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ON OF LIQUEFIED PETROLEUM GAS LIQUID-MEASURING DEVICES

A Manual for Weights and Measures Officials





NATIONAL EUREAU OF STANDARDS HANDBOOK 99



U.S. DEPARTMENT OF COMMERCE

EXAMINATION OF LIQUEFIED PETROLEUM GAS LIQUID-MEASURING DEVICES

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U.S. DEPARTMENT OF COMMERCE John T. Connor, Secretary

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Foreword

This publication is one of a number of Handbooks of the National Bureau of Standards designed to present in compact form comprehensive technical guides for State and local weights and measures officials.

This particular Handbook is the second of a series that will treat the examination of individual types of measuring devices. The entire series will succeed National Bureau of Standards Handbook 45, *Testing* of *Measuring Equipment*. Each of the several types of measuring devices is being considered separately in acknowledgment of the increasing specialization in weights and measures supervision, the rapidly developing technological character of commercial measurement, and the everchanging equipment utilized in the measurement process.

Authority for such activity on the part of the Bureau is found in basic legislation (64 Stat. 371) wherein the Bureau is authorized to undertake, among others, the following functions: "Cooperation with the States in securing uniformity in weights and measures laws and methods of inspection," and "The compilation and publication of general scientific and technical data resulting from the performance of the functions specified herein or from other sources when such data are of importance to scientific or manufacturing interests or to the general public, and are not available elsewhere * * *."

This Handbook has been published in "pocket" size to further its usefulness to the official in his field operations.

Although this Handbook is prepared primarily for use by weights and measures officials of the States, counties, and cities, it is believed that the information presented will be useful to manufacturers and commercial and industrial establishments interested in the measurement of liquefied petroleum gas.

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EXAMINATION OF LIQUEFIED PETROLEUM GAS LIQUID-MEASURING DEVICES

Malcolm W. Jensen

A manual for State and local weights and measures officials, describing the devices, testing equipment and its calibration, inspecting and testing procedures, and a reporting system.

Hazardous Substance Warning

Inspectors are cautioned to exercise extreme care throughout the inspection and test of devices dispensing this product. Liquefied petroleum gas is a compressed flammable product that may have a vapor pressure as high as 175 to 200 pounds per square inch at 100 °F.

Liquefied petroleum gas in the liquid state will cause severe burns if it comes in contact with the skin; consequently, protective gloves with gauntlets should be worn by the inspector whenever he is working around a supply source. It may be advisable for the inspector to carry safety glasses with the prover and use them during tests to protect the eyes (especially until he is experienced with the equipment).

The product is flammable.¹ When testing is in process, appropriate fire extinguishers (see Appendix) should be readily available. An area in which testing is to take place should be free of open flame and other sources of ignition. The inspector is cautioned that it is better to allow a burning leak that cannot be stopped to continue to burn rather than to allow the gas to escape and hazard an area. In such a case, large quantities of water should be used to wet down any flammable material near the flame. In general, a liquefied petroleum gas "leak" flame should be extinguished with a fire extinguisher only if this is necessary to reach a valve or some other means to cut off the flow of the product.

¹ See Standard Number 58, Standard for the Storage and Handling of Liquefied Petroleum Gazes, published and sold by National Fire Protection Association, 60 Battery March Street, Boston 10, Massachusetts, and included in Volume 1 of NFPA Codes, that may be found-in many libraries.

A liquefied petroleum gas liquid-measuring device may be defined as a system, including a mechanism or machine of the meter type, designed to measure and deliver liquefied petroleum gas in the liquid state by definite volume, whether installed in a permanent location or mounted on a vehicle. Means may or may not be provided to indicate automatically, for one of a series of unit prices, the total money value of the liquid measured.

Liquefied petroleum gas (referred to herein as LP Gas) is defined as petroleum product composed predominantly of any of the following hydrocarbons, or mixtures thereof: propane, propylene, butanes (normal butane or isobutane), and butylenes.

Accordingly, an LP Gas liquid-measuring device is an entire dispensing system in which there is accomplished measurement of the liquid product; thus there is included the supply vessel, the pump, the piping, the valving (including any manifolding), the vapor separator, the metering device, the back-pressure device, and the discharge hose and valve.

2. CLASSES OF COMMERCIAL DEVICES

In use in commercial service are three classes of LP Gas liquid-measuring devices. These are defined as follows in National Bureau of Standards Handbook 44:²

RETAIL DEVICE.—A device used for single deliveries of liquefied petroleum gas for domestic use and, in addition, any motor-fuel device.

MOTOR-FUEL DEVICE.—A stationary device used for retail deliveries of liquefied petroleum gas as motor fuel to the fuel tanks of individual highway vehicles.

WHOLESALE DEVICE.—Any device other than a retail device.

Examples of "retail devices" are those installed on vehicle tanks and used to measure LP Gas as it is delivered to the storage tanks at residences where it ultimately will be used for domestic purposes, and retail dispensers similar to those in gasoline service stations (called motor-fuel devices), from which LP Gas is dispensed to the fuel tanks of automobiles or trucks in which it serves as engine fuel. However, a device installed on a loading rack and used to measure LP

² National Bureau of Standards Handbook 44, Specifications, Tolerances, and Regulations for Commercial Weighing and Measuring Devices, available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402.

Gas as it is delivered to a vehicle tank for resale is a "wholesale device." (Thus, in general, retail devices are measuring LP Gas for individual sales to consumers; whereas wholesale devices are measuring the product sometime prior to the retail sale, and the product measured through wholesale devices will be measured at least one additional time.)

3. TESTING METHODS

Two separate and distinct testing methods have been applied to LP Gas liquid-measuring devices-the "gravimetric test" and the "volumetric test." The gravimetric test involves the use of a receiving vessel that is not a standard measure, a weighing scale, and means of determining the specific gravity of the delivered product. (The field determination of the specific gravity of the product, which cannot be accomplished precisely, reduces the accuracy of the gravimetric test.) In the volumetric test, a standard volumetric measure is used to compare volume actually delivered with volume indicated on the commercial device. volumetric test is considered to be the method that more nearly approximates the actual operation of the measuring device, and this test is less complicated and more accurate, thus more appropriate for field operations of the weights and measures official. The test with a specific type volumetric prover will be described herein.

The volumetric test is conducted with a connection between the standard measure (meter prover) and the tank supplying the liquid-measuring device. The purpose of this connection is to provide a "balanced" condition between the vapor pressure in the supply tank and the vapor pressure in the prover; that is, a condition in which the pressures are equalized between the supply tank and the prover. As the metered liquid is pumped into the prover, this liquid displaces an equal volume of vapor from the prover. This vapor in turn passes from the prover, through the pressureequalizing line, back to the supply tank.

The inspector's action in connecting a pressure-equalizing line from his prover to the supply tank during the official test 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, this vapor will be compressed as liquid is pumped into the prover. The compression of this vapor will cause an increase in temperature as well as 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 pressureequalizing 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, during, and immediately following 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 nonuse of a pressure-equalizing line, unless that rate of flow is reduced below the accuracy limit of the meter.

4. TESTING APPARATUS—VOLUMETRIC PROVER

4.1. Description.—An LP Gas meter prover such as is recommended is illustrated in figure 1 and shown schematically in figure 2. This is very special equipment, designed and constructed for high internal pressures.

The body of the prover is spheroidal, with top and bottom gage-glass necks. Because of the pressure of the product, the prover must be constructed for a working pressure of 250 p.s.i.g. (pounds per square inch, gage) under ASME (American Society of Mechanical Engineers) 1956 Unfired Pressure Vessel Code.³ The prover capacity should be at least 50, and preferably 100, gallons. (Testing drafts should be equal to at least the amount delivered by the device under test during one minute at its maximum discharge rate.)

The prover may be either stationary, truck mounted, or trailer mounted. The installation should be such as to provide easy access to all valves and fittings and ease in reading

 $^{^3}$ Available from American Society of Mechanical Engineers, 345 East 47th Street, New York, N.Y., 10017.

both the upper and lower gages. The prover must be equipped with a pump and motor designed especially for use in LP Gas service. All electrical connections must be explosion-proof.

The upper neck should be of such capacity and the scales so graduated as to accommodate in volume at least 1½ times the sum of the official maintenance tolerance in underregistration plus the maintenance tolerance in overregistration for LP Gas liquid-measuring devices, at the nominal total volume of the prover. The lower neck serves as the "zeroing" indicator and should be of reasonably small horizontal cross-sectional area to provide maximum sensitiveness.

Significant elements of the prover are described in the Appendix.

4.2. Calibration.—The prover should be calibrated with water. It is suggested that the prover pressure-relief valve be removed and an appropriate funnel be inserted in the opening from which the valve was removed. The air in the prover that must be allowed to escape, as water is poured in, can be evacuated through the vapor-discharge connection. Water must be drained from the prover by gravity (not through the pump), and this can be accomplished at the prover inlet, using the inlet valve as the control.

- Step 1. Fill the prover with water.
- Step 2. Level the prover.
- Step 3. Open the prover inlet valve and drain the prover until the water-level line appears in the lower gage glass—above the zero graduation—then shut the prover inlet valve and allow the water to drain from the interior of the prover into the the lower neck for 30 seconds.
- Step 4. Carefully drain out such additional water as is necessary to lower the water level so that the bottom of the meniscus in the lower gage glass is even with the "zero" line on the scale. (This step actually can be begun before the end of the 30-second period.)
- Step 5. Pour into the prover, through the funnel, measured water in an amount equal to the nominal capacity of the prover and mark with a sharpened crayon or a strip of masking tape on the upper scale at the level where the bottom of the meniscus shows in the upper gage glass. (In order that no calculation and consequent adjustment need be made for water-temperature



FIGURE 1. Volumetric LP gas meter prover.

correction, the prover and the water should reach the same temperature before the mark is made.) (Since the prover is to be adjusted to indicate its nominal capacity with internal pressure (Step 8), no scale adjustment should be made at this time.)

- Step 6. To verify, repeat Steps 2, 3, 4, and 5. Step 7. With the measured water in the prover, remove the funnel, attach to the pressure-relief-valve connection a source of air or inert gas under



FIGURE 2. Volumetric LP gas meter prover (schematic).

pressure (bottled nitrogen is suggested), and raise the pressure in the prover to 100 pounds per square inch, gage measurement (p.s.i.g.).

Step 8. In order that a minimum amount of correction for pressure need be made when the prover is in use, the prover should be adjusted to indicate exactly its nominal capacity with 100 pounds of internal pressure. (An internal pressure of 100 p.s.i.g. is suggested as being convenient. It may be that in certain sections of the country some other pressure, a "local" pressure—that is, the average of the pressures of LP Gas actually encountered in that area—will be more convenient.) With the appropriate pressure in the prover, adjust the position of the upper scales so that the nominal capacity graduations are even with the bottom of the meniscus in the gage glass.

If the upper scales are not adjustable and the adjustment is to be made on the lower scales, the length of lower scale adjustment may be calculated mathematically by applying the formula for the volume of a cylinder ($V=\pi r^2 h$, or the volume is equal to 3.1416 times the square of the radius times the height.) Thus the following steps:

(a) Measure the distance between the bottom of the meniscus and the nominal capacity mark on the upper scale.

(b) Multiply the measurement obtained in (a) by 3.1416 times the square of the inside radius of the upper neck. (If the radius is not available from the fabricator of the prover, 1/2 the "nominal" inside diameter of the neck may be used, since the adjustment is to be checked later.) The result of this calculation is the volume, in cubic inches, of the required adjustment.

(c) The length (height) of lower scale adjustment is determined by dividing the result obtained in (b) by the product of 3.1416 times the square of the inside radius of the lower neck. (If the radius is not available from the fabricator of the prover, 1/2 the "nominal" inside diameter of the neck may be used, since the adjustment is to be checked later.)

Example: Inside diameter of upper neck=8 inches (radius=4 inches)

Inside diameter of lower neck=4 inches (radius=2 inches)

Distance between bottom of meniscus and nominal capacity mark on upper neck scale= 3/32 (0.09375) inch.

 $V = \pi \times r^2 \times \text{height}$

Volume of Adjustment=3.1416×4²×0.09375=4.7124 in.³ h=volume÷ $(r^2 \times \pi)$

Length of lower-scale adjustment= $4.7124 \div (2^2 \times 3.1416) = 0.375$ (3/8) inch.

Any such adjustment should be checked by at least one additional calibration run.

Step. 9. The prover now has been adjusted so as to indicate its nominal capacity with an internal

pressure of 100 p.s.i.g. (or some other predetermined pressure). Obviously, a range of pressures will be encountered when the prover is in testing service. In order that corrections for such pressure differences may be made, careful upper scale readings should be taken at internal pressures from 50 to 200 p.s.i.g. at 50-pound intervals. These pressure-correction runs should be made at least two times in order to be sure that the results are accurate. From these scale readings there should be prepared through interpolation a Pressure-Correction Table as is illustrated in Table 1. The Pressure-Correction Table should be kept with the prover at all times, and a copy of the table should be retained in the office file.

 TABLE 1. Pressure corrections to indicated volume of typical LP gas meter provers

If gage pressure is	Add to prover gage reading (cubic inches)				
	53–56 gallon prover	100-106 gallon prover			
50 60	$-3 \\ -2$	$-6 \\ -5$			
70 80 90	$ \begin{array}{r} -2 \\ -1 \\ -1 \end{array} $	-4 -2 -1			
$100 \\ 110 \\ 120$					
120 130 140 150	+2 +2 +2	+2 +4 +5			
$150 \\ 160 \\ 170 $	+3 +4 +4	+6 +7 +8			
180 190 200	+5 +5 +6	+10 +11 +12			

Step 10. After the Pressure-Correction Table has been made and verified, allow the prover to return to atmospheric pressure. Then check the accuracy of the graduations of the two upperneck scales. At least three graduations on the scales should be checked by adding or removing measured water—one at the upper limit, one midway between the nominal "zero" and the upper limit, and one at the lower limit of scale reading.

- Step 11. Attach lead-and-wire security seals to all adjustment means.
- Step 12. Drain the prover completely through the drain plug, and then, to prevent corrosion of the internal surfaces, dry the prover thoroughly by several purgings with dry air or an inert gas such as nitrogen or carbon dioxide.
- Step 13. Prepare the Temperature-Correction Table. During the test of LP Gas liquid-measuring device, correction must be made for any difference between the temperature of the liquid as it passes through the meter and the temperature of the liquid in the prover. This correction, which corrects for changes in the volume of liquid only, is accomplished by means of a "Temperature-Correction Table" which is constructed from factors given in the Butane-Propane Gases Handbook,⁴ or as a matter of simplicity, may be calculated from the figures shown in Table 2, an example of a completed Temperature-Correction Table. (The corrections shown are for a nominal 100-gallon prover; corrections for a 50-gallon prover are obtained by dividing these figures by 2; likewise, corrections for a 250-gallon prover would be obtained by multiplying the corrections in Table 2 by 2½.) The Temperature-Correction Table must be kept with the prover at all times, and a copy should be kept on file in the office.

5. INSPECTION OF COMMERCIAL DEVICES

For a discussion of the purposes and scope of "inspection" as distinguished from "Testing," see Section 4, National Bureau of Standards Handbook 44, Specifications, Tolerances, and Regulations for Commercial Weighing and Measuring Devices.

⁴ Published by Jenkins Publication, Inc., 198 South Alvarado Street, Los Angeles, Calif., 90057.

TABLE	2.	Temperature	corrections	to	indicated	volume	of	103-gallon
			LP gas me	ter	prover			-

Temperature of	Correction per °F difference between meter temperature and prover temperature			
liquid in prover	Propane (Sp. Gr. 0.510)*	Butane (Sp. Gr. 0.580)*		
$({}^{\circ}F)$ 0-20 21-40 41-60 61-80 81-100 101-120 121-140	$(in.^{3}/^{\circ}F)$ 32 34 37 39 42 45 50	$(in.^{3})^{\circ}F)$ 25 25 25 26 27 29 31		

*Approximate specific gravities for two typical LPG products.

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

5.1. Inspection procedures.—Because either a system in a fixed location or a vehicle tank equipped to dispense LP Gas through a meter, whether wholesale or retail, is a closed system, the inspection procedure is reasonably simple. The piping should be traced to see that there is no mechanical facility that would allow the diversion of measured liquid (except as specifically provided in official technical regulations); the means for vapor elimination should be examined to assure that the vapor-outlet line is at least as large as recommended by the meter manufacturer and that such line is free of restriction; the meter should be inspected for compliance with all technical requirements. A motor-fuel device should be examined for compliance with the requirements having to do with zero-setback interlock, delivery hose, visibility of indicating elements, unit-price indication, and money-value computations.

5.2. LIGHTING.—As a safety precaution, portable inspection lights on extension cords should *not* be used around LP Gas equipment. Battery-powered flashlights should conform to the requirements of the National Electrical Code for Portable Electric Torch, Class 1, Group D Location.⁵

6. TEST PROCEDURE FOR COMMERCIAL DEVICES

It is recommended that the test of an LP Gas liquidmeasuring device include at least two runs at normal flow rate and at least one special test at a slower rate.

The "normal" test should be made at the maximum discharge rate developed under the conditions of the installation. The "special" test should be made to develop the operating characteristics of the meters or meter-type device as circumstances require.

6.1. Test site.—The test site should be clear of traffic, pedestrians, and other congestion. (See fig. 3.) The prover and the device under test should be at least 50 feet from any source of open flame or spark. (This, of course, may not be possible when the device under test is stationary, such as a motor-fuel device, but every precaution should be taken to avoid the danger of fire.) Fire extinguishers (dry-chemical type, see Appendix) should be available immediately adjacent to both the prover and the dispensing unit. Under no normal circumstance should a test be conducted inside a building.

6.2. Prover hookup.—The device under test is connected to the prover as follows:

Step¹. Connect meter discharge line to prover inlet.

Step 2. Connect prover vapor-return line to supply-tank vapor inlet.

Step 3. Connect prover pump discharge line to supplytank liquid inlet.

6.3. Test preparation.—Certain steps must be taken prior to the start of the actual test. (If the meter is equipped with an automatic temperature compensator, this should be disconnected prior to the test so that the basic accuracy of the meter may be determined. At the end of the test of the meter (see 6.7) the capability of the compensator should be determined.)

Step 1. Balance system. Slowly open valves at prover vapor-return line and supply-tank vapor inlet and allow the two vessels to "balance"; that is, to arrive at the same pressure through the open vapor connection. The pressure gage in the

⁵ Available at National Board of Fire Underwriters, 85 John Street, New York, N.Y., 10038.



FIGURE 3. Test Site—LP gas meter testing.

supply tank of the device under test and the pressure gage in the prover should read alike (to the limit of their accuracies). The vaporreturn line will remain open throughout the test runs.

Step 2. Wet prover. With prover-discharge valve closed, start the dispensing-unit pump, open the proverinlet valve, and pump liquid into the prover until the liquid can be seen in the upper gage glass; then close the prover-inlet valve, and shut off the dispensing-unit pump. (This step should be taken for every meter that is tested, regardless of whether the prover has just previously been used. The step 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 might be of different physical composition. This step also tends to bring the prover to the temperature of the tank supplying the device under test.) (During the prover wetting operation, the pressures in the prover and the supply tank should be observed.

If significant pressure differences occur, the cause must be located and the condition corrected before the start of the first test run.)

- Step 3. Level prover. With the prover full of liquid, adjust the level of the prover with jacks or other level-adjusting means.
- Step 4. Thermometer wells. *Partially* fill the proverthermometer well and the thermometer well in or near the meter or the vapor separator with an appropriate temperature-conducting fluid. (Ethylene glycol---"permanent" automobile antifreeze solution—is suggested.) (A bulb syringe will facilitate the filling of the thermometer wells.) Then place the thermometers in the wells. (Some meters have been constructed without provision for a thermometer well. Since the temperature of the liquid as it passes through the meter is critical with respect to the test result, an alternative means of determining such temperature must be found. It is suggested that the bulb of the thermometer be taped to the meter-inlet with sufficient tape or other temperature-insulating material that neither the atmospheric temperature nor direct sunlight will affect the thermometer indications.)
- Step 5. Evacuate the prover. Open the prover-discharge valve and start the prover-discharge pump in order to return the product to its source and thus evacuate the prover. When the liquid level can be seen in the lower-neck gage glass and below the "zero" graduation, close the prover-discharge valve, shut off the prover pump, and allow the prover to drain for 30 seconds. At the end of the prescribed drainage period, the bottom of the meniscus in the lowerneck gage glass should be brought into exact coincidence with the "zero" graduation by manipulating the prover-inlet valve. (This usually can be accomplished without starting the dispensing-unit pump.)
- Step 6. Start dispensing-unit pump.
- Step 7. Zero the meter.

6.4. The normal (fast) test.—

Step 1. With the dispensing-unit pump operating at normal speed, quickly open the prover-inlet valve.

- Step 2. Observe the pressure-gage indications at the prover and at the supply tank. (If a significant difference occurs, the test must be stopped and the fault corrected, or there is apt to be vapor condensation during the prover filling process with consequent inaccuracy of result.)
- Step 3. During the run, read very carefully and record meter temperatures to the nearest 1/2 (0.5) degree when the meter indicates approximately 35 gallons and again at approximately 70 gallons for a 100-gallon prover, or at regular 30-gallon intervals for a prover of different capacity, in order that an average temperature of the liquid as it passes through the meter may be calculated.
- Step 4. Determine and record the rate of flow of the meter during the normal test. The rate of flow in gallons per minute best can be determined with a stopwatch by timing 10 gallons and dividing 600 by the number of seconds required for the 10 gallons. If a stopwatch is not available, the number of gallons pumped in 30 seconds as indicated by a wrist or pocket watch can be multiplied by 2 to arrive at the gallons per minute.
- Step 5. When the meter indicates exactly the nominal capacity of the prover, close the prover-inlet valve and shut off the dispensing-unit pump. (As the meter indication reaches approximately 4 gallons less than the nominal capacity of the prover, the inspector should glance at the gage glass in the upper neck. If liquid can be seen in the gage glass, the test should be stopped before the liquid level reaches the vaporreturn outlet and the test results calculated on the basis of the actual meter reading.) It will be necessary to reduce the flow rate just prior to the final shutoff in order that the desired shutoff may be accomplished precisely. If the meter is, by accident, allowed to overrun the desired shutoff point, it should be run to the next tenth-gallon graduation on the meter, and this amount corrected for at the rate of 23 cubic inches per tenth-gallon.
- Step 6. Read and record the tank pressure and prover pressure to the nearest pound as indicated by the pressure gages.

- Step 7. Read with care and record to the nearest 1/2(0.5) degree the prover temperature as indicated by the prover thermometer.
- Step 8. Read, at least to the nearest 10 cubic inches or 0.05 gallon, and record the liquid level indication in the upper neck-reading as the liquid level the bottom of the meniscus as it appears in the gage glass. (If bubbling appears in the upper gage glass, delay the reading until such bubbling ceases, and repeat the test in order to be sure that such bubbling has not affected the test result.) (If bubbling continues for some time after completion of the test run, this undoubtedly is an indication of a pressure differential between the prover and the supply tank. Since the cause of such differential probably is a temperature difference, several flushings of the prover should correct this difficulty.)

Step 9. Record the meter reading.

Step 10. Open the prover-discharge valve and start the prover pump to evacuate the prover.

6.5. The special (slow) test.—The special test at the slower rate of flow is conducted exactly the same as the normal test except that the rate of flow through the meter is controlled to the prescribed rate by the proper manipulation of the prover inlet valve.

6.6. Ticket printer.—If the meter under test is equipped with a ticket printer, a ticket should be printed for each test run.

6.7. Temperature compensator.—If the meter is equipped with an automatic temperature compensator, and the compensator was disconnected at the beginning of the test, it should now be connected and a test should be made to determine the capability of the device to correct the volume to a base temperature of 60 °F. This test is identical to the normal test except that the meter temperatures need not be determined during the test. On the report form, the inspector should record 60 °F as the meter temperature. In the calculations the temperature correction is based on the difference between the prover temperature and 60 °F.

7. TEST REPORT FORM

A suggested Test Report Form is shown in figure 4. The form provides space at the top for the necessary owner and

Date	DEPARTMENT H	EADING t Report	Test No	
Name	Address			
Make of Meter	_Serial No		Marked Max. Rate(GPM)	
Truck	Totalizer		Indicator D Temperature	
Identification	Reading:Start	Finish	Recorder Compensator	
ProductSp. Gr	Meter Thermometer Well:	Tolerance Appli	Acceptance 🔲 ied: Maintenance 🗖	
Test Data	1st Run	2nd Run	3rd Run	
1. Type test	Normal Special	Normal Spec	ialNormal_Special	
 Flow rate Motor temp (25 col.) 	GPM	G1	PMGPM	
4. Meter temp. (70 gal.)	°F		•F •F	
5. Tank pressure	PSI	F	PSI PSI	
Prover pressure	PSI	F	SI PSI	
Prover temperature	*F		°F °F	
8. Prover reading	galin. ³	gal, in	n. ³ gal in. ³	
9. Meter reading	galin. 3	gali	n. ³ galin. ³	
10. Average meter temp. (3+4)÷	-2 = °F		°F °F	
11. Prover temp. (7) =°F°F			°F *F	
 Temp. difference (10 - 11) 	· ····································		°F ? °F	
14 Correction for temp. diff	$= \frac{x_{10.0}}{x_{10.0}}$	xin. 07	3 <u>x</u> in 3/°F	
15. Correction for prover press	ine - in 3	in	3in 3	
16 Total correction (14 + 15)	in. 3	in	3in, 3	
17. Corrected prover reading (8	+ 16) = gal, in, 3	gal. in.	3 gal. in. 3	
18. Meter reading (9)	⊨ gal, in. 3	gal. in.	galin. 3	
19. Net meter error (17) vs (18)	=in. 3	in	3in. 3	
Action Taken: Approved 🗋 Adjusted 📄 Rejected 📄 Co Remarks			Condemned 🗌	
Inspector Owner/Operator				
USCOMM-NBS-DC				

FIGURE 4. LP gas meter test report form.

equipment identification, and for indicating the tolerance applied. In the body of the form is space for recording three separate test runs and for the calculations involved in the three runs. At the bottom is space for indicating the official action taken as the result of the test, any remarks or instructions, the signature of the inspector, and the "acknowledgment" signature of the equipment owner or operator. The heading of the Report Form should be filled in completely before a device under test is operated for the purpose of the test. A separate form (or more than one form if more than three runs are made) should be used for each device tested.

8. REPORTING A TEST

8.1. Test data.—The test data are entered at the appropriate spaces on the Report Form during and immediately following the test run. While the prover is being evacuated, the necessary calculations can be made to determine the test result.

8.2. Test calculations.—In figure 5, the "Test Data" section of a sample Report Form has been filled out. Each line is identified by a number. The several steps and appropriate entries in the data calculation for this run will refer to these identifying numbers for the "1st Run."

- Step 1. The average meter temperature is determined by taking the sum of the two temperatures recorded during the run (63+64) and dividing the sum by 2 (127/2). The average temperature of the meter is recorded on line 10 (63.5 °F).
- Step 2. The difference between the temperature of the prover (65 °F, recorded on line 7 and entered on line 11) and the average temperature of the meter (63.5 °F, line 10) is determined by direct subtraction (-1.5 °F). The sign of the difference is noted here (as minus) as it will determine the sign of the correction for temperature difference.
- Step 3. The correction per degree F is found in the Temperature-Correction Table in the 60 to 80 °F range and is entered on line 13 (39 in.³/°F).
- Step 4. The correction for temperature difference is obtained by multiplying the temperature difference on line 12 (-1.5 °F) by the temperature correction factor on line 13 (39 in. 3 /°F). The correction (-58 in. 3) is inserted on line 14 with the appropriate sign (minus).
- Step 5. The correction for pressure difference between the prover at the end of the run and the truck tank is made next. The correction is taken from the Pressure Correction Table at the prover pressure nearest to that entered on line 6 and recorded on line 15 $(+2 \text{ in.}^3)$.
- Step 6. The total correction for the prover is then determined by adding the corrections for temperature difference and pressure difference (line 14 plus line 15), while taking into account the algebraic sign (-56 in.^3) and entering the sum on line 16.
- Step 7. The corrected prover reading is then obtained by adding the total correction of -56 in.³ (line 16) to the prover reading of 101 gallons 65 in.³ (line 8) and entering the sum on line 17 (101 gal. 9 in.³).
- Step 8. The net meter error is determined by comparing the corrected prover reading (line 17) to the meter reading (line 9) which has been entered again on line 18. The difference between these two figures is recorded on line 19 either directly in cubic inches (+240 in.³), or if the error is large, in gallons and cubic inches (1 gal. 9 in.³).

0	Test Data	1st Run
1.	Type test	Normal / Special
2.	Flow rate	24 GPM
3.	Meter temp. (35 gal.)	63 °F
4.	Meter temp. (70 gal.)	64 °F
5.	Tank pressure	(20 PSI
6.	Prover pressure	115 PSI
7.	Prover temperature	65 °F
8.	Prover reading	101 gal, 65 in. ³
9.	Meter reading	100 gal. 0 in. ³
10. 11. 12. 13. 14. 15. 16. 17. 18.	Average meter temp. $(3+4) \stackrel{*}{,} 2$ Prover temp. (7) Temp. difference (10 - 11) Temp. correction factor Correction for temp. diff. Correction for prover pressure Total correction (14 + 15) Corrected prover reading (8 + 16) Meter reading (9) Net meter error (17) vs (18)	= 63.5 °F = 63.5 °F = 65 °F = 7.5 °F =
19.	Net meter error (17) vs (18)	= <u>+ 240</u> in.

FIGURE 5. Test Data section of a sample report form.

9. OPERATIONS FOLLOWING THE TEST

At the completion of testing at one test site and before moving the prover if it is portable, or before leaving the test site if the prover is fixed as to location, the pressure in the prover should be bled to approximately 40 p.s.i.g., as indicated on the pressure gage. It is not advisable to leave the prover devoid of pressure and thus devoid of LP Gas vapor, because air may enter the prover at atmospheric pressure with possible moisture condensation and consequent internal surface corrosion.

After the pressure has been lowered to 40 pounds, all valves should be closed tightly.

Certain components of a volumetric LP Gas meter prover are described below with identification references to the nomenclature shown on the schematic sketch, figure 2.

Prover pressure-relief valve.—Suggested setting for relieving pressure—250 p.s.i.g.

Vapor-return line.—At least 20 feet in length, with excess flow check valve and angle valve at prover and appropriate shutoff valve (equipped with bleeder) at outlet end.

Pressure gage. -0 to 300 p.s.i.g. by 5-pound graduations, with needle.

Upper neck.—8-inch "standard" pipe with reflex gage (built in as an integral part of the neck and not extended from the side and separate from the neck) and two scales, one graduated by 10 cubic inches, the other by 0.05 gallon.

Leveling shelves.—So designed as to accommodate spirit level. (If levels are permanently mounted, these should be of 3-inch length and armored.)

Thermometer well.—3/4 inch seamless pipe welded into the body of the prover with at least 8 inches extending into and 2 inches extending out from the prover. The Thermometer Well should be so located that its lower (closed) end is at the approximate center of the vertical cross section of the prover. The well should have a removable cap at the outer end so that the temperature-conducting liquid can be retained in the well between tests.

Lower neck.—4-inch "extra heavy" pipe, with reflex gage (built in as an integral part of the neck and not extended from the side and separate from the neck) and one adjustable scale with "zero" graduation.

Prover inlet.—1¼-inch nipple with excess-flow check valve and appropriate shutoff valve.

Liquid bleeder.—3/8-inch o.d. tube with angle valve mounted to expel the liquid in a downward direction.

Prover-discharge line.-14-inch nipple with appropriate valve.

Pump and electric motor.—Explosion-proof, for LP Gas service.

Power cord.—Three-wire, No. 14, 110-volt, neoprene covered.

Pump bypass line.—Flexible line equipped with springloaded pump bypass valve. (See pump manufacturer's specifications for the necessity of a relief valve.)

Pump pressure-relief valve.—Suggested setting, 375 p.s.i.g. Pump discharge line.—At least 20 feet in length, with appropriate shutoff valve equipped with bleed valve at outlet end.

Thermometers.—A supply of liquid-in-glass partial immersion type thermometers, -30 to 130 °F, by 1 °F, at least 12 inches in length, must be kept with the prover. These are quite fragile, so an ample supply is necessary.

Suggested accessories.—

- 1. Necessary adaptors to facilitate connections to various types of LP Gas dispensers.
- 2. Pipe and crescent wrenches and other tools should be carried in an appropriate box.
- 3. Fire extinguishers. A portable dry chemical extinguisher is suggested as the most effective extinguisher for LP Gas flames.
- 4. A supply of protective gloves, with gauntlets should be kept with the equipment.
- 5. An adequate first-aid kit with appropriate burn ointment, bandages, gauze, adhesive tape, and the like.
- 6. Signs. At least two warning signs should be carried and set up at each test site to give notice, in large letters, of the hazardous nature of the tests. "WARNING-NO SMOKING-FLAMMABLE GAS."



