

2015 EPO No. 25

NIST Examination Procedure Outline

Loading-Rack Meters

It is recommended that this outline be followed as minimum criteria for examining loading-rack meters used to measure petroleum products sold at wholesale. The outline may be applied to devices with or without Automatic Temperature Compensating Systems. Non-retroactive and retroactive requirements are followed by the applicable date in parentheses.

SAFETY NOTES

When excerpting this Examination Procedure Outline for duplication, the "Safety Considerations" section and the "Glossary of Safety Key Phrases" should be duplicated and included with the outline.

Safety policies and regulations vary among jurisdictions. It is essential that inspectors or servicepersons be aware of all safety regulations and policies in place at the inspection site and to practice their employer's safety policies. The safety reminders included in this EPO contain general guidelines useful in alerting inspectors and servicepersons to the importance of taking adequate precautions to avoid personal injury. These guidelines can only be effective in improving safety when coupled with training in hazard recognition and control

The inspector is reminded of the importance of evaluating potential safety hazards prior to an inspection and taking adequate precautions to avoid personal injury or damage to the device. The inspector should read and be familiar with the introductory section on safety "Safety Considerations" found at the beginning of this publication. As a minimum, the following safety precautions should be noted and followed during the inspection. Definitions of each reminder are found in the "Glossary of Safety Key Phrases" at the back of this publication.

Clothing	Material Safety Data Sheets (MSDS)
Electrical Hazards	Nature of Product
Emergency Procedures	Personal Protection Equipment
Eye Protection	e.g., Safety Shoes, Safety Aprons, Respirators, Gloves, Barrier Cream, etc., if deemed necessary.
Fire Extinguisher	Hard Hat -- for protection from overhang in rear of vehicle tank truck
First Aid Kit	Safety Cones/Warning Signs
Grounding	Static Discharge
Ignition Sources	Support -- for prover
Lifting	Switch Loading
Location	Obstructions and Overhead Hazards
also: Wet/Slick Conditions	
Chemicals, Petroleum Products, and Hazardous Materials	

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Safety First !!!

Check the inspection site carefully for safety hazards and take appropriate precautions.

Check to be certain that the ground surface of the inspection site is sufficiently strong and rigid to support the prover when it is filled with product -- don't forget to chock the wheels of the prover.

Learn the nature of hazardous products used at or near the inspection site--obtain and read copies of MSDS's.

Know emergency procedures and location and operation of fire extinguishers and emergency shut-offs.

Post safety cones/warning signs and be aware of vehicular and pedestrian traffic patterns.

Use caution moving around in wet, slippery areas and in climbing on prover, storage tanks, and vehicles.

Use personal protection equipment and clothing appropriate for the inspection site.

Be sure that a first aid kit is available and that the kit is appropriate for the type of inspection activity.

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Pretest Determinations:

1. Prover must have valid calibration certificate and security seals must be intact on sight gauge.
2. Prover capacity must be sufficient to hold the amount of product that would be delivered by the meter to be tested during 1 minute of flow at its maximum discharge rate and in no case be less than 200 liters (50 gallons)..... N.3.5.
3. Prover and system design must be compatible (top loading/bottom loading).
4. Thermometers are to be accurate to within:
 - a. ± 0.5 °C, have a range of at least 0 °C to 50 °C, and be divided in increments of no greater than 0.5 °C for liquid-in-glass thermometers and 0.1 °C for digital thermometers or
 - b. ± 1 °F, have a range of at least 0 °F to 120 °F, and be divided in increments of no greater than 1 °F for liquid-in-glass thermometers and 0.1 °F for digital thermometers.

Thermometers may be of the partial immersion or digital type.
(See NIST HB 105-6 for additional information)

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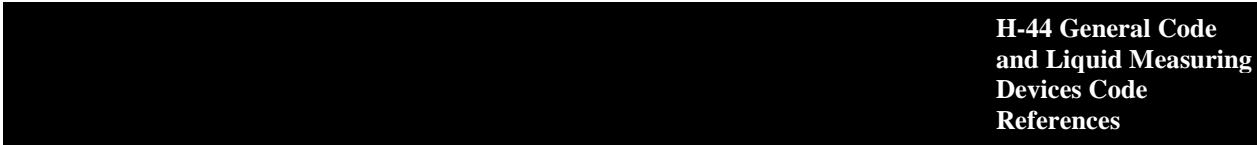
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Pretest Determinations (cont.):

5. Inspect prover's interior surface for dents, product clingage, rust, water, or other foreign material.
6. Prover sight glass must be clean and fittings must not leak.
7. Available test fluid must be of the same general physical characteristics as that of the liquid to be commercially measured by the device. N.1.1., N.1.2.
8. For top loading provers, the prover inlet must be lower than the outlet of the meter discharge line.
9. Determine applicable tolerance values:
 - Applicable requirements G-T., T.1.
 - Basic values T.2.
 - a. On normal tests:
 - Acceptance tolerance – Asphalt meters > 50 °C 0.3 percent
 - Acceptance tolerance – Other products 0.2 percent
 - Maintenance tolerance 0.3 percent
 - b. Special tests tolerance 0.5 percent

Inspection:

1. Indicating and recording elements.
 - Design:
 - Device must be equipped with indicating elements and MAY be equipped with a recording element. S.1.1.
 - Units:
 - Units are to be in terms of liters, gallons, quarts, pints, fluid ounces, or binary-sub-multiples or decimal subdivisions of the liter or gallon. S.1.2., S.1.2.3.(b)
 - Readability: G-S.5., S.1.4., S.1.5.
 - Indicating and recording elements must be clear, definite, and easily read.
 - Required markings shall be distinct, easily readable, and of a permanent nature G-S.6. (1/1/77), G-S.7.



Inspection (cont.):

1. Indicating and recording elements. (continued)

Values of intervals:

Values of the graduated intervals must be uniform throughout the series of indicating elements or, if equipped, recording elements..... G-S.5.3.

For devices indicating or recording in more than one unit, the values must be appropriately identified..... G-S.5.1.3.

Advancement and return to zero: S.1.3.

Indicating and recording elements may only be advanced to zero by the mechanical operation of the device, UNLESS:

- a. Advancement cannot be stopped until zero is reached, OR
- b. The indicating elements are automatically obscured until the elements reach a correct zero position.

Travel of Indicator

Device shall be readily operable to deliver accurately any quantity from 200 L (50 gal) to the capacity of the device. If the most sensitive element utilizes an indicator and graduations, their relative movement corresponding to a delivery of 4 L (1 gal) shall be not less than 5 mm (0.20 in). S.1.7.1.

Provision for sealing: G-S.8. (1/1/90), S.2.2.,

Provision must be made for sealing electronic adjustable components Table S.2.2. (1/1/95)

For multiple measuring elements with a single provision for sealing, a change to the adjustment of any measuring element must be individually identified. G.S.8.1. (1/1/10)

A security seal must be affixed to any adjustment mechanism designed to be sealed. G-UR.4.5.

G-S.5.6.

Recording elements, General.

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Inspection (cont.):

2. Measuring elements.

Determine that system has an effective vapor or air eliminator (or other automatic means for preventing the passage of vapor and air through the meter) and that vent lines are suitably rigid..... S.2.1.

Verify that means are provided for determination of product temperature
- for devices without automatic temperature compensating systems..... S.2.6. (1/1/85)
- for devices with automatic temperature compensating systems..... S.2.7.4.

Determine that provision is made for applying security seals to the meter and to the automatic temperature compensating system, and that security seals are intact on both..... G-UR.4.5., S.2.2., S.2.7.3.

3. Marking.

Device is clearly and permanently marked for the purpose of identification. G-S.1., G-S.1.1., G-S.1.2.

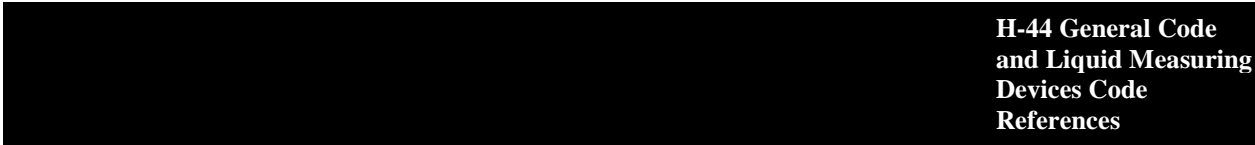
All switches, lights, displays, pushbuttons, and other operational controls and features must be clearly and definitely identified..... G-S.6. (1/1/77)

The limitation on a device's use shall be clearly and permanently marked on any device intended to measure accurately: S.4.1.
a. only products having particular properties,
b. only under specific installation conditions, or
c. only when used in conjunction with specific accessory equipment.

Designed minimum and maximum discharge rates must be clearly and permanently marked on meter. Minimum discharge rate shall not exceed 20 percent of the maximum discharge rate..... S.4.3.1.

For devices equipped with temperature compensation, the primary indicating elements, recording elements, and recorded representations shall be clearly and conspicuously marked to show that the volume has been adjusted to the volume at 15 °C (60 °F) S.4.3.2.

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Inspection (cont.):

4. Installation.

Device must be readily accessible for purposes of testing. Assistance shall be provided by the firm if needed..... G-UR.2.3., G-UR.4.4

Examine discharge line and valves to insure that measured liquid cannot be diverted from the measuring chamber or discharge line and that any directional flow valves are automatic in operation. S.2.3., S.3.1., S.3.2.

No leaks should exist in the system on the outlet side of the meter. G-UR.4.1., S.3.1.

Note: If leaks are detected on the inlet side of the meter, a notation should be made on the inspection report and the firm should be made aware of the location of the leak for purposes of safety.

Examine the system and any associated equipment to insure that the assembly, installation, and construction do not facilitate fraud..... G-S.2.

The details of the installation must be proper and must not adversely affect system performance. The actual maximum discharge rate must not exceed that specified by the manufacturer. G-UR.2.1., UR.2.1., UR.2.2.

The device shall be installed so that there is no obstruction between a primary indicating element or recording element and the measuring element. Otherwise, there shall be convenient and permanently installed means for direct oral or visual communication between an individual located at the primary element and an individual located at the measuring element..... G-UR.2.2.

A device or system equipped with a primary indicating element and used in direct sales shall be positioned so that its indications may be accurately read and the measuring operation may be observed from some reasonable "customer" and "operator" position. The positioning shall be determined on a case-by-case basis, considering the individual circumstances, including the size and character of the indicating element..... G-UR.3.3.

5. Selection and use.

Device must be suitable for the service in which it is used with respect to the elements of design, including flow rate, computing capability, the details of its indicating and recording elements, and the value of its smallest unit and unit prices. Device must also be suitable for use in the environment in which it is installed..... G-UR.1.1., G-UR.1.2

Device and any associated equipment are to be operated and maintained as intended by the manufacturer G-UR.3.1., G-UR.4.1.

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Inspection (cont.):

UR.3.6.1.1.

If a device is equipped with a mechanical automatic temperature compensator, it shall be connected, operable, and in use at all times.....

6. Devices equipped with automatic temperature compensating systems.

Provision must be made to deactivate the automatic temperature compensating system so that the meter may indicate and record, if equipped to record, in terms of the uncompensated volume..... S.2.7.2.

Thermometer well must be provided for determination of the temperature of the liquid S.2.7.4.

Primary indicating and recording elements on devices equipped with automatic temperature compensating systems shall be marked to show that the volume delivered has been adjusted to 15 °C (60 °F)..... S.4.3.2.

Wear appropriate personal protection equipment such as petroleum-resistant, non-skid safety shoes (to prevent possible injury from spills or slipping on slick surfaces), protective clothing, eye protection (to prevent injury from splashed product), and a hard hat (to prevent injury from overhangs and projections on vehicle tank truck).

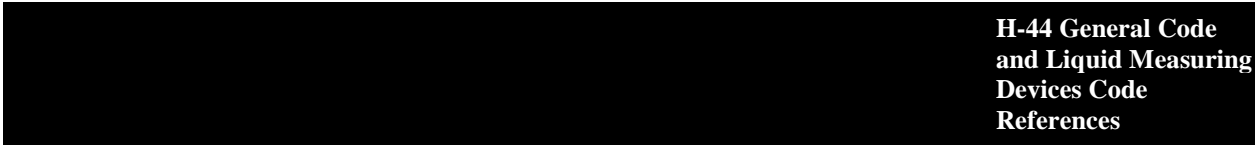
Use proper grounding procedures!

Device operator should be present at all times during testing.

Test Notes:

1. Check for the proper operation of the level indicators on the prover and level the prover.
2. Connect safety interlock and ground cable. If applicable, connect the vapor recovery hose.
3. Verify that all valves in the proving system are closed and that the prover pumping mechanism is functional.
4. Note the totalizer reading. Totalizer should be checked before and after each draft to determine its proper operation.

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Test Notes (cont.):

- 5. Care should be exercised to insure that the temperature difference between product in the prover and in the meter is small. N.2.
- 6. For top-loading provers, take precautions to minimize splashing and to maintain the spout fill in a consistent position.
- 7. Examine printed tickets and invoices:
 - a. Print a ticket after each test draft, if device is so equipped. G-S.5.6.
 - b. For devices of the computing type:
 - 1) Check price computations on indicator and on printed indications S.1.7.2.
 - 2) The total price, the total volume of the delivery, and the price per liter or gallon shall be shown, either printed by the device or in clear hand script, on any printed ticket issued by a device and containing any one of these values.
 - c. Check that all indicated and recorded values for proper comparability. UR.3.4.
 - d. For systems equipped with automatic temperature compensation, check invoices G-S.5.2.2. to determine if:
 - 1) deliveries which are adjusted to 15 °C or 60 °F show that the volume has been adjusted to 15 °C or 60°F.....
 - 2) in the case of an electronic wholesale device equipped with an automatic S.4.3.2.,UR.3.6.1.2.(a) temperature compensating system, the API gravity, specific gravity, or coefficient of expansion; product temperature; and gross reading are also indicated.
 - e. For nonautomatic temperature compensation: UR.3.6.1.2.(b)
 - 1) the volume of the product delivered is adjusted to the volume at 15 °C or UR.3.6.2.1 60 °F, verify that the product temperature is taken during delivery in:
 - the liquid chamber of the meter;
 - the meter inlet or discharge line adjacent to the meter, or
 - the compartment of the receiving vehicle at the time it is loaded.

The accompanying invoice for these systems shall indicate that the product has been adjusted to a volume at 15 °C or 60 °F and shall state the product temperature used in making the adjustment. UR.3.6.2.2.
 - f. In addition to tickets printed during inspection and testing, several examples of actual used tickets are to be examined. This serves to verify the format of and information on actual printed tickets.
 - g. Verify that any options for obtaining a recorded representation are appropriate. The customer may be given the option of not receiving the recorded representation. If the system is equipped with the capability, the customer may also be given the option of receiving the recorded representation electronically in lieu of or in addition to a hard copy. G-S.5.6.

Test Notes (cont.):

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8. Period of Use for Temperature Compensation UR.3.6.3.

When fuel is bought or sold based on temperature-compensated volume, it shall be bought or sold on this basis over at least a 12-month consecutive period, unless otherwise agreed to in writing by both the buyer and seller.

9. Prover readings are to be determined by reading the bottom of the meniscus for transparent liquids, and the top of the meniscus for opaque liquids.
10. When monitoring drainage of the prover, one of the following methods should be followed depending on prover design. Precautions should be taken to insure that drainage procedure is followed in a consistent manner for each test.

a. If the prover has a lower neck equipped with a drain sight glass, close the drain valve prior to the liquid level reaching the zero mark indicator. After 30 seconds drain time, open the small drain-off valve and lower the liquid level to the zero mark. (Do not adjust the liquid level again, even if continued drainage raises the liquid level above the zero mark before the test is started.)

b. If the prover is not equipped with a lower sight glass, leave the drain valve open until continuous flow ceases and dripping commences. Close drain valve after 30 seconds.

11. Temperature readings are to be taken to the nearest 0.25 °C or 0.5 °F or for digital thermometers, to the nearest increment. Take the temperature of the test liquid in the prover immediately following each accuracy test. For provers equipped with more than one thermometer, the temperature of the test liquid is the mathematical average of the individual readings.

A thermometer placed in the thermowell adjacent to the meter is to be used to determine meter temperature. Meter temperature is to be taken at 1/3 and 2/3 prover capacity during each delivery and averaged.

12. Automatic-stop-mechanism must stop flow within one-half the minimum interval indicated S.2.4.

Test Procedure:

Use proper lifting techniques to lift and move equipment!
**Be aware of and attempt to eliminate potential ignition sources
in or near the inspection site.**
Be aware of vehicular and pedestrian traffic in the area.

1. Wet prover.
2. Empty prover. Allow a 30-second drain period each time the prover is emptied, using one of the methods outlined in the Test Notes. The amount of time between wetting the prover and the first test draft should be minimal.
3. Insert a meter ticket and set preset stop mechanism for the rated capacity of the prover.

Reset the meter to zero.
4. Start the pump, then open the prover delivery valve.
 - If any test result is close to or outside of applicable tolerance, then repeat the test.
 - If two consecutive tests are found to exceed applicable tolerance values, discontinue accuracy test and proceed to next portion of EPO.

For Repair Personnel:

Three consecutive test runs should be performed to insure repeatability. The difference between the high and low readings of these three consecutive runs should not exceed 0.05 percent of the prover's certified volume.

If test results exceed applicable tolerance values, the meter should be adjusted at this point. Repair personnel should follow company policy regarding adjustment of meter; for meters equipped with a temperature compensator, it may be necessary to first deactivate the temperature compensator prior to making any adjustment.

A check for the performance of the temperature sensor should be performed at the end of each accuracy test. Utilize the section at the end of each worksheet to analyze the performance of the sensor. Should a variation of 1 °C or 2°F exist for two consecutive runs, the normal operating thermometer must be recalibrated against a National Institute of Standards and Technology traceable thermometer.

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5. Accuracy Tests

a. Nontemperature-compensated meters.

Temperature corrections are to be made for accuracy tests to account for any difference between the temperature of the liquid passing through the meter and the liquid in the prover.

1) Normal test--full flow. N.5.

a) Fill prover in a manner simulating actual use and determine actual flow rate. Test should be run at the maximum discharge rate anticipated under the conditions of the installation. Actual rate of flow should be within manufacturer's ratings of minimum and maximum flow. N.4.1., N.4.1.1., N.4.1.2, T.2., Table T.2., T.3.

b) Verify that all valves are closed and that prover remains level. Examine prover piping to insure that there is no entrapment of air and that there are no leaks. G-UR.3.1., UR.2.2.

c) Disconnect the bottom loading coupler or remove the loading spout from the liquid.

d) Allow time for product settling and foam dissipation prior to taking prover reading.

e) Read the thermometers as described in **Test Notes**, and record the reading to the nearest 0.25 °C or 0.5 °F.

f. For an analog device, record ending meter reading to the nearest 0.1 gallon. For a digital-indicating device, record the meter indication to the smallest quantity division available, e.g., test mode indication. Check totalizer against actual amount dispensed.

g) Disconnect vapor recovery hose and then drain prover. N.4.4., N.4.4.2

h) Use appropriate worksheet to determine meter error.

2) Special test--slow flow N.4.2., N.4.2.4., T.2., Table T.2.

a) Reconnect vapor recovery hose, if applicable.

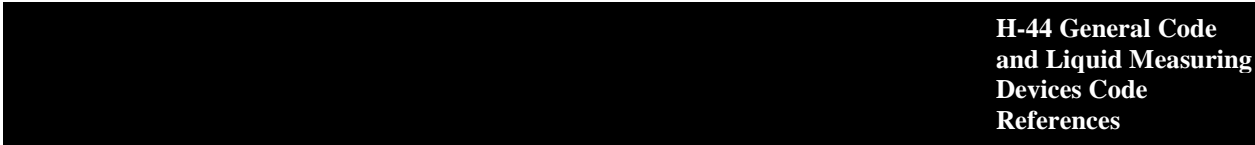
b) Fill prover at or slightly above the slower of
-the minimum discharge rate marked on the device; or
-20% of the minimum discharge rate marked on the device.

In no case shall the test be performed at a flow rate less than the minimum discharge rate marked on the device.

c) Repeat steps (b) through (h) of part 5.a.(1) above.

Test Procedure (cont.):

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b. Temperature compensated meters.

For meters that indicate in "net" gallons. With temperature compensator activated:

- 1) Normal test--full flow (do not deactivate temperature compensating system)..... N.4.1., N.4.1.1.,
N.4.1.2., T.2., Table
T.2., T.3.
 - a) Fill prover as described in part 5.a.(1) above.
 - b) Obtain temperature of product at meter at 1/3 and 2/3 prover capacity. Determine the average.
 - c) Follow remaining steps in part 5.a.(1) above, using the worksheet for compensated meters to determine meter error.

Deactivate temperature compensator:

- 2) Normal test--full flow..... N.4.1., N.4.1.1.,
N.4.1.2., T.2., Table
T.2., T.3., T.4. (1/1/88)
Follow testing procedure described in part 5.a. (1) above for normal test, uncompensated meters, determine meter error using worksheet for uncompensated meters.
- 3) Special test--slow flow N.4.2., N.4.2.4., T.2.,
Table T.2.
 - Follow testing procedure described in part 5.a.(2) above for special test, uncompensated meters. Determine meter error using worksheet for uncompensated meters.

Reactivate temperature compensator.

c. Temperature compensated meters.

For meters that indicate or record in "gross" gallons (uncompensated) and "net" gallons (compensated).

- 1) Accuracy of "gross" gallons is to be determined following the test procedure for non-temperature compensated meters in part 5.a.(1) and (2) above to perform both normal and special tests.
- 2) Accuracy of "net" gallons is to be determined as follows:
 - a) For each normal test run in part 5.c.(1) above, obtain the temperature of product at meter at 1/3 and 2/3 capacity of prover and determine the average.

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Test Procedure (cont.):

b) Follow remaining steps in 5.a.(1) using the worksheet for compensated meters to determine the error.

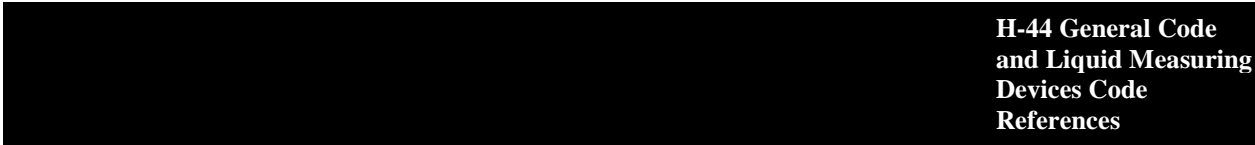
6. For automatic temperature compensating systems. The difference between the meter error for tests performed with and without the automatic temperature compensating system activated shall not exceed 0.2 percent for mechanical ATCS and 0.1 percent for electronic ATCS of the test draft. The results of each test shall be within applicable tolerances.

For systems that indicate or record in both “gross” (uncompensated) and “net”(compensated) quantities, it is not necessary to run multiple tests. “Compensated” and “Uncompensated” test results can be calculated from a single test draft using the T.4. “gross” and “net” indications along with observed temperature information.

Tests: All Meters

1. For a wet-hose system, check the effectiveness of the anti-drain valve. S.3.7.
2. For a dry-hose system, check for complete drainage of the hose. S.3.4.
3. Radio Frequency Interference (RFI)/Electromagnetic Interference (EMI) (only if a problem is suspected). Test using only equipment on site in the vicinity of the metering system, perform a test for radio frequency/electromagnetic interference.

Results of this test must indicate that use of such equipment does not adversely affect performance of the metering system..... G-N.2., G-UR.1.2., G-UR.3.2., G-UR.4.2.



Post-Test Tasks:

1. Security Means.

Check for the presence of security seals on the device. Document missing seals on the official report and apply new ones as needed. G-UR.4.5.

Adequate provision shall be made for applying a physical security seal or providing for other approved means of security. G-S.8., S.2.2., Table S.2.2. (1/1/95)

Audit Trail Information. If the system is equipped with an audit trail, note the event counter settings on the report form for future reference. If equipped with an event G-S.8., S.2.2., Table logger, print a copy of the event log and attach it to the report form for future S.2.2. (1/1/95) reference.

2. Following completion of a successful examination, attach a label or tag indicating the type of liquid used during the test. N.1.2.

3. After all equipment at a location has been tested, review results to determine compliance with equipment maintenance and use of adjustments. G-UR.4.1., G-UR.4.3.

4. Record the compliance action and disposition of the device on the report and explain the results to the device owner.

**Use extreme caution when switch-loading product!
Test devices metering low-vapor pressure products (e.g., diesel fuel and kerosene) before testing devices metering high-vapor pressure products (e.g., gasoline and ethanol blends up to E85) with the same test measure or prover. Additional precautions may be necessary with other high-vapor pressure products.
Take precautions to isolate equipment when transporting it to avoid exposure to hazardous fumes.**

