CHAPTER 6

THE TEST

CHAPTER OBJECTIVES

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

1. Make Pretest Determinations relating to tolerances and product storage identification.

2. Understand and use the Test portion of the appropriate Examination Procedure Outline, including Test Notes.

3. Identify specific procedures for testing single-product retail motor-fuel devices.

4. Identify specific procedures for testing blended-product retail motor-fuel devices.

INTRODUCTION

This chapter presents the procedures for testing retail motor-fuel dispensers to determine compliance with performance requirements. These performance requirements relate to the ability of the device to measure and deliver motor fuel and to indicate, compute, and record these deliveries accurately and consistently under normal operating conditions. Performance is tested against specified tolerances.

As with the section on the Inspection, we will follow the EPO's, quoting and commenting on relevant code references and describing the step-by-step procedure.

PRETEST DETERMINATIONS

Before the Test is conducted, certain Pretest Determinations must be made to ensure that proper tolerances are applied and that other test factors are correct.

Figure 6-1 shows a portion of the Pretest Determinations section of EPO 21 and 22. Pretest Determinations for single- (includes dual and multi-product dispensers) and blended-product dispensers are identical.

Excerpts from EPO 21 and 22

Pretest Determinations:

1. Tolerances.
   Applicable requirements.....G-T., T.1.
   Basic values.....T.2.

2. Product storage identification.....UR.2.5.

Test Notes:

Wear appropriate personal protection equipment such as petroleum-resistant, nonskid safety shoes (to prevent possible injury from spills or slipping on slick surfaces), protective clothing, and eye protection to prevent injury from splashed product

Do not leave an activated dispenser unattended !

1. If test measure is dry, add 16.4 milliliter (one cubic inch) to gauge reading to allow for amount of liquid required to "wet" measure.

2. Hand held test measures require a 30-second (± 5 second) pour followed by a 10-second drain, with the measure held at a 10 to 15 degree angle from vertical. (see NIST HB 105-3, Specifications and Tolerances for Graduated Neck Type Volumetric Field Standards, 1997, section 7).

Ground test measure properly and only use a <u>metal</u> funnel when returning product to storage

Note: For the remainder of the EPO see the complete copy in the back of your notebook

Figure 6-1. EPO, Pretest Determinations

Tolerances

It is recognized that errorless value or performance of weighing and measuring devices is virtually unattainable. Tolerances are established, therefore, to fix the acceptable range of inaccuracy for devices in commercial use. Tolerances are intended to permit errors that are small enough that they can not cause serious economic injury to either buyer or seller. At the same time, tolerances can not be so stringent as to make the costs of manufacturing and maintaining equipment unreasonably burdensome: these costs would simply be passed on to the consumer in any case. Tolerances established by code or regulation are considered by manufacturers as minimum requirements. Individual manufacturers and industries can, and often do, establish performance tolerances that are more stringent.

For motor-fuel dispensers two sets of tolerances are established:

- acceptance tolerances are applied to new equipment when it is first put into service, when it is returned to service after reconditioning or replacement of major components, when adjustments or repairs have been made as the result of official rejection in a previous examination, or when it is undergoing type evaluation; and

- maintenance tolerances are applied to equipment that has been in service for more than 30 days.

Acceptance tolerances for retail motor-fuel devices are specified as 1/2 the value of the maintenance tolerances (see T.2., below). Thus maintenance tolerances provide a somewhat less stringent compliance standard. This allows a limited degree of deterioration in performance and generally assures a reasonable period of use before the device must be reconditioned.

G-T.1. Acceptance Tolerances. - Acceptance tolerances shall apply to:

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

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

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

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

(e) equipment undergoing type evaluation.
(Amended 1989)

G-T.2. Maintenance Tolerances. - Maintenance tolerances shall apply to equipment in actual use, except as provided in G-T.1.

Both acceptance and maintenance tolerances apply to errors of underregistration and overregistration.

- Underregistration involves the indication of a smaller volume of product than has actually been delivered, and favors the buyer.

- Overregistration involves the indication of a greater volume of product than has actually been delivered, and favors the seller.

G-T.3. Application. - Tolerances "in excess" and tolerances "in deficiency" shall apply to errors in excess and to errors in deficiency, respectively. Tolerances "on overregistration" and tolerances "on underregistration" shall apply to errors in the direction of overregistration and of underregistration, respectively. (See Appendix D, Definitions.)

G-T.4. For Intermediate Values. - For a capacity, indication, load, value, etc., intermediate between two capacities, indications, loads, values, etc., listed in a table of tolerances, the tolerances prescribed for the lower capacity, indication, load, value, etc., shall be applied.

T.1. Application to Underregistration and to Overregistration. - The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration, whether or not a device is equipped with an automatic temperature compensator.

Reference is made to "normal" and "special" tests. This distinction will be explained below. Note, however, that the same tolerances apply to both normal and special tests. Maintenance and acceptance tolerances for retail motor-fuel devices are based upon a percentage of the quantity of the test draft.

Referring to paragraph T.2 and Table T.2., if a 5-gallon draft is to be used, the maintenance tolerance will be 6 cubic inches.

The acceptance value for this draft will be 3 cubic inches. For a maintenance test, if the difference between the indicated volume and the delivered volume was greater than 6 cubic inches (either plus or minus), the dispenser would not be in compliance. The test procedure used to make this determination will be discussed later.

Repeatability tests are tests made at approximately the same flow rate. For instance two or more tests made at the high nozzle latch position, or two or more tests made at the low nozzle latch position could be considered repeatable tests. Care should be taken to assure that the flow rate is approximately the same for each repeatability test run; other dispensers in use at the same time, for instance, may have an effect on the flow rate of the particular dispenser being tested. The range of tests (spread) shall not exceed 40 percent of the absolute value of the maintenance tolerance, reference paragraph T.3.. In the above example the maintenance tolerance is 6 cubic inches. The repeatability tolerance for additional tests taken at approximately the same flow rate is 2 cubic inches (0.40 x 6 cu in = 2.4 use 2 cu in).

Applicable tolerances should be determined and recorded before the test procedure begins. To do this, you need to know the number of indicated gallons that will be used in the test procedure. This will normally be 5 if the device has a maximum discharge rate of less than 20 gal/min (less than 80 L/min for metric devices), as is the case for most retail dispensers. For dispensers with higher maximum discharge rates, test drafts are required to equal the amount of fuel discharged in one minute at the highest rate (see paragraph N.3.4., which appears in the Test section of this Chapter).

T.2. Tolerance Values. Maintenance, Acceptance, and special Test Tolerances shall be as shown in Table T.2.

Table T.2. Accuracy Classes for Liquid Measuring Devices Covered in NIST Handbook 44 Section 3.30

Accuracy Class	Application	Acceptance Tolerance	Maintenance Tolerance	Special Test Tolerance
0.3	**Petroleum products including large capacity motor fuel devices (flow rates over 115 L/min (30 gpm))**, heated products at or greater than 50 °C asphalt at or below temperatures 50 °C, all other liquids not shown where the typical delivery is over 200 L (50 gal)**	**0.2 %**	**0.3 %**	**0.5 %**
0.3A	**Asphalt at temperatures greater than 50 °C**	**0.3 %**	**0.3 %**	**0.5 %**
0.5*	**Petroleum products delivered from small capacity (at 4 L/min (1 gpm) through 115 L/min (30 gpm))** motor-fuel devices, agri-chemical liquids, and all other applications not shown.**	**0.3 %**	**0.5 %**	**0.5%**
1.1	**Petroleum products and other normal liquids from devices with flow rates** less than 1 gpm and devices designed to deliver less than one gallon.**	**0.75 %**	**1.0 %**	**1.25%**

***The maintenance tolerances on normal and special tests for 5-gallon and 10-gallon test drafts are 6 cubic inches and 11 cubic inches, respectively. Acceptance tolerances on normal and special tests are 3 cubic inches and 5.5 cubic inches.**

**** Flow rate refers to designed or marked maximum flow rate.**

T.3. Repeatability. - When multiple tests are conducted at approximately the same flow rate, the range of the test results for the flow rate shall not exceed 40 percent of the absolute value of the maintenance tolerance.

(Added 1992)

Product Storage Identification

As you know, except for blended products, each different product or grade of fuel sold must have its own storage tank(s). Mixture resulting from accidentally introducing a product or grade of fuel into the wrong storage tank can have serious consequences. First, the consumer will not be getting what he or she is paying for. Worse, however, many engines may be damaged by operating them with the wrong product.
To avoid accidental mixing of products in the storage tanks, fill pipes must be clearly marked to indicate to suppliers and all other persons who have access to them—including the inspector, who will be returning test

drafts to the tanks—what product and grade of fuel they contain. A number of different methods of identification are in common use, including printed tags and color coding.

UR.2.5. Product Storage Identification.

(a) The fill connection for any petroleum product storage tank or vessel supplying motor-fuel devices shall be permanently, plainly, and visibly marked as to product contained.

(b) When the fill connection device is marked by means of a color code, the color code key shall be conspicuously displayed at the place of business.
(Added 1975 and amended 1976)

You should remove the protective cover from each fill pipe opening and inspect the markings to determine that the required information is complete and that it is clearly, legibly, and permanently marked. If a color-coding system is used, a legend must be provided.

TEST NOTES

When you have completed the Pretest Determinations you are ready to begin the Test of the dispensing system's performance. The EPO provides step-by-step instructions for each stage of the procedure. Several steps are performed repeatedly at various stages in the Test. In order to make the outline of the procedure simpler and easier to follow, these steps are described in a separate section of the EPO immediately preceding the Test section, and are referred to as Test Notes.

The Test Notes for single- and blended-product dispensers are identical except that one additional note concerning returning product to storage is included in the EPO for blended-product dispensers (see Figure 6-2).

Items 1 and 2 in the Test Notes have been described in detail in Chapter 4 of this course. You may want to review that discussion before continuing.

Item 3. Handbook 44 requires totalizers (paragraph S.5. - nonretroactive as of *January 1, 1995*), however most dispensers are equipped with totalizers, both for money values and volume. These elements indicate running totals for a period of time and for a number of deliveries, they may be mechanical, electro-mechanical or electronic. They provide the proprietor with information on sales that is useful for inventory management and for detecting fraud or pilfering by suppliers or employees. The above referenced paragraph requires that totalizers be nonresettable. In most cases totalizers, prior to this requirement were also nonresettable.

Totalizers are not considered to be primary indicating elements unless they are used as the basis for transactions between a buyer and a seller. Although they are often used exclusively for the convenience of the operator and not as the basis for sales, you have learned that there are exceptional situations (self-operated devices,
consignment agreements with suppliers, etc.) in which totalizers are primary elements, and are subject to specifications and requirements for design, readability, etc. Totalizers that are primary indicating elements must also meet the performance requirements for comparability and variation between indicated price and the price computed mathematically.

Excerpts from EPO 22

Test Notes:

Wear appropriate personal protection equipment such as petroleum-resistant, nonskid safety shoes (to prevent possible injury from spills or slipping on slick surfaces), protective clothing, and eye protection to prevent injury from splashed product

Do not leave an activated dispenser unattended !

1. If test measure is dry, add 16.4 mL (one cubic inch) to gauge reading to allow for amount of liquid required to "wet" measure.

2. Hand held test measures require a 30-second (± 5 second) pour followed by a 10-second drain, with the measure held at a 10 to 15 degree angle from vertical. (see NIST HB 105-3, Specifications and Tolerances for Graduated Neck Type Volumetric Field Standards, 1997, section 7).

Ground test measure properly and only use a <u>metal</u> funnel when returning product to storage

3. To determine proper operation of totalizers, read and record the totalizer indications before and after all test drafts. S.5. (1/1/95)

4. After each test draft:
   a. print ticket if device is so equipped.....G-S.5.6., S.1.6.7. (1/1/86), UR.3.4.
   b. check price computations on all indicators .....S.1.6.5.(a) (1/1/91) (including consoles) and on recorded representations.
      digital equipment .....G-S.5.5.
      analog equipment.....S.1.6.5.(b), N.4.3.2.
   c. check for agreement between indications .....G-S.5.2.2., S.1.6.6.(a), S.1.6.6.(b) (1/1/88)

5. Verify after a delivery is completed, the quantity and total price are displayed for at least 5 minutes or until the next transaction S.1.6.5.5. (1/1/94

FIGURE 6-2 TEST NOTES, EPO FOR BLENDED-PRODUCT DISPENSERS

Even if the totalizers are not primary elements in the system you are examining, readings should be recorded at the beginning and end of each test draft. There are two reasons for this procedure. The first is that you will have to account for all product dispensed in the course of the examination so that the operator can reconcile inventory figures (totalizers will show that product has been delivered, even though test drafts have subsequently been returned to storage tanks). The second reason is that totalizers are interlocked with other indicating elements, and thus provide a means of checking other indicated values.

Both money and volume totalizers should be read and the indicated values recorded before and after each test draft is drawn. The difference between ending and beginning readings should agree with primary indicating elements. If they do not agree, there is a malfunction in the indicating system, and further tests may be required to locate it.

Item 4

4.1 If the dispenser is connected to an automatic ticket printer, the printer is a primary recording element, and is generally subject to the same requirements for readability, Maximum Allowable Variation (MAV) between recorded price and mathematically computed price, and comparability with other primary elements as indicating elements (G-S.5.6.; see discussion of this paragraph in the last chapter, under **Indicating and Recording Elements, Readability**). These requirements are described under **b** and **c** in this section.

Receipts printed by cash registers that are interfaced with dispensers (as at a convenience store) may include sales information for other merchandise. However, when the receipt includes motor fuel, in accordance with Paragraph S.1.6.7. (explained in Chapter 5 under "Recorded Representations, Point of Sale Systems"), the receipt must show the volume, unit price, total computed price, and the product identity. An example of such a ticket is shown in Figure 6-3..

GAS TO GO
1234 Fifth Street
Your Town, State Zip

Trans. # 87654321 11/17/97 8:40 A

Product	Quantity (gal)	Price	Total
Prem. unl.	8.678	$1.299	$11.27
Other Merchandise (incl. Tax)			2.89
	Total Purchase		$14.16

FIGURE 6-3. PRINTED TICKET

A related requirement, UR.3.4., states that any printed ticket issued by the device must display the total price, unit price, and total volume, although these items may be written in a clear hand script. This provision would allow, for example, for a ticket issued by a totalizing device: the beginning and ending totalizer readings might be printed, with the operator computing the total price and volume and marking these by hand, along with the unit price, on the ticket. Paragraph UR.3.4. does not apply to bank card readers or other printing elements that are not interfaced with a retail motor-fuel dispenser, console, or other portion of the measuring system.

> **UR.3.4. Printed Ticket.** - The total price, the total volume of the delivery, and the price per gallon or liter shall be shown, either printed or in clear hand script, on any printed ticket issued by a device and containing any one of these values.
> (Amended 2001)

Because repeatability is a requirement of an accurate device, printed tickets should be checked after each test draft, even if the first recorded indications are correct. If discrepancies are found between the printer and other primary elements, additional tests may be required to isolate the malfunctioning element.

4.2 The unit price for most motor-fuel products includes fractional cents and the quantity delivered often includes a fraction of a gallon, but the computed price is always indicated in whole cents. The computing device, whether analog or digital, resolves fractions of cents into whole cents continuously. So the indicated or recorded price of a delivery will most often not be in exact agreement with the price computed mathematically.

For example, if the unit price is $1.299/gal and 8.678 gallons of the product are purchased, the price of the sale will be $11.27. However, computed mathematically, it will be slightly more:

Unit Price x Quantity = Sale Price
$1.299/gal x 8.678 gal = $11.273

The difference between the indicated or recorded money-value and the mathematically computed value is limited by Handbook 44 requirements. Note that the Maximum Allowable Variations (MAV's) specified are different for analog and digital devices.

In accordance with S.1.6.5.(b), the difference (whether plus or minus) between the indicated price and the price computed mathematically by an analog device must not exceed the MAV's specified in Table 1 of the LMD Code (reproduced in the last chapter, under **Money-Value Divisions**). The MAV's in Table 1 vary with the unit price and the type of examination (design tests are those performed as part of the NTEP evaluation; field tests are those conducted as part of a routine examination; see N.4.3.2.).

> **S.1.6.5. Money-Value Computations**
>
> * * *
>
> (b) The analog sales price indicated for any delivered quantity shall not differ from a mathematically computed price (quantity x unit price = total sales price) by an amount greater than the value in Table 1.
> (Amended 1984, 1989)
>
> **N.4.3.2. Field Tests**. - In the conduct of field tests to determine compliance with paragraph S.1.6.5., the maximum allowable variation in the indicated sales price shall be as shown in Table 1.

Note that S.1.6.5.(a) relates to computing capability, and was described in the last chapter, under **Multiple Unit Price Dispensers**).

In accordance with G-S.5.5., a digitally indicated, or recorded money value must agree with the mathematically computed value to the nearest one cent of money value. Formula: Quantity x Unit Price = Sales Price ± 1/2 cent.

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

Variation in excess of the MAV may indicate a mechanical malfunction in the computer, the effects of radio frequency or electromagnetic interference (RFI/EMI) if the device is electronic, or tampering with the computing device. The cause may become apparent as you continue the examination. If it does not, additional tests may be required.

Again, since repeatability is a requirement of accuracy, checks should be made of each primary indicating element after each draft. When testing multiple unit price dispensers, different unit prices should be selected on each test draft, to assure that the dispenser can meet the money-value computation requirement at all unit prices for which it can be set.

4.3 The readings taken from the primary indicating and recording elements after each draft should be recorded and compared. All indicated money values must agree exactly. If a system has both analog and digital elements, like values must agree to the nearest minimum graduation.

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

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

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

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

(d) *A digital zero indication includes the display of a zero for all places that are displayed to the right of the decimal point and at least one place to the left. When no decimal values are displayed, a zero shall be displayed for each place of the displayed scale division. [Nonretroactive as of January 1, 1986.]*
(Amended 1973 and 1985)

S.1.6.6. Agreement Between Indications. - When a quantity value indicated or recorded by an auxiliary element is a derived or computed value based on data received from a retail motor fuel dispenser, the value may differ from the quantity value displayed on the dispenser, provided the following conditions are met:

(a) all total money values for an individual sale that are indicated or recorded by the system agree, and

(b) within each element, the values indicated or recorded meet the formula (quantity x unit price = total sales price) to the closest cent.

[Nonretroactive as of January 1, 1988.]
(Added 1985) (Amended 1987 and 1988)

Quantity values indicated or recorded on auxiliary elements may vary from those shown on the main primary indicator (as a result of using derived values) provided that all total money values indicated or recorded agree exactly and that the computed money-value displayed by the auxiliary element agrees with the mathematically computed value to the closest cent. For example, the money values on a remote indicator, such as a control console, must agree with those of the dispenser for any given delivery exactly; the indicated quantities may vary slightly, as long as the applicable requirements for agreement between indicated and mathematically computed values can also be met by the dispenser and the console separately.

THE TEST

The test comprises the same steps for single- and blended-product dispensers. However, several steps are repeated in the latter procedure. So we will look at the procedures given in EPO 21 for single-product dispensers first (see Figure 6-4), then compare them with the procedures in EPO 22 for blended-product dispensers.

1. Normal Test

The first procedure in the Test is referred to as the "Normal Test." The Normal Test of a retail motor-fuel dispensing system is intended to approximate as closely as possible the operating characteristics of the system during a normal delivery—that is, in the type of service for which the equipment is most often used. The performance of the entire system's ability to measure and indicate correctly under these conditions is tested.

When testing retail motor-fuel dispensers in the field you will always use the actual product dispensed, since substituting another liquid of the same general physical characteristics would necessitate draining the storage tanks, and this would constitute an unreasonable burden for the operator. (The requirement of N.1.1. is intended primarily for wholesale devices, especially loading-rack meters, which may be used to dispense liquids that cannot practicably and safely be tested, usually because of extreme toxicity, corrosiveness, or volatility.)

N.1.1. Type of Liquid. - The liquid used for testing a liquid-measuring device shall be the type the device is used to measure, or another liquid with the same general physical characteristics.

FIGURE 6-4 EPO FOR SINGLE-PRODUCT DISPENSERS, TEST SECTION

Excerpts from EPO 21 Test Section

Test:

Use proper lifting techniques when lifting test measure !

Be aware of and attempt to eliminate potential ignition sources in or near the inspection site

Be aware of vehicular and pedestrian traffic when moving between dispenser and storage tanks

1. Normal test--full flow, basic tolerance N.1.1., N.2., N.3.4., N.4.1., T.2., UR.2.2
   At the beginning of the first delivery,
   check for suppressed values. .....S.1.6.1.
   If first test result is at or near the tolerance
   limit, repeat this test. .....T.3., N.4.1.2.
   Petroleum Product Sampling[1]

2. Special test--slow flow, basic tolerance .....N.4.2., N.4.2.2., T.2.

3. RFI/EMI test (electronic equipment only) .....G-N.2., G-UR.1.2., G-UR.3.2., G-UR.4.2.
   Radio Frequency Interference (RFI)
   Electromagnetic Interference (EMI)

4. Check effectiveness of anti-drain means.....S.3.7.

5. Check effectiveness of zero-setback interlock. .....S.2.5.
   On equipment with remote pumping systems,
   activate one dispenser and check all others
   operated by the same pump to make certain
   they will not operate without activating the
   individual starting levers.

6. Power loss test .....S.1.6.2.1.(1/1/83), S.1.6.2.2. (1/1/83)
   Check with your supervisor before requiring shutdown of power to equipment under test.

7. Security means
   a. Check for / apply security seal .....G-UR.4.5.
   b. Record audit trail information.....S.2.2. (c) (1/1/95), Table S.2.2. (1/1/95)

Record on the official report, the number of gallons of product dispensed during testing.

[1] When taking gasoline samples from single hose multi-product dispensers, the samples should be collected after an observed sale of the particular grade or product to be tested, or sufficient product should be purged from the hose to ensure the sample is representative of the grade or product being sampled. The National Conference on Weights and Measures policy on procedures for taking samples for octane verification is as follows: **"A minimum of a liter (0.3 gallon) of engine fuel shall be flushed from the dispensers before taking a sample for octane verification. This flush shall be returned to the storage tank containing the lowest octane."** (see NCWM Publication 21, Petroleum Products Sampling Procedures and Safety Manual, August 1997).

Reset the dispenser to zero (this may require "authorizing" the pump if it is controlled by a remote console) and check all indicators for zero reading.

A small amount of fuel may remain in the discharge nozzle (ahead of the antidrain valve) from the previous delivery. This is usually no more than a drop or two of liquid, and should under no circumstances be more than one cubic inch (it is simply clingage that was not drained when the nozzle was righted and hung on the dispenser). But even a small amount can affect test results. So you should drain this residual fuel into some suitable metal container other than the test measure before beginning the test.

Remove the nozzle from the boot and switch the dispenser on. When switched on, the dispenser's indicating elements should automatically reset to zero, with no values visible during the resetting process (S.1.3., discussed in the last chapter, under **Indicating and Recording Elements, Advancement and Return to Zero**). Before the discharge nozzle is operated, quantity and total sale price indicators should read zero exactly. However, you may observe what is known as "computer jump", that is, the indicators jumping ahead and showing a slight amount when the dispenser is pressurized, even though no fuel has actually been delivered. This condition is not abnormal when the dispenser has been out of use for a matter of hours. So if computer jump is observed, shut off the dispenser, re-zero the computer, and try again. If the computer jumps again on the second try,
the device is not operating properly. You should inform the operator of this condition, even if the dispenser performs within tolerances, since it indicates a need for prompt attention to prevent the cause from affecting accuracy.

Computer jump can be attributed to one of several causes (see Figure 6-5):

- a deteriorated or substandard discharge hose that "gives" when the pump is pressurized, requiring a small amount of fuel to pass through the dispenser control valve and the meter before pressure is equalized;

- malfunctioning check or relief valves, allowing pressure to bleed back to the pump side;

- a malfunctioning antidrain means; or

- the effects of temperature change on the volume of fuel in the system, especially in the discharge hose

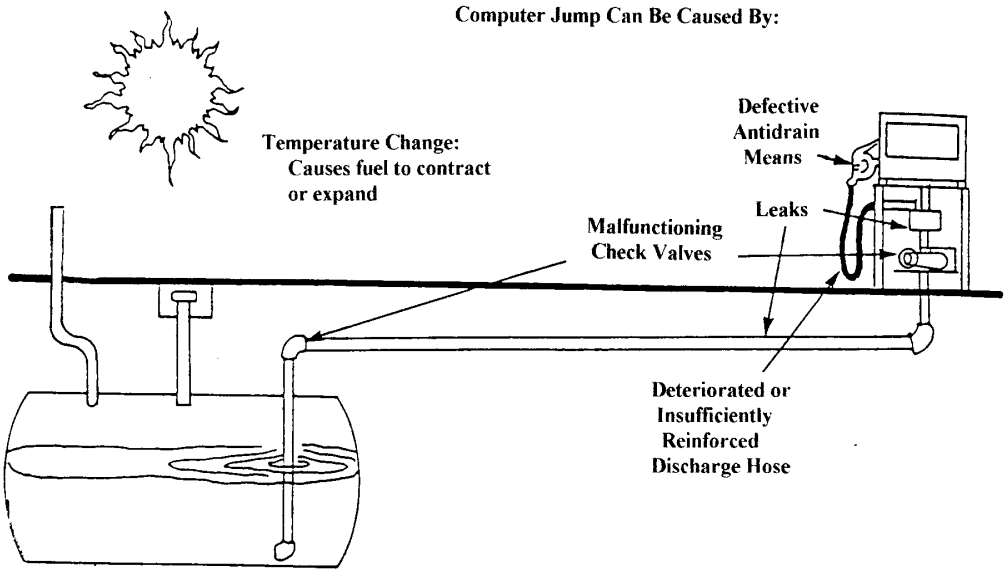

FIGURE 6-5. COMPUTER JUMP

(A special "elapsed-time test", was formerly included in the EPO's to determine the amount of leakage error for a dispenser that showed computer jump in two consecutive trials. This test is no longer required for routine field examinations. However, your jurisdiction may require an elapsed-time test under certain test conditions. Your instructor will explain your jurisdiction's policy regarding elapsed-time tests and explain any required procedures to you.)

In fact, a very small amount of computer jump occurs every time the pump is pressurized, and is unavoidable. This small amount will not be detectable on most analog devices, which indicate amounts no smaller than hundredths of gallons. But many digital devices indicate thousandths of gallons. To avoid confusion and misunderstanding, such devices may suppress the first 0.009 gal (or 0.03 liters) and the associated price indicated (S.1.6.1., discussed in the last chapter under **Indicating and Recording Elements, Indication of Delivery**). These indications are generally simply blanked out, the first visible indications occurring at 0.010 gal. When testing digital equipment indicating in thousandths of a gallon, notice the first indicated amount to determine that it is not more than 0.010 gal (or 0.04 liters).

The normal test should be conducted in a manner that approaches, as far as possible, normal operating conditions. Since the greater part of most actual deliveries are made at the maximum discharge rate of the dispenser, you should do the same when dispensing drafts for this test, holding the discharge lever wide open until it is necessary to reduce flow to stop at the correct indication, or to prevent spillage from foaming fuel.

N.4.1. Normal Tests. - The "normal" test of a device shall be made at the maximum discharge flow rate developed under the conditions of installation. Any additional tests conducted at flow rates down to and including one-half of the sum of the maximum discharge flow rate and the rated minimum discharge flow rate shall be considered normal tests.
(Amended 1991)

For most dispensers installed to service primarily automobiles, a 5-gallon draft is sufficient for this test. Pumps intended for fueling large trucks generally are designed with higher flow rates, since truck fill pipes are larger and can generally accept high flow rates without backing up fuel and causing spillage. If the dispenser you are testing has a maximum flow rate of 20 gal/min (80 L/min) or greater, drafts of up to 50 gal may be required. In such situations, you will need a special prover, usually truck-mounted, to conduct the Test.

N.3.4. Other Retail Devices. - On devices with a designed maximum discharge rate of:

(a) less than 20 gallons (80 L) per minute, tests shall include drafts of one or more amounts, including a draft of at least 5 gallons.

(b) 20 gallons (80 L) per minute or greater, tests shall include drafts of one or more amounts, including a draft of at least the amount delivered by the device in one minute at the maximum flow rate of the installation.
(Amended 1984)

Test the discharge nozzle's automatic shut-off valve, by touching the tip of the nozzle to the surface of the fuel toward the end of the draft. The nozzle should respond immediately, shutting off the flow.

Continue filling until the volume indicated on the dispenser equals the nominal capacity of the test measure (5 gal, etc.). The correct techniques for setting up and reading the test measure were described in Chapter 4. A reading should be taken as soon as possible after the draft is taken in order to prevent the effects of temperature change or evaporation from influencing Test results. Record errors, both plus and minus, carefully on your report form.

N.2. Volume Change. - Care shall be taken to minimize changes in volume of the test liquid due to temperature changes and evaporation losses.

If the error is close to the applicable tolerance (as identified in the Pretest Determinations described earlier in this chapter), a second draft should be taken to confirm the results. Readings for this second draft should also be recorded.

Remember to observe all primary indicating and recording elements following each draft to determine agreement between indicated price and the mathematically computed price. Record any variations that exceed the MAV. This will require either arithmetic, a hand-held calculator, or the use of price computation tables. Also check all auxiliary indicating and recording elements for comparability and record any discrepancies.

2. Special Test (slow flow)

Special Tests are used to test the performance of the device under conditions that are not usual, but which may occur. They thus confirm (or fail to confirm) the results of "normal tests" for the range of operating characteristics of the dispenser. In the case of retail motor-fuel dispensers, the Special Test required is a slow-flow test. Your first step will be to determine the appropriate flow rate for the test, the least of the following:

- 5 gallons (19 L) per minute,
- the minimum discharge rate marked on the dispenser, or
- the minimum rate deliverable by an automatic nozzle set at its lowest setting.

N.4.2. Special Tests. - "Special" tests, to develop the operating characteristics of a liquid-measuring device and any special elements and accessories attached to or associated with the device, shall be

made as circumstances require. Any test except as set forth in N.4.1. shall be considered a special test.

N.4.2.2. Retail Motor-Fuel Devices. –

(a) Devices with a flow-rate capacity less than 100 L (25 gal) per minute shall have a "special" test performed at the slower of the following rates:

(1) 19 L (5 gal) per minute, or

(2) the minimum discharge rate marked on the device, or

(3) the minimum discharge rate at which the device will deliver when equipped with an automatic discharge nozzle set at its slowest setting.

(b) Devices marked with a flow-rate capacity 100 L (25 gal) or more per minute, shall have a "special" test performed at the slowest of the following rates:

(1) the minimum discharge rate marked on the device, or

(2) the minimum discharge rate at which the device will deliver when equipped with an automatic discharge nozzle set at its slowest setting.
(Added 1984)

The only way to assure yourself that you are delivering at the required rate is to time the draft. If you must regulate the flow rate manually, try to maintain as steady a rate as possible while remaining within the time limit. If the appropriate flow rate is anything other than 5 gal/min, you can determine the time required to deliver 5 gal at that rate by dividing 5 gal by the number of gallons/minute. For example, if the minimum discharge rate marked on the dispenser is 2.5 gal/min, a delivery of 5 gal should be made at such a rate as to be completed in 2 minutes:

$$\frac{5 \text{ gal}}{2.5 \text{ gal/min}} = 2 \text{ min}$$

(Convert fractional minutes to seconds by multiplying by 60. For example, 5.25 minutes is equal to 5 minutes and 15 seconds: .25 minute x 60 = 15 seconds.)

In all other ways, the procedure for this special test is identical to that for the normal test, except that it need not be repeated.

3. RFI/EMI Test

All weighing and measuring devices that have electronic components are subject to the effects of radio frequency and electromagnetic interference (RFI/EMI). These two types of interference have different sources, but are basically the same in their nature and their effects.

The passage of electric current through a conductor creates a magnetic field around the conductor. If the direction, amplitude, or intensity of the current changes, the magnetic field surrounding the conductor changes in response. This changing magnetic field is then capable of inducing a current in another conductor located within the field (see Figure 6-6). The same effect can be achieved by changing the position of the conductor relative to a stationary magnetic field (this is the basic principle employed in electric power generation).

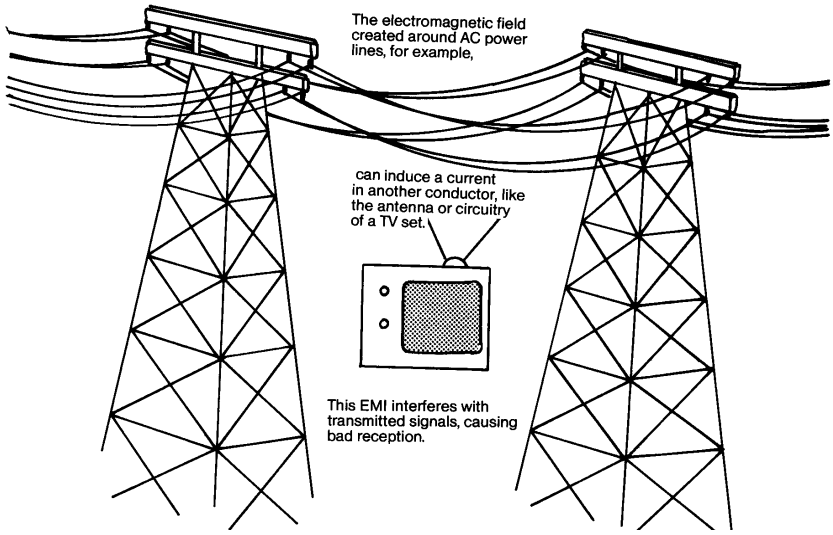

FIGURE 6-6. ELECTROMAGNETIC INTERFERENCE (EMI)

The circuitry of electronic devices consists of conductors that carry electrical signals. For example, you will recall from our discussion in Chapter 3, that in electronic fuel dispensers, discrete signals generated by the transducer (pulser) driven by the revolving meter shaft are transmitted through wiring to the CPU, where they are interpreted. If this wiring, or the circuitry of the transducer or the CPU, were to be brought into contact with a changing electromagnetic field, extraneous current could be produced. This extraneous current could either interfere with the pulses generated by the transducer, rendering them unrecognizable as signals, or under certain conditions it could produce additional pulses that might be interpreted as signals. In either case, the accuracy of the measuring device would obviously be impaired.

Under normal operating conditions, fuel dispensers are exposed to electromagnetic fields produced from a variety of sources. Among these are:

- radio-frequency transmitters from nearby broadcast facilities and mobile transmitters, like CB and commercial band two-way radios and mobile phones (RFI).
- generators, including those driven by vehicle engines to provide a continuous power supply (EMI).
- electrical discharge ignition (spark plugs) (EMI).
- power supply lines (EMI).
- appliances that have electric motors, like air conditioners and refrigeration systems, compressors, etc. (EMI).
- fluorescent lighting (EMI).

The electronic components of retail motor-fuel dispensers are designed in such a way as to be protected from interference from RFI and EMI under normal operating conditions. However, if these protections are defective or improperly installed, or if the equipment is located in a place where it is exposed to extraordinary amounts

of RFI or EMI (for example, next to the transmitting facility of a commercial radio or TV station) interference may occur.

The purpose of a testing procedure is not to determine the presence of RFI/EMI in the environment of the dispenser, but to determine whether the device is adequately protected from its effects, as required. Several sections in the General Code include requirements that relate to RFI/EMI (G-UR.1.2., G-UR.3.2., G-UR.4.2., and G-N.2.; these paragraphs are quoted together on the next page of text).

G-UR.1.2. Environment. - Equipment shall be suitable for the environment in which it is used including but not limited to the effects of wind, weather, and radio frequency interference (RFI).
(Added 1976)

G-UR.3.2. Associated and Nonassociated Equipment. - A device shall meet all performance requirements when associated or nonassociated equipment is operated in its usual and customary manner and location.
(Added 1976)

G-UR.4.2. Abnormal Performance. - Unstable indications or other abnormal equipment performance observed during operation shall be corrected and, if necessary, brought to the attention of competent service personnel.
(Added 1976)

G-N.2. Testing with Nonassociated Equipment. - Tests to determine conditions, such as RFI, that may adversely affect the performance of a device shall be conducted with equipment and under conditions that are usual and customary with respect to the location and use of the device.
(Added 1976)

Note that G-N.2. states that when testing with nonassociated equipment only "usual and ordinary" equipment may be used and that devices may be tested only under conditions that are usual and customary for their operation and service.

The Normal Test described above should be repeated with all sources of EMI/RFI that are present under normal operating conditions. All fluorescent lighting and electric motor-driven appliances and generating devices installed at the station should be turned on. In addition, a vehicle should be parked in the position appropriate for a delivery with its motor and any additional appliances (like an air-conditioner) turned on.

4. Antidrain Means

As you know, the purpose of the discharge nozzle antidrain means is to prevent the hose from being drained at the completion of a delivery. If the antidrain means is not functioning properly, the next delivery may not include all the fuel that has passed through the meter and the customer will be charged for product that he or she has not received. Note that the LMD Code requires that wet hose devices, like gas pumps, be equipped with means such as this to prevent draining of the hose between deliveries.

S.3.7. Antidrain Means. - In a wet-hose, pressure-type device, means shall be incorporated to prevent the drainage of the discharge hose.
(Amended 1990)

A simple test ensures that the antidrain means is operating properly. With the dispenser turned off, place the tip of the nozzle in an appropriate container and open the discharge valve. A small amount of fuel that remains in the nozzle ahead of the antidrain means may dribble out, but this flow should be only momentary. Then raise about three feet of the hose immediately behind the nozzle connector so that it is higher than the nozzle. If fuel flows when the discharge valve is opened, the antidrain means is malfunctioning.

5. Zero-Setback Mechanism

Once the dispenser has been turned off, it should not be possible to dispense fuel until the dispenser has been reset to zero. This is intended to prevent a subsequent delivery from being added to the indicated volume and price of the preceding one. The on-off control is therefore required to be interlocked with the zero-setback mechanism, so that the dispenser can not be turned on until the setback has been effected. In addition, it is required that means be provided to assure that the dispenser control switch can not be left in the on position after a delivery has been completed.

Requirements relating to the design of zero-setback mechanisms (S.2.5.) was described in the last chapter, under **Advancement and Return to Zero**. Note, also, that the LMD Code includes a user requirement (UR.3.5.), which requires that at the conclusion of a delivery the on/off lever must be placed in the OFF position, the zero-set-back interlock engaged (this should occur automatically when the dispenser is switched off), and the nozzle returned to its hanging position (unless all indicating and recording elements have returned to zero.)

UR.3.5. Steps After Dispensing. - After delivery to a customer from a retail motor-fuel device:

(a) the starting lever shall be returned to its shutoff position and the zero-set-back interlock engaged; and

(b) the discharge nozzle shall be returned to its designed hanging position unless the primary indicating elements, and recording if the device is equipped and activated to record, have been returned to a definite zero indication.

Activate the dispenser and check the zero indication. Then attempt to return the nozzle to its hanging position, with its tip placed in the receptacle. It should be impossible to do this without first moving the on-off switch to the off position. (In some designs the control switch in the on position physically blocks the reinsertion of the nozzle; in others, the control is built into the hanger, and must be switched off in order to accept the nozzle.) In other designs there is a "flapper" switch in the nozzle receptacle which turns the dispenser off when the flap is engaged by the nozzle. The most common malfunction of this assembly results from wear or improper adjustment of the control lever stop, with the result that the on position does not obstruct the nozzle receptacle.

If this test is satisfactory, remove the nozzle and attempt to switch the dispenser on. If it is equipped with a separate reset control (sometimes key-operated), it should be impossible to move the on-off control lever to the on position until the reset mechanism has been activated, either at the dispenser or by authorization from the control console. If the control lever can be operated, the reset must be actuated automatically. If fuel can be dispensed without the dispenser being reset, there is a malfunction in the interlock mechanism.

In remote dispenser systems and single-product dual dispensers, the on-off switch activates a control valve. To test the function of this automatic valve, remove the nozzle and attempt to operate the device without switching the dispenser on. If fuel flows from the nozzle (excepting the small amount of residual liquid in the nozzle itself) the control valve is defective. Next, switch on another dispenser that is served by the same pump (the other side of the dual dispenser, multi-product dispenser, or another dispenser in the same remote system) and

operate the discharge valve of the dispenser being tested. If fuel flows, this is also an indication of a malfunctioning control valve.

6. Power Loss Test (electronic systems)

Electronic systems are dependent upon a continuous power supply, not only for the operation of control components, but also for the maintenance of correct indications. During the course of a delivery, cumulative totals for the volume and price are stored in the electronic circuitry. If the electrical supply to these circuits is interrupted—even momentarily—this information could be lost.

For this reason, electronic systems are equipped with an auxiliary power source, usually a battery, so that in the event of a failure in the main power supply, indicating functions are maintained, at least long enough to complete pending transactions, and so that information on the transaction can be preserved, even if not displayed, for the duration of the power loss.

S.1.6.2. Provisions for Power Loss.

S.1.6.2.1. Transaction Information. *- In the event of a power loss, the information needed to complete any transaction in progress at the time of the power loss (such as the quantity and unit price, or sales price) shall be determinable for at least 15 minutes at the dispenser or at the console if the console is accessible to the customer.*
[Nonretroactive as of January 1, 1983.]

S.1.6.2.2. User Information. *- The device memory shall retain information on the quantity of fuel dispensed and the sales price totals during power loss.*
[Nonretroactive as of January 1, 1983.]

Testing the system's auxiliary power supply under performance conditions generally requires creating a main power loss by turning off circuit breakers to the dispenser(s) and any remote indicating or control devices. This can not be done without causing severe disruption to the operation of the entire station. For this reason, this test is not recommended for routine examinations. It may be conducted on the first examination of a system or device that is put into service for the first time, or in response to specific complaints. Most emergency and auxiliary power supplies are equipped with test circuits. These may be checked as an "audit" procedure in routine examinations.

To test the system's protection against power loss, main power should be shut off first to any remote devices. This should be done by a station employee while the inspector simulates a delivery, dispensing product into a test measure or other suitable container. Indications at these devices should then be observed for at least 15 minutes. Correct indications should be maintained and be readable during this period.

The next step is to restore main power to remote devices and shut off main power to the dispensers. Sufficient power should be available from the auxiliary source to accurately maintain indications for at least 15 minutes without loss of data.

Finally, main power should be cut off to both dispensers and remote devices simultaneously, and maintenance of indications and stored data for a period of 15 minutes observed.

Testing Blended-product Dispensers

Figure 6-7 is an excerpt from the Test portion of the EPO for blended-product dispensers (an entire copy of EPO 22 is in the back of your notebook). As you can see by comparison, items 4-9 correspond exactly to procedures (though numbered differently) just described for single-product dispensers. A closer look at the first three items will show that the differences in testing procedure for this type of dispenser are in the sequence and repetition of certain steps, and reflect the special design features and operating characteristics of this type of device.

A blended-product dispenser is really two dispensing units. One unit delivers high grade product, the other low-grade product. Either unit may be operated independently, or both may be operated simultaneously, combining high- and low-grade product in the discharge nozzle to produce an intermediate grade. So tests of the operating performance must cover each unit operating independently and both units operating together.

Item 1 applies a Normal Test and Special Test (slow flow) to the unit that measures and delivers the lowest grade of product. The procedure is exactly the same as for a Normal Test and Special Test on a single-product pump.

Item 2 applies a Normal Test and Special Test to the unit dispensing the highest grade, exactly as in Item 1.

Under Item 3, the Special Test (slow flow), is applied to the operating condition in which both units are operating simultaneously. The selector should be set at the middle grade for the first test. Again, the procedure is the same as for single-product dispensers, except that it is repeated (at different intermediate settings) if the results show an error that is greater than the average of errors observed in Items 1 and 2.

Item 3.4. The computing device in blended-product dispensers, whether electronic or mechanical, is far more complex than its counterpart in a single-product dispenser. It must integrate volume totals for both dispensing units and compute a price that will vary for each different blend available. For this reason, money-value computations must be checked for all blends. (These checks will have been made for at least the highest and lowest grades, and middle blend in Items 1-3, so only the remaining blends must be tested.)

The procedure is the same as that described above as part of the Normal Test for single-product dispensers, except that these checks may be made after only one indicated gallon has been delivered. Measurement errors need not be recorded for these drafts.

Remember that blended products used for tests must be returned to the storage tank for the lowest grade dispensed.

FIGURE 6-7. BLENDED PRODUCT DISPENSERS EPO, TEST SECTION

Excerpts from EPO 22 Test Section

1. Test at lowest grade. Set selector control so that lowest grade product is dispensed.
   Normal test—full flow, basic tolerance .....N.1.1., N.2., N.3.4., N.4.1., T.2., UR.2.2.
   At the beginning of the first delivery, check for suppressed values. .....S.1.6.1.
   If first test result is at or near the tolerance limit, repeat this test. T.3., N.4.1.2

   Petroleum Product Sampling[1] Lowest Octane.

2. Test at highest grade. Set selector control so that highest grade product is dispensed.
   Normal test—full flow, basic tolerance .....N.3.4., N.4.1., T.2.

   If this test is at or near tolerance limit, repeat this test. .....T.3.

   Petroleum Product Sampling[1] Highest Octane

3. Test at blend. Set selector control at intermediate blend. Special test--slow flow, basic tolerance .....N.4.2., N.4.2.2., T.2.

   If this test result is at or near the tolerance limit and the error is the same as or greater then the average error of the previous tests, repeat this test .....T.3.
   Otherwise, slow flow test at first blend above lowest grade and first blend beneath highest grade.

   Petroleum Product Sampling[1] Blended Product

   Return blended product to the storage tank containing the lowest octane

[1] When taking gasoline samples from blended product dispensers, the samples should be collected after an observed sale of the particular grade or product to be tested, or sufficient product should be purged from the hose to ensure the sample is representative of the grade or product being sampled. The National Conference on Weights and Measures policy on procedures for taking samples for octane verification is as follows: **"A minimum of a liter (0.3 gallon) of engine fuel shall be flushed from the dispensers before taking a sample for octane verification. This flush shall be returned to the storage tank containing the lowest octane."** (see NCWM Publication 21, Petroleum Products Sampling Procedures and Safety Manual, August 1997).

SUMMARY

The Test portion of an official field examination involves procedures to determine whether the dispensing system performs within established tolerances. Tolerances are the limits of inaccuracy that are considered acceptable for a metering system in the commercial marketplace. Before the Test is conducted, the inspector must make Pretest Determinations to establish applicable tolerances and other factors relating to the Test. The Test itself comprises several separate tests. Some are intended to test the system's performance over its full range of operating characteristics. Others are intended to determine whether specific elements of the system, like the antidrain valve, are functioning properly. Tests are performed under conditions that approximate as closely as possible the conditions under which the equipment is normally used. Test procedures for single-product and blended-product dispensing systems differ in details, but are fundamentally similar.

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