vapor return line from the top of the prover to the top of the vapor space of the system storage tank. (The prover should also be properly grounded to the system under test.)

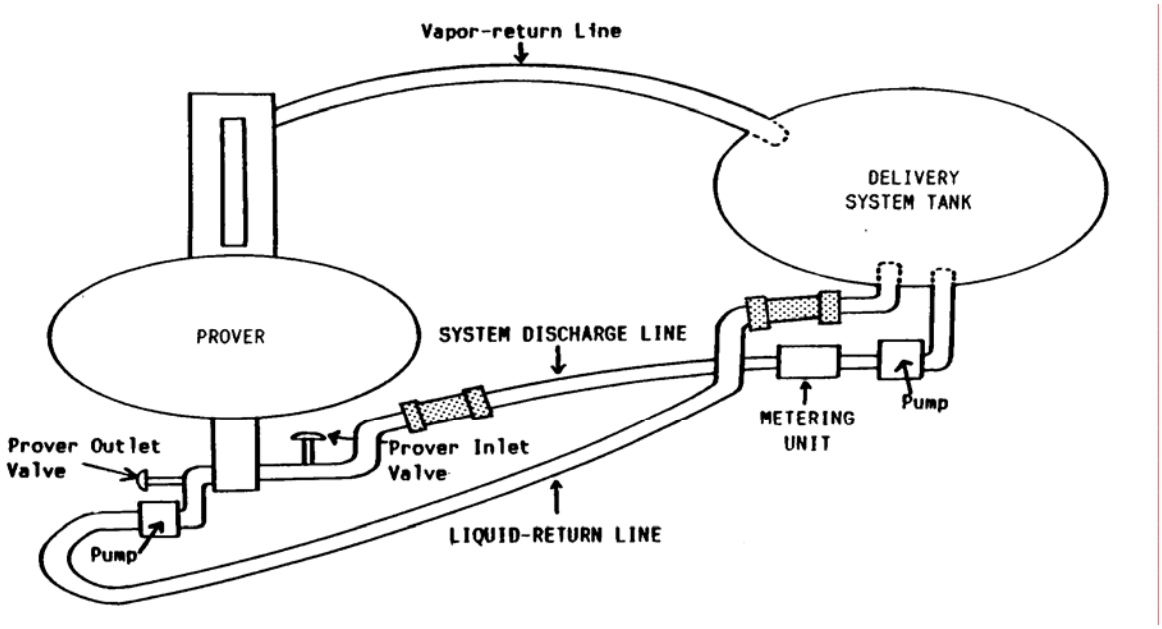

Figure 5-1. LPG prover and metering system connections.

Because the product must be maintained in its liquid state for accurate measurement, the prover is closed and pressure-tight and is connected in such a way as to become incorporated with the

metering system as part of a single closed system. After the system discharge line and the liquid return line are properly connected, the vapor return line connecting the top of the prover with the vapor space in the storage tank is then opened, permitting pressure inside the prover and the system vapor space to balance. It is important that this balance be achieved before delivery begins, because it assures that vapor inside the prover will be under sufficient pressure (the same as in the storage tank) to maintain the product in the same liquid state in the prover as when it went through the meter.

When the system pump has been engaged and the prover inlet valve opened, liquid LPG begins to fill the prover, pushing vapor from the top of the prover through the vapor return line and back into the vapor space in the storage tank. When the level of liquid in the prover reaches the upper neck of the prover, it becomes visible through a glass reflex gauge (see Figure 5-3). When the metering system register arrives at the next even gallon reading, the delivery is halted by closing the prover intake valve. The level in the gauge indicates the quantity of liquid that is contained in the prover; this reading provides the basis for determining meter error.

When drawing official test drafts, you will take temperature and pressure readings at the prover and record both the prover gauge reading and the register reading for the delivery before returning the liquid to the system storage tank. Before taking these readings, the vapor return line is closed to fix conditions in the prover and prevent changes while the data are being recorded. After you have recorded all required information for the draft, the liquid is returned to the system storage tank by opening the liquid return line and the vapor return line and turning on the prover return pump. When nearly all of the liquid has been returned to the system storage tank, the outlet valve is closed, leaving the prover in readiness for another test draft.

When you connect a pressure-equalizing (vapor return) line from the prover to the supply tank during the official test, it may be questioned by operators of commercial devices, especially in view of the accepted principle that, to assure accurate commercial deliveries of any liquid product through fluid meters, there should be no means of diverting measured liquid or vapor from the customer's tank to the supplier's tank. This is justified, however, when consideration is given to the difference between the two procedures -- the official test and the commercial delivery.

During the test, if the vapor in the prover at the start of the test run is not free to pass back to the supply tank in volume equal to the volume of the liquid metered into the prover, the vapor in the prover will be compressed into liquid as product is pumped into the prover. The compression of this vapor will cause an increase in temperature as well as in pressure. Subsequently, as the pumping of the liquid into the prover continues, some of the vapor will condense into liquid.

It would be extremely difficult to calculate accurately the volume of the liquid that results from vapor condensation, and any such liquid obviously would have to be corrected for, or the test result would be adversely affected. Both calculation and correction are avoided through the use of the pressure-equalizing line, which permits vapor in the prover to pass to the supply tank and the pressures in the supply tank and in the prover to remain equal prior to and during the test run.

On the other hand, in the case of a commercial delivery, the vapor in the customer's tank is fuel that rightfully belongs to the customer and as such should not be piped back to the supplier's tank. The

accuracy of the meter itself during commercial delivery is not affected by the use or non-use of a pressure-equalizing line, unless the rate of flow is reduced below the accuracy limit of the meter.

Many operators believe that the use of a vapor return line increases the efficiency of their delivery system since the pump does not have to overcome rising back pressure as the product level rises inside the receiving tank. This argument had some validity before receiving tanks with spray fill pipes (described in Chapter 2) were in common use. However, this design, which is now virtually universal in new tanks, promotes condensation and thus reduces pressure buildup to the degree that the effects on pump efficiency and discharge rate are negligible.

An LPG liquid meter prover is very special equipment, designed and constructed for high internal pressures. Because of the product pressure, the prover must be constructed for the working gauge pressure of at least 250 psi, as required by the American Society of Mechanical Engineers (ASME) Unified Pressure Code.

The prover may be stationary, or may be mounted on the bed of a truck or trailer. The installation should be such as to provide easy access to all valves and fittings and ease in reading the upper and lower gauges. The pump, motor, and hoses provided with the prover must be designed for use with LPG products. All electrical connections must be explosion-proof, and all valves, gauges, fittings, etc., should be suitable for use with LPG.

LPG liquid provers are available with different capacities. Those most commonly used by weights and measures jurisdictions are 25-, 50-, and 100-gallon provers. According to test procedures set forth in Handbook 44, test drafts must equal at least the quantity of product that the metering system is capable of delivering at its maximum flow rate in one minute. Accordingly, a 50-gallon prover would be appropriate for testing systems having a maximum discharge rate that does not exceed 50 gpm (as is the case for most LPG retail motor-fuel devices), and a 100-gallon prover would be chosen for systems that do not develop flow rates in excess of 100 gpm (as is the case for most other retail devices).

Now let us take a closer look at the prover itself. The principal features and components of a typical LPG prover are illustrated in Figure 5-2. The body of the prover is spheroidal, with top and bottom gauge-glass necks. The upper neck reflex gauge in the upper neck is used to read the quantity of liquid in the prover when it is filled. We will take a closer look at the design of this gauge shortly.

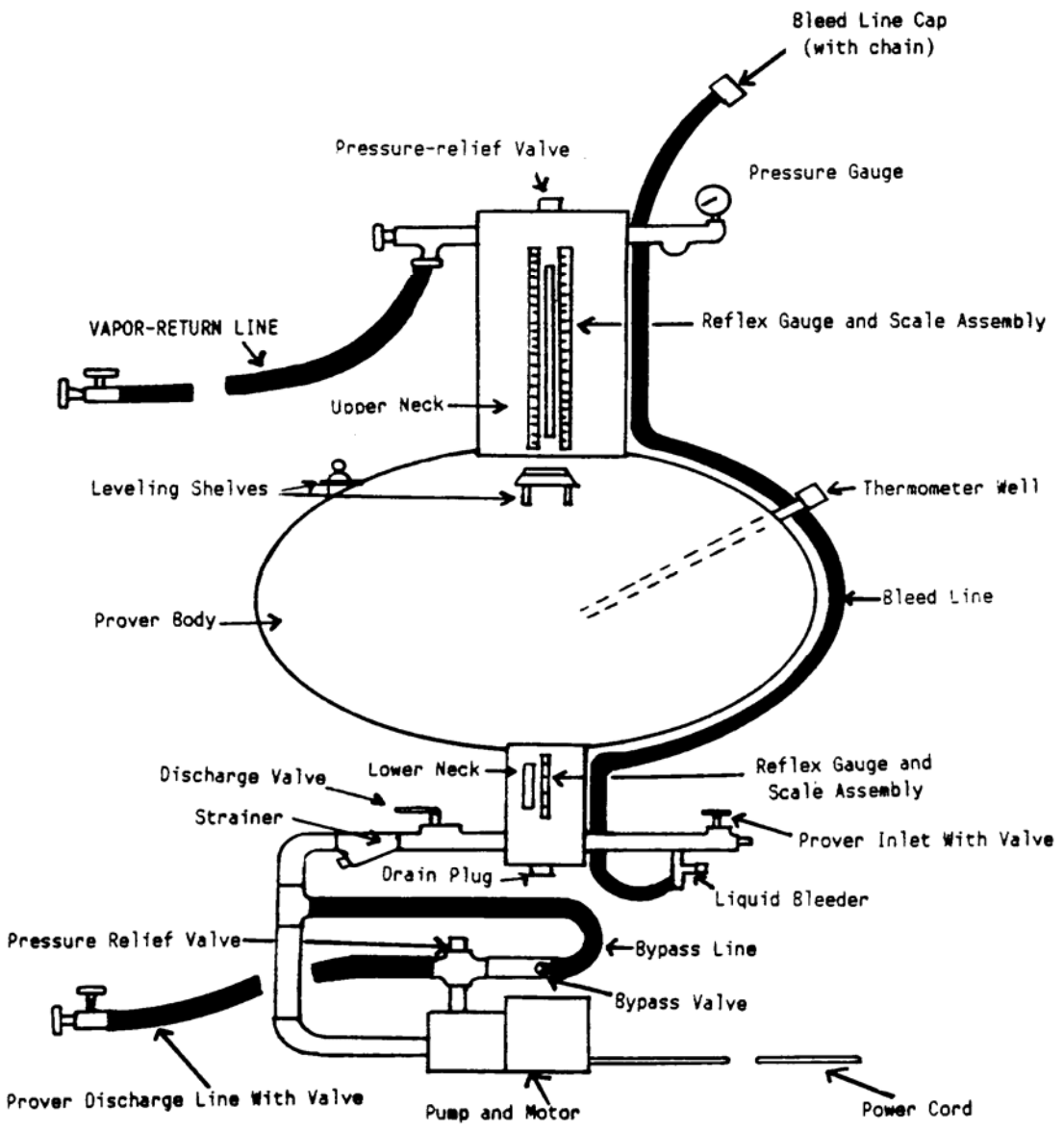

Figure 5-2. LPG liquid prover.

The lower neck reflex gauge serves two purposes. First, it allows you to monitor the return of liquid to the storage tank so that you can halt the return by closing the outlet valve before liquid is drained completely; when the falling liquid level appears at the top of the lower neck gauge, close the prover discharge line valve. The other function of the lower neck gauge is to permit you to "zero" the prover before the next test draft. If the quantity of liquid remaining in the bottom of the prover was not known, the capacity of the prover itself would be indefinite. So the lower gauge has a zero line. After the discharge has been halted and the pump switched off, you can adjust the level of liquid in the gauge to coincide with this zero line (the procedure for doing this will be explained below).

Adjusting the liquid level in the lower neck gauge to the zero line fixes the capacity of the prover for the next run at exactly its nominal capacity.

Notice that the prover discharge line includes a strainer and a pump bypass circuit. Both of these are intended to protect the pump. The removable strainer traps solid contaminants before they can be drawn into the pump; it should be cleaned or replaced at regular intervals to prevent its becoming clogged, which could restrict flow sufficiently to strain the pump and produce vapor in the return line.

The prover pump bypass circuit is similar in function and design to that found in the metering system; the spring-loaded bypass valve is calibrated to open when pressure at the pump outlet rises too high, as occurs between the time when the delivery is halted at the discharge line valve and the pump is turned off. This permits liquid to circulate through the pump and bypass line to relieve the pressure.

A thermometer well extends into the center of the prover body. During test drafts, a thermometer is inserted into the well to record the temperature of the delivered product. As you will learn, a temperature reading taken at the conclusion of the draft is essential for making temperature corrections to the prover volume reading. One of these corrections compensates for expansion or contraction of the prover container itself in response to ambient temperature (including the temperature of the liquid contents), which can have a significant effect on test results. The prover is usually calibrated at a temperature of 60 °F. At any other temperature, its capacity will be more or less than its calibrated capacity because the metal of which it is constructed expands when heated and contracts when cooled.

The degree of this change in volume depends upon the material from which the prover is made. Most LPG provers are made of low-carbon steel. A volume correction table for low-carbon steel provers is included in Appendix B of this manual. For stainless steel provers, the applicable coefficient of cubical expansion for the stainless steel composition of the prover should be used to calculate the appropriate correction. We will look more closely at procedures for calculating temperature corrections in Chapter 7.

The prover will also tend to expand in response to the increase in pressure that occurs when it is balanced with the metering system. Normally, this expansion will not be more than several cubic inches, but it must be known and the correction made to assure accurate and fair test determinations. The prover is, therefore, equipped with a pressure gauge, located at the top of the upper neck (see Figure 5-2). At the conclusion of a test draft a reading is taken from this gauge and used to determine the appropriate correction from a pressure correction table, which gives corrections for various prover pressures (usually in increments of 10 psi). Because every prover responds slightly differently to pressurization, a table should be prepared for each prover when it is calibrated. You should carry a copy of this table with you into the field and keep a copy of it in your office.

Leveling shelves with spirit levels are mounted on the top portion of the prover, one on the front and one on a side. These make it possible to establish the prover in a level condition from front to back and side to side. This is necessary because the liquid level that appears in the upper and lower

gauges -- and hence the gauge reading -- can be affected by an out-of-level condition. We will discuss procedures for leveling the prover shortly.

A bleed line runs from the prover inlet to a point above the top of the prover. This line is used to bleed small quantities of product from the prover, venting it to the atmosphere. A bleeder valve is located at the point where this tube joins the inlet line. At its upper end, a removable cap covers the tube. When the cap is removed and the bleeder valve opened, internal pressure forces product through the tube and into the atmosphere in the form of vapor. The use of this bleed line during normal test procedures will be described below.

Reading the Prover Gauge

Before turning to the setup and operation of the prover, we should have a closer look at the liquid-level gauge assembly located on the upper neck of the prover, since this is where the prover is actually read. Figure 5-3 is a close-up of the gauge assembly.

On either side of the liquid-level gauge are scale plates, which are mounted on brackets that permit their height to be adjusted for calibration. The scale plates are normally sealed to the bracket assembly with lead-and-wire seals to assure that their height has not changed. The range of the scales should be no less than 1.5 times the sum of the largest applicable tolerances for the system being tested. Therefore, under current requirements, a 100-gallon prover should have a scale capacity of no less than 700 cubic inches, or 3.00 total gallons. (The largest applicable tolerance is currently plus or minus 1% which corresponds to plus or minus 1 gallon or 231 cubic inches on a 100-gallon test draft. Since the largest applicable tolerance is 231 cubic inches in either the plus or minus direction, the sum of the largest applicable tolerances is 231 + 231 = 462 cubic inches. The range of the scale plate must be no less than 1.5 times 462 cubic inches or 693 cubic inches, which is rounded to 700 cubic inches for convenience.)

One scale may be graduated in cubic inches or (as in the example Figure 5-3) in units of the metric system (liters), the other in decimal gallons. (As you will learn in Chapter 7, performance tolerances are expressed in cubic inches. However, since computations for volume corrections use decimal gallons, the use of decimal gallons facilitates these computations. One unit can easily be converted to the other.) NIST recommends that the smallest graduated intervals for these scales have values no greater than 10 cubic inches (or 0.20 liters) and 0.05 gallon.

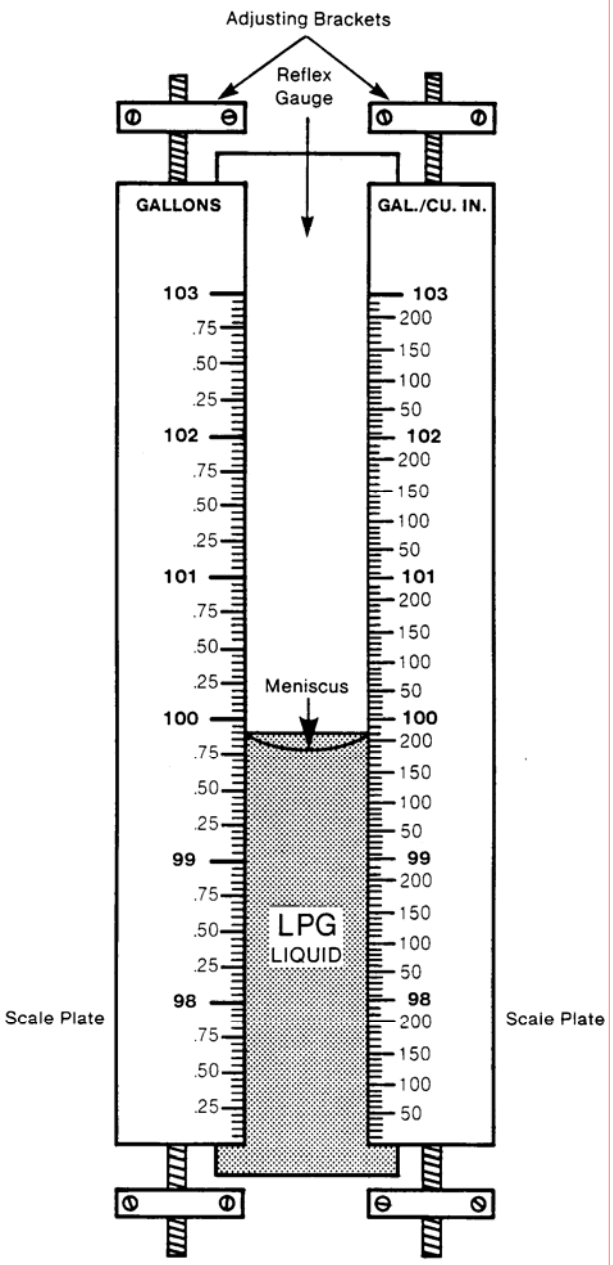

Figure 5-3. Gauge and scale assembly.

You should be at eye level with the liquid level in the gauge when reading the gauge. The top surface of the liquid may be slightly concave, and so when viewed from this position may appear to have two surfaces, one flat and a lower one that is slightly curved. This curvature results from capillary attraction of liquid to the gauge glass. The apparent curved level when viewed from the side is called the meniscus.

When reading the gauge you should observe and record the scale graduation that coincides most nearly with the lowest part of the meniscus, as depicted in Figure 5-4 (the curvature of the meniscus in this drawing has been exaggerated somewhat for illustrative purposes). If the bottom of the meniscus appears to be exactly in the middle of a graduated interval, record the higher value.

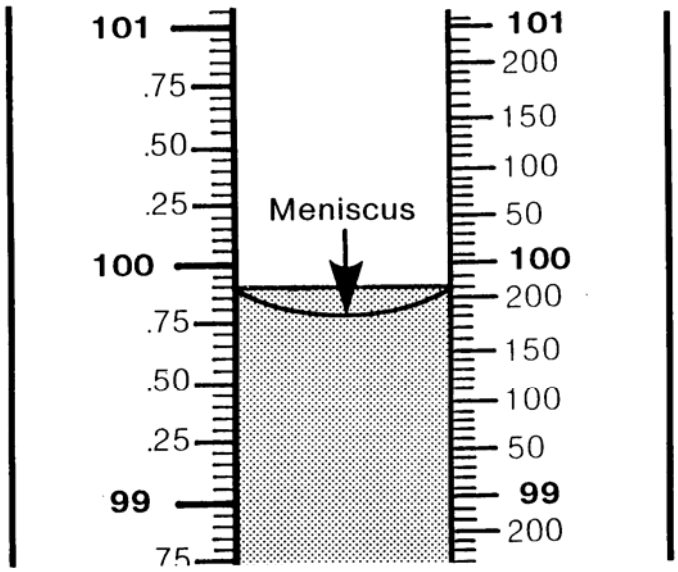

Figure 5-4. Reading the prover gauge.

For example, the bottom of the meniscus shown in Figure 5-4 appears to coincide with a point exactly midway between the graduations that represent 99.75 and 99.80 gal on the left-hand scale, and coincides most closely with the graduation representing 99 gal plus 180 cu in on the right-hand scale. In this case, the reading should be recorded either as 99.80 gal or as 99 gal plus 180 cu in.

Setting Up the Prover

Now that you understand the basic design and operation of the prover, let us look at procedures for setting it up and preparing it to accept a test draft. Note that several of these steps should be performed by the operator of the metering system. Specifically, you should require that the operator, who is familiar with the metering equipment, stand by to make the connections between the prover and the system. The operator should also be responsible for operating the system during the test. If you make the connections or operate the system incorrectly and damage to the metering system results, you will be responsible for that damage.

NOTE: You should always double check everything before starting the test.

You will practice and review these procedures thoroughly in the course of your Field Training. Test procedures are covered in detail in Chapter 7 of this manual. As always, the cardinal rule is: SAFETY FIRST.

- Position the prover on a level surface at least 100 feet from any source of spark, flame, or static discharge, and near to a 110-volt power source. The location of the prover should be such that you can see the meter and register from the position from which you operate the prover valves.

- Always chock the trailer or vehicle on which the prover is mounted to be sure it does not shift or roll away during testing. Check to be sure that the chocks are still secure when the prover is full of product.

- Position fire extinguishers where they will be within easy reach if needed.

- Position caution signs to prevent vehicles or pedestrians from moving through the area adjacent to the prover and meter. (Traffic patterns are also a factor in selecting test site location.)

- Ground the prover to a suitable ground using the grounding cable included with your equipment.

- Check fittings for adaptors required for connecting the prover to the system.

- Note and record totalizer reading on the metering system register (the reason for this step will be explained in Chapter 7).

- Inspect thermometer wells for dirt and other obstructions; clear them as necessary and fill with ethylene glycol.

- Check prover valves to make sure that they are closed tight. Also check bleed valves.

- HAVE THE OPERATOR:

    1. connect the system discharge (delivery) hose to the prover inlet line. Make sure that the correct fitting is used and that the seal is tight.

    2. connect the vapor return line to the system tank vapor connection.

    3. connect the prover liquid return line to the system liquid inlet.

- Check all connections to assure yourself that they are tight and that prover valves and bleeders are fully closed.

- Open vapor return line valves at the prover and the system storage tank. Open these valves slowly, since pressure difference between the system and the prover is likely to be substantial. Avoid abrupt pressurization of the prover.

- Observe pressure gauges at the meter and at the prover. Keep in mind that the metering system gauge may not be accurate. If there is a difference in readings, record it and proceed.

- Install thermometers in meter and prover thermometer wells.

At this point the prover is balanced with the metering system and ready to accept delivery of LPG liquid. However, the setup procedure is not yet complete; the prover must be leveled and it must be "wet", and these conditions can only be established when it is full of liquid. Before describing these procedures, let us consider briefly what is involved in "wetting" the prover, and why it is necessary.

LPG liquid provers are calibrated to "deliver" their rated capacity when filled to the capacity line on the upper neck gauge. In fact, they contain slightly more than their rated capacity when full. The reason for this is that LPG, like any other liquid, has a tendency to cling to surfaces with which it comes in contact. After the prover has been drained, a film of liquid is present on the inner surfaces of the container.

Because it is impracticable to remove the clingage between test drafts, the prover is calibrated when it is wet, that is, with clingage already present. Accordingly, the prover should be wet before it is used to measure an official test draft. In the following procedure, the prover is filled, then emptied and allowed to drain for 30 seconds (the drain period that was used when the prover was calibrated). At the end of this period, the liquid remaining in the bottom of the container and return line is zeroed using the bottom neck gauge. The prover is then "wet". After the prover has been wet, the same drain procedure must be followed for all subsequent test drafts to assure that the calibrated volume and the actual volume are the same.

Wetting the prover is part of the setup procedure described below. However, this step must be repeated for every meter that is tested, regardless of whether the prover has previously been used at the same test site. This "wet down" not only wets the inside of the prover, but also forces the evacuation of any vapor left in the prover from a previous test -- vapor that may be of a different physical composition. The process of wetting the prover by filling it with liquid and then draining it also tends to bring the prover to the temperature of the product that is introduced during subsequent official test drafts.

Even though the procedure described below is similar to that used for official test drafts, the "wet down" is not an official test draft, and results obtained should not be used in determining the accuracy of the metering system. However, pressure readings are recorded in order to verify that the metering system and prover remain in a correctly balanced condition (as described above) while product is actually being delivered to the prover. If this balanced condition cannot be maintained during the wet down, the cause of the problem (usually a restriction in the vapor return line from the prover to the system tank caused by an undersized hose, valve, or fitting) should be remedied since results from subsequent official test drafts will be invalidated by a significant divergence in pressure readings.

- HAVE THE OPERATOR activate and engage the system pump.

- Open the prover inlet valve. Again, this must be done slowly to prevent hydraulic shock.

- As liquid fills the prover note pressure readings at the system and prover to determine that a balanced condition is being maintained. Readings within 5 psi of those noted when the prover was pressurized should be maintained consistently throughout the filling process. Widely divergent or varying readings will probably indicate a restriction in the vapor return line. As mentioned above, the cause must be discovered and remedied before drawing an official draft.

- Close the prover inlet valve when the liquid level in the prover upper neck gauge reaches the capacity line.

- HAVE THE OPERATOR disengage the system pump.

- With the prover full of liquid, level the prover from back to front and side to side, using the levels mounted on the prover. If the prover is mounted on a truck bed or trailer, jacks should be manipulated to raise the bed so that it is not resting on the vehicle wheels before leveling. (This step need only be performed the first time the prover is filled after being moved.)

- Open prover liquid return (discharge) line valve slowly.

- Start the prover return pump.

- As product is returned to the system storage tank, monitor the lower neck gauge.

- As the liquid level appears in the top of the lower neck gauge, quickly close the liquid line return valve.

- Start stopwatch.

- Turn off the prover return pump.

- During the 30-second drain period (as indicated by the stopwatch), zero the liquid level in the lower neck gauge of the prover. If the liquid level is above the zero line, open the bleed valve located in the liquid inlet line while monitoring the liquid level in the gauge; a small amount of product will be vented to the atmosphere, lowering the level in the gauge. Close the bleed valve when the level is at the zero line. If the liquid level in the gauge is below the zero line at the start of the 30-second drain period, or if it falls below it during the drain period, have the operator start the system pump and add sufficient liquid to the prover to bring the level above the zero line, then bleed off the excess with the bleeder valve, as described above. In either case, the liquid level in the lower neck gauge should be on the zero line at the end of the 30-second drain period.

The prover is now wet and level and ready to receive an official test draft.

Test Drafts

As you will learn in Chapter 7, an official field examination of an LPG liquid-measuring system requires a minimum of three test drafts, and sometimes several more. The basic procedure is similar to that described above for wetting the prover, but there are a few important differences and several additional steps.

Before beginning delivery:

- Check the prover for correct zero condition. A level slightly above the zero line is not a cause for concern, since it probably reflects clingage that has continued to drain into the bottom of the prover. If the level is below the zero line, however, some liquid has evaporated or leaked out. Check and correct the condition. Then re-zero the prover as described earlier.

- HAVE THE OPERATOR start the system pump to pack the delivery hose.

- Reset the system register so that it indicates zero exactly.

- During delivery:

- Monitor pressure gauges throughout the delivery. If a significant pressure difference from initial readings is observed (5 psi or more), condensation may occur. Because condensation in the prover will invalidate test results, the draft should be halted, the prover drained, and the condition remedied before beginning the next draft.

- Use your stopwatch to monitor the flow rate. Start timing when the system register indicates 10 gallons delivered. Reasons and the procedure for this step are explained in Chapter 7.

- Except when a system equipped with an automatic temperature compensator is being tested with that device activated (that is, a "compensated" test draft; see Chapter 7 for details) observe and record meter temperatures at 35 and 70 gallons for a 100-gallon draft, or at intervals corresponding to one-third and two-thirds of the prover capacity if the prover is a different size. Temperatures should be recorded to the nearest one-half degree. These readings are needed for making temperature corrections at the conclusion of the test.

- Halt delivery at an even gallon on the meter as soon as possible after the liquid level appears in the prover upper neck gauge, by closing the prover inlet valve. You should reduce the delivery rate as soon as possible after liquid appears in the upper neck gauge in order to make the shutoff precise; this is done by having the operator drop the pumping speed and throttling the prover inlet valve.

After delivery has been halted:

- HAVE THE OPERATOR turn off the delivery system pump.

- Close the vapor return line to fix pressure and temperature inside the prover.

- Record the prover pressure and temperature. Record the pressure to the nearest pound-per-square-inch. (See Chapter 7 for an explanation of the use of these data.)

- Record meter and prover readings. If bubbles appear in the prover gauge, wait until they have subsided before taking a reading. If bubbling does not subside, vaporization is probably the result of temperature difference between the liquid and the prover (this is especially likely if the outdoor temperature is either very hot or if the prover has not already been filled with several drafts). It may be necessary to flush the prover with product one or more times to reduce the difference. Record the prover reading as described above. If the register has not stopped exactly on an even graduation, record the indication to the nearest 1/10th of a graduation.

- Open the vapor return line.

- Return product to the delivery system. Be sure to observe the correct drain procedure and the 30-second drain period described above.

Maintenance of the Prover

The following are general maintenance procedures for an LPG liquid prover. Be especially careful to note any damage that has occurred to the prover, any performance that seems abnormal to you, and especially any leaks, and report these observations to your supervisor immediately. If repairs are required, qualified service personnel must make them and the prover recalibrated if necessary before it is returned to service. Your jurisdiction should have a regular program of re-inspection and re-certification for LPG provers.

- After the last delivery at a particular site or the last delivery of the day, bleed the prover hoses. This must, of course, be done in an area where there is no danger of ignition. Remember that LPG vapor is heavier than air, and that venting vapor in an upward direction will promote dilution and dissipation better than if the valve is pointed downward.

- Store vapor and liquid return hoses carefully to avoid damage and crimping.

- Clean dirt from fittings and connections at the end of an examination and at the end of each day. Make sure that inlet and outlet connections, including the bleed line, are capped securely and that adaptors and other fittings are stored in a manner that will minimize the possibility of damage during transportation.

- Cover the thermometer well when it is not in use and check regularly to make sure it is clean. Never leave a thermometer in the well while the prover is being transported. Clean dirt from thermometers and store them carefully.

- Check the strainer in the liquid return line regularly. Clean or replace the strainer if it shows signs of excessive contamination.

- The prover container should not be evacuated of LPG vapor or bled to atmospheric pressure. If this is done, moisture-laden air may enter the prover, and water vapor condensing inside the prover may corrode the inner surfaces of the container.

- Follow manufacturer's instructions for lubricating the return pump and servicing valves.

Report Forms

Every official action you take must be recorded. Reports of your activity are used not only for your own recordkeeping, but also by your jurisdiction for a variety of administrative, research, and planning purposes. For examinations of LPG liquid-measuring systems you will have to keep records of:

- the device(s) examined,

- the findings of your examination,

- the official disposition regarding approval or rejection of each device, and

- actions taken as a result of that disposition.

This list represents a minimum set of required information. It is quite probable that your jurisdiction will require additional items.

The Uniform Weights and Measures Law, which has been adopted by most of the States, requires that adequate records be maintained. However, these statutes make little or no specification of detail for the official records.

A good report form should:

- Be complete enough and in a suitable form so that it may be the primary record; that is, it should not be necessary for someone to copy the report information onto other records.

- Contain space for recording all the test data you collect and use when you follow the Examination Procedure Outline.

- Give the owner or operator of the metering equipment a clear and specific understanding of the compliance or noncompliance of his or her equipment and the official action taken as a result of examination findings.

- Serve as a guide to servicepersons in providing service for a rejected device.

- Provide an historical record of individual devices and commercial operators, with necessary data from which statistics can be derived.

- Be of a clear and straightforward design, easy to use and understand.

At the present time, every jurisdiction uses its own report forms and reporting procedures. Your instructor will explain the forms and procedures used in your jurisdiction. A sample form is provided on the next page. The sample report form shown on the following page was designed for recording official test data and other relevant information for LPG liquid-measuring devices. It has the features described above and will be used for illustrating the recording of test data and computations that are covered in Chapter 7 of this manual.

DATE	DEPARTMENT HEADING LPG METER TEST REPORT	TEST NO	TRUCK ID
NAME		INSPECTOR:	
ADDRESS STATE: ZIP:		OWNER:	
MAKE OF METER: MODEL: SN:		REGISTER MODEL:	
METER SIZE (INCHES)	TOTALIZER FINISH:	SERIAL NUMBER:	
FLOW RATE: MIN MAX	TOTALIZER START:	PRODUCT:	
THERMOMETER WE LL ☐ PRINTER ☐ TEMPERATURE COMPENSATOR: ☐ ELEC ☐ MECH	TOTAL PRODUCT: *RETURNED TO STORAGE*	SPECIFIC GRAVITY:	
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	GAL/MIN	GAL/MIN	GAL/MIN	GAL/MIN
3. METER TEMP (1/3 PROVER CAP)	° F	° F	° F	° F
4. METER TEMP (2/3 PROVER CAP)	° F	° F	° F	° F
5. TANK PRESSURE	PSI	PSI	PSI	PSI
6. PROVER PRESSURE	PSI	PSI	PSI	PSI
7. PROVER TEMPERATURE	° F	° F	° F	° F
8. PROVER READING TO 0.05 GAL	GAL	GAL	GAL	GAL
9. METER READING	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 5.5. Sample Report Form.

Summary

The correct test equipment and its proper operation, care, and maintenance are essential to safe, accurate, and efficient examinations of LPG liquid-measuring systems. Two basic methods have been employed in testing LPG systems: the gravimetric method and the volumetric method. The latter is considered more accurate and efficient for testing in the field and approximates more closely the actual operating conditions of a commercial delivery.

The field standard LPG liquid prover is a precision test instrument. Before it can be used to perform volumetric tests it must be set up correctly. Procedures for prover setup include making connections to the metering system and balancing, leveling, and wetting the prover. Procedures for drawing test drafts are similar to those used in wetting the prover, but include several important differences and additional steps. Regular and proper maintenance of the prover is necessary if it is to perform accurately and reliably in the field.

Report forms, which are used to record all official activities of the weights and measures official, are an essential item of standard equipment for field examinations. Their design and use must be clearly understood.