

CHAPTER 5

THE INSPECTION

CHAPTER OBJECTIVES

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

1. Use the Examination Procedure Outlines (EPOs) developed by NIST for retail motor-fuel dispensers.
2. Describe the purpose of the inspection portion of the EPO and each of its major elements.
3. Describe the procedures employed in routine inspections.

INTRODUCTION

What you have learned about the prominent role of retail motor-fuel dispensers in the commercial marketplace should help you appreciate the importance of your jurisdiction's program of regular field examinations for dispensers currently in service. Similarly, the basic knowledge you have acquired about the design and operation of these sophisticated liquid-measuring devices should make it obvious that systematic procedures must be employed for inspecting and testing them. Given the complexity of the retail motor-fuel dispensing system and the number of individual components that must function correctly to provide accurate and consistent measurement, a haphazard approach would at best be inefficient, requiring excessive time and effort to achieve complete and significant results, and thereby diminishing the overall effectiveness of the program. At worst, a haphazard approach could lead to overlooking or misinterpreting significant data, thereby compromising—even invalidating the entire examination. In this chapter and those that follow you will receive a thorough introduction to examination procedures that employ a systematic approach to inspection and testing.

The purpose of an official weights and measures examination is to determine whether the device being examined meets requirements that are established by law or by legally mandated regulation. Thus, legal requirements form the basis of all examination procedures, and a thorough knowledge of applicable codes and administrative policies is as important a part of the inspector's job as knowing how to use a test measure or how to conduct a slow-flow test.

Most jurisdictions have adopted the comprehensive specifications, tolerances, and other technical requirements set forth in NIST Handbook 44. The requirements that apply to retail motor-fuel dispensers are included in Sections 1.10 (General Code) and 3.30 (LMD Code) of the handbook. These codes will be referenced throughout the following discussions. Some jurisdictions have modified portions of these codes, and in some jurisdictions, additional requirements have been imposed by State or local laws and regulations. Your instructor will point out specific differences between Handbook 44 and the applicable codes in force in your jurisdiction and explain the significance of these differences.

Codes provide the basis for field procedures, but they are organized in a way that suits their primary function as legal documents and as a result are often not very well suited to use in the field. Specific requirements that

govern a particular component or feature of the fuel-dispensing system—like the zero-setback mechanism—sometimes occur at separate places in the codes, and some requirements are applicable to more than one element of the system. In recognition of the need for a more systematic organization of requirements, one that is suited to efficient field procedures, the Office of Weights and Measures at the National Institute of Standards and Technology has developed Examination Procedure Outlines (EPOs) for many weighing and measuring devices, including retail motor-fuel dispensers.

Figure 5-1, on the next page, is the first operations page of EPO 21 for single-, dual-, and multi-product dispensers. Differences in design and operating characteristics necessitated the development of separate EPOs for single, dual, and multi-product systems (EPO 21) and blended-product systems (EPO 22). As you can see, the EPO provides a systematic organization, referencing the applicable paragraphs of the Handbook 44 codes for each of the major functional components of the system that are involved in measuring and indicating deliveries. As you will see in the next chapter, a subsequent portion of the EPO presents a step-by-step procedure for conducting a series of performance tests. Because of its systematic organization, the EPO is a useful guide for the inspector in the field, and is also a tool that can be used by the inspector as a checklist, to ensure that all the steps in the examination have been performed. Pages one and two of the EPO contain important safety-related information with which each inspector must be familiar. The information on these two pages is important to your safety and well being.

The EPO is intended as an outline of what should be considered a minimum examination procedure. When the inspector encounters a device that has features that are “new” to him or her or in non-routine examinations (conducted in response to complaints, or when there is reason to suspect that the device is being used improperly or to facilitate fraud), further procedures are likely to be needed.

Complete copies of EPO 21 (single, dual, and multi-product retail motor fuel dispensers) and EPO 22 (blended-product retail motor-fuel dispensers) are included in the Appendix to this manual. These EPOs should be updated periodically to include changes in the codes or policies of your jurisdiction.

An official field examination consists of four components:

- The Inspection, to determine compliance with specifications and other requirements;
- Pretest determinations, to assure the correct application of tolerances and other test factors;
- The Test, to determine compliance with performance requirements; and
- The Evaluation of Inspection and Test results, followed by approval or rejection of the device.

This division is based upon distinctions which are observed in Handbook 44 and in the EPOs. Notice that the terms, “inspection,” “test,” “evaluation,” and “examination,” refer to specific and different activities (“examination” comprising the other three terms). These distinctions will become clear as we discuss the separate components in concrete terms.

EPO No. 21 (Excerpt)

**Examination Procedure Outline for
Retail Motor-Fuel Dispensers
Single, Dual and Multi-Product
(Except Blenders)**

**H-44 General Code and
Liquid-Measuring Devices
Code References**

1. General considerations	
Selection.....	G-S.3., G-UR.1.1., G-UR.1.2., G-UR.1.3.
Installation.....	G-S.2.,G-UR.2.1.,G-UR.2.2., UR.2.1., UR.2.4.
Position of equipment.....	G-UR.3.3.
Accessibility.....	G-UR.2.3.
Assistance	G-UR.4.4.
Use and maintenance.....	G-UR.3.1., G-UR.4.1., G-UR.4.2., UR.3.5.
2. Indicating and recording elements	
Design	S.1.1.
Units	S.1.2.1., S.1.2.3.(a)
Readability	G-S.5., G-S.6.(1/1/77), G-S.7., S.1.4., S.1.5.
Values of intervals.....	G-S.5.3., G-S.5.3.1.
Indication of delivery	S.1.6.1.,
Money-value divisions	
Analog.....	S.1.6.5.1.
Digital.....	S.1.6.5.2.
Auxiliary indications.....	S.1.6.5.3. (1/1/85)
Unit Price and product identity	S.1.6.4.1.(a), S.1.6.4.2., UR.3.2.
Multiple unit price dispensers	S.1.6.4.1.(b) (1/1/91), S.1.6.5.(a) (1/1/91), S.1.6.5.4. (1/1/91), UR.3.3.
Advancement and return to zero.....	S.1.3., S.1.6.3., UR.3.1.
Recorded representations, point of sale systems	S.1.6.7. (1/1/86)
Provision for sealing.....	G-S.8. (1/1/90), G-UR.4.5., S.2.2.(a&b), S.2.2.(c) (1/1/95), Table S.2.2. (1/1/95)
3. Marking.....	G-S.1.,G-UR.2.1.1.,G-UR.3.4., S.4.1., S.4.4.1. (1/1/85), S.4.4.2. (1/1/03)

FIGURE 5-1. EPO FOR RETAIL MOTOR-FUEL DISPENSER, INSPECTION

INSPECTION

The first part of the EPO is devoted to Inspection (see Figure 5-1). In the Inspection portion of the official examination, you will determine the dispensing system's compliance with specifications and other requirements pertaining to design, installation, and operation. The extent and emphasis of your inspection will depend on a number of factors relating to the specific device being tested and the circumstances under which it is being tested. Some of the more important factors are:

- your familiarity with the device,
- the age of the device,
- whether or not the device is of a type that has been type evaluated, and
- whether or not a complaint has been received.

Naturally, your previous experience with the particular device and then location (business) will impact on the inspection process. If this is a first time inspection of the device or location (business), you may want to perform an extensive inspection that includes a careful check of all applicable requirements in Handbook 44, including those concerned with design and installation. If you are checking a device you are familiar with, one that has been in service for some time, you may not need to spend much time on design and installation requirements; however, you will want to look for such things as fraudulent use or abuse of the equipment and inappropriate applications of the device.

The age of the device—when it was manufactured and when it was put into commercial service—is important because a number of requirements in Handbook 44 are nonretroactive as of a certain date. As a result, you will find that old equipment will be required to meet a different set of requirements than new equipment.

In most cases, the device you will be testing will be of a type that has been evaluated under the National Type Evaluation Program (NTEP). NTEP, which is managed by the National Conference on Weights and Measures (NCWM), Inc., is a program for determining conformance of a weighing and measuring device “type” or “model” with the relevant provisions of Handbook 44. Manufacturers voluntarily submit models of their devices for evaluation under the NTEP program. An authorized State or Federal government laboratory conducts the evaluation. When a device is found to meet all applicable technical requirements, the NCWM issues a Certificate of Conformance (CC) for that device. The CC provides details of the evaluation results and device characteristics necessary for inspection and use in commerce.

Before testing a new type of device, you should determine if a model of the device has been type evaluated. If it has, you should review the CC issued to the device to determine which features have been evaluated. Copies of the CCs are available from the manufacturer and from State weights and measures jurisdictions. Copies of CCs are also available at NTEP's web site on the Internet at <http://www.ncwm.net>.

During the type evaluation process, extensive tests are performed to determine if a particular device model meets all applicable requirements in Handbook 44. Some of these tests are difficult (if not impossible) to perform correctly in the field; consequently, the existence of a Certificate of Conformance can make your job easier—during a field inspection, you may not need to extensively examine certain design criteria on a type evaluated device. But remember that type evaluation means that a model of a device has been examined, not each device; therefore, you should still review all applicable requirements when inspecting a new device. The review may simply consist of a brief visual check of an item.

Devices are designed with specific applications in mind. Some devices are designed for a narrow range of applications, whereas others have a multitude of features to satisfy many different applications. Not all features are suitable for all applications. A CC will state the application of a device type that is covered on the CC. Use of the device in applications other than those listed on the CC are not covered by the CC. If you encounter a new or unusual device or feature on a device in an unusual application, it should be thoroughly tested to determine its appropriateness and to assure that it does not facilitate fraud.

Another factor that affects the nature and extent of the Inspection portion of your examination is the existence of a complaint about a particular device or the practices of a device owner or operator. You may want to perform a more extensive inspection than usual if your office has received complaints about a device or business.

As you will see in the detailed discussion that follows, most Inspection determinations are made on the basis of a careful visual examination and the inspector's experience and knowledge of the device. This does not mean, however, that the Inspection may be approached casually, or that compliance with any requirement can be taken for granted just because the device has received approval. It is not at all uncommon to discover noncompliance in a number of areas covered in the Inspection, especially when the equipment is old or has not been properly maintained. Furthermore, it is much more likely that modifications intended to facilitate fraud will show up in the course of a careful inspection than in performance tests.

You should also keep in mind that your inspection is not limited to visual means, or any other. It is the inspector's responsibility to decide what is necessary to determine the compliance status of the device. If you have reason to believe that a correct determination requires additional testing, either in the field or under more controlled conditions, you should consult your supervisor so that appropriate arrangements can be made. However, the cost of additional testing to the owner or operator of the equipment, including the cost of lost productivity while it is out of service, must not constitute an unreasonable burden. The decision to conduct additional testing will generally involve weighing the probability that a suspected violation will be confirmed against the cost of testing—including the cost to the jurisdiction. So you should be prepared to explain and justify your recommendation.

The remaining sections of this chapter will present the inspection procedures for retail motor-fuel dispensers. Each of the items included in the EPOs will be discussed in detail. However, in the interest of providing a basic framework for field procedures, we will begin with the General Considerations and Marking sections of the EPO, but some of the sub-headings will be presented in modified order. The inspection portion of the EPO (21) for Single, Dual, and Multi-product) retail motor-fuel dispensers and the EPO (22) for blended-product dispensers are identical; specific differences will be pointed out as we proceed.

General Considerations

The items under this heading refer, for the most part, to requirements and specifications from the General Code that are necessarily broad and comprehensive in nature. They may relate specifically to items covered in earlier sections of the Inspection or to the Test portion of the examination. They are nonetheless important, and should not be ignored simply because they are general in nature. On the contrary, the inspector should keep in mind and refer to these General Considerations throughout the examination procedure.

Accessibility

Because fuel dispensers are designed and intended to be positioned and readily accessible to the public, accessibility for the weights and measures official is rarely a problem (an example of an exception to this is boat marinas, where the dispensers may be located in remote areas that can be reached only by boat). The inspector must have access not only to the dispensers (including the inside of dispenser cabinets), but also to storage tank fill pipes and any remote primary indicating or recording elements, such as a control console located in a cashier's office.

G-UR.2.3. Accessibility for Inspection, Testing, and Sealing Purposes. - A device shall be located, or such facilities for normal access thereto shall be provided, to permit:

- (a) inspecting and testing the device;
- (b) inspecting and applying security seals to the device; and
- (c) readily bringing the testing equipment of the weights and measures official to the device by customary means and in the amount and size deemed necessary by such official for the proper conduct of the test.

Otherwise, it shall be the responsibility of the device owner or operator to supply such special facilities, including such labor as may be needed to inspect, test, and seal the device, and to transport the testing equipment to and from the device, as required by the weights and measures official. (Amended 1991)

There is no specific inspection procedure for this item. It is the responsibility of the proprietor to provide and facilitate access, including transportation for the inspector and his or her equipment to a remote or controlled-access location (as sometimes required at marinas and airports). In the case of aboveground storage tanks, a safe means of access must be provided to the top of the tank if the inspector must return product there.

Keys to locked cabinets, fill access covers, and other secure areas to which the inspector must have access during the field examination must be provided (see Assistance, below).

Assistance

Assistance is generally not required for the examination of retail motor-fuel dispensers. However, the proprietor or operator may be needed to gain access to locked dispenser cabinets, storage tank filler pipes, etc., as well as to activate key-, card-, or coin-operated dispensers.

G-UR.4.4. Assistance in Testing Operations. - If the design, construction, or location of any device is such as to require a testing procedure involving special equipment or accessories or an abnormal amount of labor, such equipment, accessories, and labor shall be supplied by the owner or operator of the device as required by the weights and measures official.

In addition, at facilities with aboveground storage tanks, assistance may be required either in returning product to the top of the storage tanks or in operating a pump return.

Selection

To be suitable for its application, a motor-fuel device should be capable of indicating volume and computing prices for all deliveries for which it is normally used. In addition, it must have such other features as are available and appropriate to its usual service.

For example, for dispensers installed in service stations that serve primarily cars and small trucks, the largest single delivery is likely to be no more than 30 gallons. However, dispensers installed at truck stops or other stations that often serve large trucks may make single deliveries of 100 gallons or more. Such devices may need to be specially equipped with computers capable of computing and displaying total sales prices for these larger deliveries. A device that is often used for deliveries to large trucks that is not so equipped might not be suitable for its application. Devices must also be capable of producing accurate measurement over a range of flow rates (usually from 5 to 15 gpm for pumps used primarily to service automobiles; those used primarily for sales to trucks have maximum discharge rates of 20 gpm and more).

The increased use of self-service marketing concepts, including self-pay and self-operated systems has understandably led to some confusion on the part of motorists, who must deal with equipment whose operation is different from what they are accustomed to and often, from their point of view, quite complex. It is of primary importance that consumers be able to understand the transactions they are undertaking and that indicators and operating elements designed to be used by them be clear. There should be no question as to what product the consumer is purchasing and how much the purchase will cost. Specific requirements relating to the design, marking, and use of devices used in multi-tier pricing applications will be discussed below.

G-UR.1.1. Suitability of Equipment. - Commercial equipment shall be suitable for the service in which it is used with respect to elements of its design, including but not limited to its weighing capacity (for weighing devices), its computing capability (for computing devices), its rate of flow (for liquid-measuring devices), the character, number, size, and location of its indicating or recording elements, and the value of its smallest unit and unit prices.

Ultimately, the selection and installation of suitable equipment serves the interest of the owner as well as the motorist, since increased efficiency and customer satisfaction will contribute to the commercial success and profitability of the operation.

There is no specific inspection procedure for this general requirement, although its scope and potential application are broad, especially in circumstances where more specific requirements in the LMD Code do not apply. The inspector should bear in mind the suitability of the equipment in operation for the type of service provided. At the same time, it is not the responsibility, or the role of the weights and measures official to dictate the proprietor's method of marketing or delivering his service. Rather, you should assure yourself that equipment in use is not unsuitable for its application.

Installation

Proper installation involves considerations of security, safety, and mechanical operation. The EPOs reference several paragraphs from Handbook 44 that relate to installation.

G-UR.2.1. Installation. -A device shall be installed in accordance with the manufacturer's instructions, including any instructions marked on the device. A device installed in a fixed location shall be so installed that neither its operation nor its performance will be adversely affected by any characteristic of the foundation, supports, or any other detail of the installation.

G-UR.2.1.1. Visibility of Identification. - Equipment shall be installed in such a manner that all required markings are readily observable. (Added 1978)

G-UR.2.2. Installation of Indicating or Recording Element. - A device shall be so installed that there is no obstruction between a primary indicating or recording element and the weighing or measuring element; otherwise there shall be convenient and permanently installed means for direct communication, oral or visual, between an individual located at a primary indicating or recording element and an individual located at the weighing or measuring element. [See also G-UR.3.3.]

UR.2.1. Manufacturer's Instructions. - A device shall be installed in accordance with the manufacturer's instructions, and the installation shall be sufficiently secure and rigid to maintain this condition. (Added 1987)

UR.2.4. Diversion of Liquid Flow. - A motor-fuel device equipped with two delivery outlets used exclusively in the fueling of trucks shall be so installed that any diversion of flow to other than the receiving vehicle cannot be readily accomplished and is readily apparent. Allowable deterrents include, but are not limited to, physical barriers to adjacent driveways, visible valves, or lighting systems that indicate which outlets are in operation, and explanatory signs. (Amended 1991)

- Installation must follow manufacturer's specifications. Most manufacturers furnish detailed instructions for installation of a new dispenser. These instructions, and any associated specifications, are designed to assure that the system will perform efficiently and accurately. Installation that does not follow these specifications, or non-approved modifications to the equipment made after its installation, are violations of G-UR.2.1.
- The device must not be installed in such a way that required markings are obscured or obstructed. For the markings required for retail motor-fuel devices, see **Marking Requirements**, below.
- Primary indicating elements must be visible from the position at which the operator of the pump stands. In the case of retail motor-fuel devices, indicators must be provided on both sides of the dispenser (unless operation is not possible from one side. (See also G-UR.3.3., under **Position**, below, for a related requirement, and see S.1.6.4. and S.1.6.5., discussed under **Indicating and Recording Elements**, below, for an extension of this requirement to the display of unit price and product identity.)
- Multiple-outlet dispensers must be installed in such a way that they do not facilitate fraud. This requirement applies only to dispensers that are specially equipped with two discharge outlets that can be used simultaneously for a single large delivery of product to a truck. If an unscrupulous operator were to divert product through one of these hoses to some receptacle other than the truck's receiving tank while normal delivery was being made through the other hose, the customer could be charged for product he or she had not received. It is practically impossible to design a dispenser that makes such fraudulent use impossible. However, a dispenser with such special equipment must not be installed in a manner that would make it easy or convenient for an unscrupulous operator to abuse the device in this way (for example, by positioning the dispenser where some physical obstruction makes it difficult or impossible for the customer to see the entire length of both discharge hoses).

Specific design requirements for multiple-outlet devices are established in paragraphs S.3.1 and S.3.2., which are discussed later in this chapter.

It is obviously impracticable to check every item included in the manufacturer's installation instructions as part of a routine examination. However, you should at least check to determine:

- that the dispenser chassis is securely bolted to the service island;
- that an impact valve is installed on a remote dispenser, that its breakaway mechanism is clear of debris, and that the valve is not wired or blocked open; and
- that there is no exposed wiring, and that all wiring is enclosed in conduit or junction boxes.

If, in the course of subsequent inspection or test procedures, you have reason to believe that substandard condition or performance of the equipment results from incorrect installation, you may wish to consult the manufacturer's specifications for particular items.

In addition, you should determine any special requirements marked on the device for accessory, auxiliary, or remote components and inspect these.

Position

Both buyer and seller participate in a direct sale. When weighing and measuring or computing devices are used in such transactions, it is essential that the information they provide be available to the customer as well as the seller. This provides some protection for the customer from accidental or intentional errors made by the seller. It is for this reason that weighing and measuring devices in retail stores must be positioned so that they can be read simultaneously by the customer and the salesperson.

G-UR.3.3. Position of Equipment. - A device equipped with a primary indicating element and used in direct sales, except a prescription scale, shall be so positioned that its indications may be accurately read and the weighing or measuring operation may be observed from some reasonable "customer" position. The permissible distance between the equipment and a reasonable customer position shall be determined in each case upon the basis of the individual circumstances, particularly the size and character of the indicating element. (Amended 1974)

For retail motor-fuel devices, primary indicating elements must be readable when viewed from a "reasonable customer position." What is a reasonable customer position will obviously depend to some degree on the type of service offered at the pump: that is, whether the customer is likely to be observing the indicator during delivery from behind the wheel of his or her vehicle or, in the case of a self-service station, from some position outside the vehicle.

Inspect devices from the customer's point of view to determine whether primary indicating elements are not only visible but readable:

- at the time when the dispenser is reset to zero;
- throughout the course of delivery; and
- at the time when the dispenser on/off switch is put in the off position, terminating the delivery.

Use and Maintenance

The accurate performance of any measuring device depends upon proper use and maintenance. The General Code therefore includes broad requirements for these activities (G-UR.3.1. and G-UR.4.1.).

G-UR.3.1. Method of Operation. - Equipment shall be operated only in the manner that is obviously indicated by its construction or that is indicated by instructions on the equipment.

G-UR.4.1. Maintenance of Equipment. - All equipment in service and all mechanisms and device s attached thereto or used in connection therewith shall be continuously maintained in proper operating condition throughout the period of such service. Equipment in service at a single place of business found to be in error predominantly in a direction favorable to the device user shall not be considered “maintained in a proper operating condition.” (Amended 1973, 1991)

All motor-fuel devices are equipped with an on/off switch and a discharge lever on the nozzle. The design of both of these elements (which is, in part, specified by Handbook 44, as you will see below) makes their misuse virtually impossible. The operation of these controls is obvious; however, instructions are usually provided, especially at self-service stations. Instructions are also often provided for dispensers with vapor recovery nozzles; again, these are useful but not required. In the case of devices equipped with additional controls, such as service, payment, or product selectors, or self-pay, card-, or key-operated devices, instructions for correct use should be displayed on the dispenser or on the dispenser display. It is the responsibility of the device owner or operator to operate the equipment consistent with any markings on the device and to use the device in such a manner as indicated by the construction of the device.

For fuel dispensers, the responsibility of the owner or operator to maintain equipment in proper operating condition includes (but is not limited to):

- readability of indicating elements;
- accuracy of the measuring device;
- repair or replacement of defective nozzles and discharge hoses.
- repair of leaks; and
- replacement of broken glass.

When examination reveals that most equipment in service at a single location errs in favor of the owner, the equipment is considered not to be “maintained in a proper operating condition,” even if errors for individual devices do not exceed applicable tolerances. This is to prevent a proprietor from benefiting from the cumulative error of a number of devices. For example, if five of six pumps are found to over register, all of these pumps can be considered to be out of compliance, even if individual errors do not exceed compliance limitations.

A determination regarding the general maintenance of all devices at the same location must be based upon results of the performance tests described in the next chapter. You must use your judgment in applying this requirement. Obviously, it should not be applied unless a majority of pumps are over registering and unless the cumulative effect of these overregistration is likely to significantly benefit the owner. In doubtful cases, the past compliance history should be considered. The readability and accuracy of reading the test measure also needs to be taken into account. Many jurisdictions have established guidelines or policies within their

own jurisdictions for applying the maintenance of equipment requirement. These guidelines or policies help to ensure that the inspectors in their jurisdiction are applying the requirement consistently and uniformly.

Procedures for inspecting the readability of indicating elements and the condition of the discharge hose are described below. The accuracy of the measuring device and the discharge nozzle are tested in a later segment. Thus, a thorough inspection should be made:

- for broken glass covering the indicating elements; and
- for leaks inside the dispenser cabinet.

MARKING REQUIREMENTS

All retail motor-fuel devices are required to be marked with information that identifies the manufacturer or distributor of the device, the model or design, and (for all devices manufactured, sold, or rebuilt after January 1, 1968) a nonrepetitive serial number. For devices manufactured, sold, or rebuilt after certain dates as defined in G-S.1 (see below), the model designation and serial number must be prefaced with terms clearly identifying these designations. In addition, nonretroactive and effective as of January 1, 2003, devices covered under an NTEP Certificate of Conformance (CC) must be marked with the NTEP CC number. The purpose of these marking requirements is to make it possible for the inspector, the manufacturer, and the device owner to monitor the equipment while it is in service, to obtain technical information necessary to determine compliance with regulations, and effect repairs or adjustments when they are required.

The required information must be permanently marked. This means that it must not be removable or alterable, unless provision is made that removal or alteration will be readily evident. Most manufacturers use a thin metal plate upon which the identifying information is etched. This plate should be attached in some way that prevents its being removed without being mutilated or destroyed. For example, rivets might be used to attach the plate, but removable screws would be inappropriate. This is required to prevent the identification plate from being replaced or transferred to another device. To prevent alteration of the information imprinted on it, the plate itself may be made of some pressure-sensitive material. This may cause some problem when the plate is affixed in a position where it is exposed to accidental wear during operation (for example, when it is attached near the discharge nozzle). Repeated abrasion by metal objects may result in accidental obliteration of markings on pressure-sensitive materials.

In general, it is the proprietor's responsibility to assure that identifying markings are accessible after installation and positioned in such a way as to minimize the risk of accidental damage. The information required by G-S.1. may be located inside the dispenser cabinet, provided that it can be observed without dismantling that requires the use of a tool.

Note the nonretroactivity of subparagraphs (d), (e), and (f), indicated by italic print and the appended notes. These requirements were made nonretroactive and have been maintained as such, despite the passage of time, because requiring manufacturers to supply nonrepetitive serial numbers for equipment already in existence would have imposed an excessive burden.

As of January 1, 2002, remanufactured devices and remanufactured main elements must also be marked with the name, initials, or trademark of the last remanufacturer or distributor as required by paragraph G-S.1.1. The remanufacturer's or distributor's model designation must also be marked on the device if it is different than the original model designation.

G-S.1. Identification. - All equipment, except weights and separate parts necessary to the measurement process but not having any metrological effect, shall be clearly and permanently marked for the purposes of identification with the following information:

- (a) the name, initials, or trademark of the manufacturer or distributor;
- (b) a model designation that positively identifies the pattern or design of the device;
- (c) *the model designation shall be prefaced by the term "Model," "Type," or "Pattern." These terms may be followed by the term "Number" or an abbreviation of that word. The abbreviation for the word "Number" shall, as a minimum, begin with the letter "N" (e.g., No or No.). The abbreviation for the word "Model" shall be "Mod" or "Mod."*
[Nonretroactive January 1, 2003]
(Added 2000) (Amended 2001)

[Note: Prefix lettering may be initial capitals, all capitals or all lower case.]

- (d) *except for equipment with no moving or electronic component parts, a nonrepetitive serial number;*
[Nonretroactive as of January 1, 1968]
- (e) *the serial number shall be prefaced by words, an abbreviation, or a symbol, that clearly identifies the number as the required serial number; and*
[Nonretroactive as of January 1, 1986]
- (f) *the serial number shall be prefaced by the words "Serial Number" or an abbreviation of that term. Abbreviations for the word "Serial" shall, as a minimum, begin with the letter "S," and abbreviations for the word "Number" shall, as a minimum, begin with the letter "N" (e.g., S/N, SN, Ser. No, and S No.).*
[Nonretroactive as of January 1, 2001]
- (g) *For devices that have an NTEP Certificate of Conformance (CC) Number or a corresponding CC addendum number, the NTEP CC shall be prefaced by the terms "NTEP CC," "CC," or "Approval." These terms may be followed by the term "Number" or an abbreviation of that word. The abbreviation for the word "Number" shall, as a minimum, begin with the letter "N" (e.g., No or No.)*
[Nonretroactive as of January 1, 2003]

The required information shall be so located that it is readily observable without the necessity of the disassembly of a part requiring the use of any means separate from the device.
(Amended 1985, 1991, 1999 and 2000)

G-S.1.1. Remanufactured Devices and Remanufactured Main Elements. - All remanufactured devices and remanufactured main elements shall be clearly and permanently marked for the purposes of identification with the following information:

- (a) *the name, initials, or trademark of the last remanufacturer or distributor;*
- (b) *the remanufacturer's or distributor's model designation if different than the original model designation.*
[Nonretroactive as of January 1, 2002]
(Added 2001)

Note: Definitions for "manufactured device," "repaired device," and "repaired element" are also included (along with definitions for "remanufactured device" and "remanufactured element") in Appendix D, Definitions.

Effective and nonretroactive as of January 1, 2003, the required marking information specified in G-S.1. must appear in a specific location on retail motor-fuel dispensers, as specified in paragraph S.4.4.2. of the Liquid-

Measuring Devices Code. The information must be placed on a portion of the device that cannot be readily removed or interchanged without a tool separate from the device. The information shall appear 24 to 60 inches from the base of the dispenser, either on the outside of the device or behind an access door or panel.

S.4.4.2. Location of Marking Information; Retail Motor-Fuel Dispensers. - *The required marking information in the General Code, Paragraph G-S.1. shall appear as follows:*

- (a) Placement of this information shall not be on a portion of the device that can be readily removed or interchanged without the use of a tool separate from the device.*
 - (b) The information shall appear 24 inches to 60 inches from the base of the dispenser when placed on the outside of the device.*
 - (c) When placed behind an access door or panel the information shall appear 24 inches to 60 inches from the base of the dispenser in a readily legible position. The use of a dispenser key shall not be considered a tool separate from the device.*
- [Nonretroactive as of January 1, 2003]*

(Added 2002)

In addition to the information described above, any limitations that apply to the use of the device must also be clearly and permanently marked. For example, some dispensers are designed to measure specific products (like diesel fuel), or are only accurate when operated at specific flow rates. Also, if the device is only compatible with specified remote or auxiliary equipment such as consoles or ticket printers, these specifications must be displayed.

S.4.1. Limitation on Use. - The limitations on its use shall be clearly and permanently marked on any device intended to measure accurately only:

- (a) products having particular properties; or
- (b) under specific installation or operating conditions; or
- (c) when used in conjunction with specific accessory equipment.

Additional marking requirements apply to high-speed retail motor-fuel dispensers such as those used at truck refueling stations. Effective January 1, 1985, Liquid-Measuring Devices Code paragraph S.4.4.1. requires that retail devices designed with a maximum discharge rate of 115 L (30 gal) per minute or greater, be marked on an exterior surface of the device visible after installation with:

- the maximum discharge rate and
- the minimum discharge rate.

In addition, the minimum discharge rate shall not exceed 20 percent of the maximum discharge rate. For example, a device with a marked maximum discharge rate of 50 gallons per minute (gpm) cannot have a minimum discharge rate greater than 10 gpm since 10 gpm is 20 percent of 50 gpm. Thus, a marked

minimum discharge rate of 20 gallons per minute would be unacceptable. The purpose of this requirement is to ensure that a meter is designed and manufactured to be accurate over a reasonably wide range of flow rates.

S.4.4.1. Discharge Rates. - *On a retail device with a designed maximum discharge rate of 115 L (30 gal) per minute or greater, the maximum and minimum discharge rates shall be marked on an exterior surface of the device and shall be visible after installation. The minimum discharge rate shall not exceed 20 percent of the maximum discharge rate.*
[Nonretroactive as of January 1, 1985.]
(Added 1984)(Amended 2002)

Some stations use “self-pay” equipment. In these installations the customer pays for his or her purchase by inserting a credit card or money into the device itself. For a money-operated self-pay device, the name, address, and phone number of the person or agency responsible for returning money paid when the dispenser does not deliver the fuel purchased or malfunctions in some other way, must be displayed, either on the device itself, or in a position immediately adjacent to the device. Where employees are present and responsible for resolving any money discrepancies with the customer, this posting requirement is not applicable.

G-UR.3.4. Responsibility, Money-Operated Devices. - Money-operated devices other than parking meters shall have clearly and conspicuously displayed thereon, or immediately adjacent thereto, adequate information detailing the method for the return of monies paid when the product or service cannot be obtained. This information shall include the name, address, and phone number of the local responsible party for the device. This requirement does not apply to devices at locations where employees are present and responsible for resolving any monetary discrepancies for the customer. (Amended 1977, 1993)

Finally, note that G-UR.2.1.1., discussed above under **Installation**, requires that the dispenser must be installed in such a way that all required markings, including those described in this section, are readily observable.

Locate the device identification plate and inspect it for position, damage, and readability. You should also determine that all required items of information are displayed.

If additional marking requirements apply (for discharge rates, use limitations, or operating information) determine that all specified information is clearly and prominently displayed. If you suspect that use limitations may apply but are not displayed, first consult the operator of the device, then contact the device manufacturer or distributor if necessary. In general, your best guide will be your past experience with equipment of similar design.

INDICATING AND RECORDING ELEMENTS

Design

As you learned in Chapter 3, indicating elements (either at the dispenser or at a console) produce temporary readings of the quantity of product delivered and the price computed automatically for that delivery. Recording elements (like a ticket or receipt printer) provide readings that are permanent. In both cases, the “readings” are produced directly by the operation of the measuring element (the meter). A primary indicating or recording element is one that is designed to be, or is, used in the normal commercial use of the device. Primary elements are thus those that are actually used—either by the customer or the operator—to determine the quantity delivered and the price of that quantity. The indicator on the pump itself is, of course, a primary element, and in some installations this might be the only primary element. But, if a remote readout is used by the operator to determine the quantity and price of the delivery—for example, at a control console—this would also be a primary device. An automatic ticket printer would be considered a primary recording element. A totalizer, however, would not normally be considered a primary element, since it is usually not used to determine the amount or price of an individual sale.

S.1.1. General. - A liquid-measuring device:

- (a) shall be equipped with a primary indicating element, and
- (b) may be equipped with a primary recording element.

The need for a primary indicating element is obvious: it provides the only basis for a transaction in which both seller and buyer are informed. Primary recording elements, on the other hand, are often just a convenience to the operator and the proprietor and to the customer, and so are not always required. Recorded representations are required for devices activated by debit cards, credit cards, and/or cash; these requirements will be discussed later in this Chapter under paragraph S.1.6.7. Recorded Representations. The units in which quantities must be indicated and recorded are also specified in paragraph S.1.2.

Quantities of product are required to be indicated in gallons or liters and fractions or decimal subdivisions of these units to avoid any confusion on the part of the motorist, to whom these units are “standard”. Most consumers will not even think to look at the units, and so might be easily misled by a pump indicating in quarts, for example.

S.1.2. Units. - A liquid-measuring device shall indicate, and record if the device is equipped to record, its deliveries in liters, gallons, quarts, pints, or binary-submultiples or decimal subdivisions of the liter or gallon. (Amended 1987, 1994)

S.1.2.1. Retail Motor-Fuel Devices. - Deliveries shall be indicated and recorded, if the device is equipped to record, in liters or gallons and decimal subdivisions or fractional equivalents thereof. (Added 1979)

S.1.2.3. Value of Smallest Unit. - The value of the smallest unit of indicated delivery, and recorded delivery if the device is equipped to record, shall not exceed the equivalent of:

- (a) 0.5 L (1 pt) on retail devices;
- (b) 5 L (1 gal) on wholesale devices.

This requirement does not apply to manually operated devices equipped with stops or stroke-limiting means. (Amended 1983 and 1986)

Retail motor-fuel devices are required to indicate deliveries in units that are the equivalent of one pint or smaller. Dispensers that indicate decimal gallons will automatically meet this requirement, since one pint = 0.125 gal. Note, however, that a separate requirement (S.1.6.5.2., described under **Money Value Divisions**, below) requires the smallest unit of delivery for digital devices to be no greater than 0.01 gallon.

Compliance with requirements under this heading can generally be determined by visual inspection, without opening the dispenser cabinet. You should:

1. Identify all primary indicating and recording elements, keeping in mind that remote elements can be primary elements for a particular dispenser, even if they are shared by other dispensers.
2. For each primary element identified, observe the units and denominations used, see Figure 5-2 on the following page. These should be gallons (or liters), with the smallest subdivision equivalent to one pint or less.

It will probably be impossible by this cursory inspection to detect mechanical or electronic modifications that have been made deliberately, with the intention of advancing indicating or recording elements beyond the final amount indicated during delivery. Such modifications are illegal, and the perpetrator will have made some effort to conceal them. If complaints have been received, or if you have any other reason to suspect such tampering, notify your supervisor and seek his or her guidance regarding further testing.

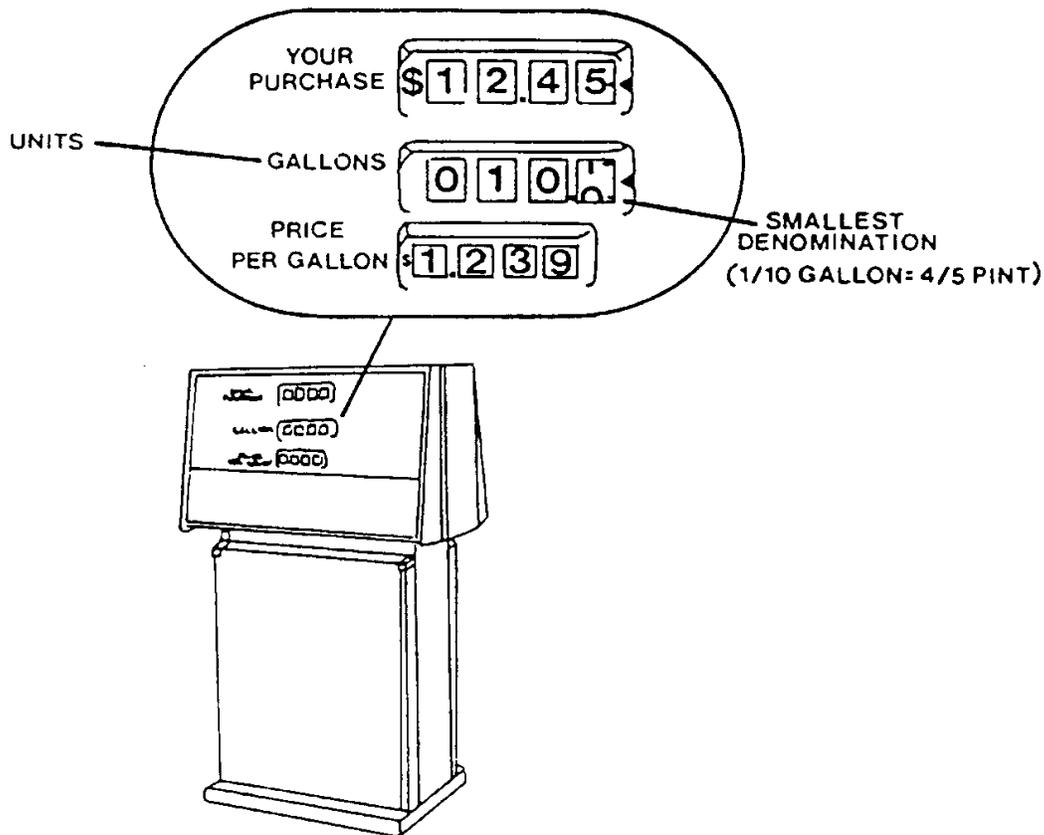


FIGURE 5-2. UNITS INDICATED

Readability

To avoid errors and the possibility of misrepresentation, the customer, as well as the operator, must be able to read and understand the information provided by primary indicating and recording elements. The general and specific requirements quoted below are intended to ensure this. Specifications are made regarding the size, uniformity, and durability of indicators using either analog or digital representations.

The extensive and increasing use of self service makes it essential that operating controls as well as indicators be clearly identified for customers whose knowledge and experience may be limited. This is especially important for installations that use “shared electronics,” as does the system pictured in Figure 5-3, where a single digital readout serves three dispenser hoses, each of which delivers a different product. It must always be clear what product is being delivered from any hose that is in operation. Note in Figure 5-3 the arrow indicating that the \$1.159 per gallon product was delivered, and the corresponding mathematical agreement of unit price, total quantity and total sale for the indicated unit price of this transaction.

Section G-S.5. of the General Code sets forth a number of requirements that apply generally to indicating and recording elements for all types of weighing and measuring devices. (Only those requirements in G-S.5. that relate specifically to readability have been quoted on the next page of text.)

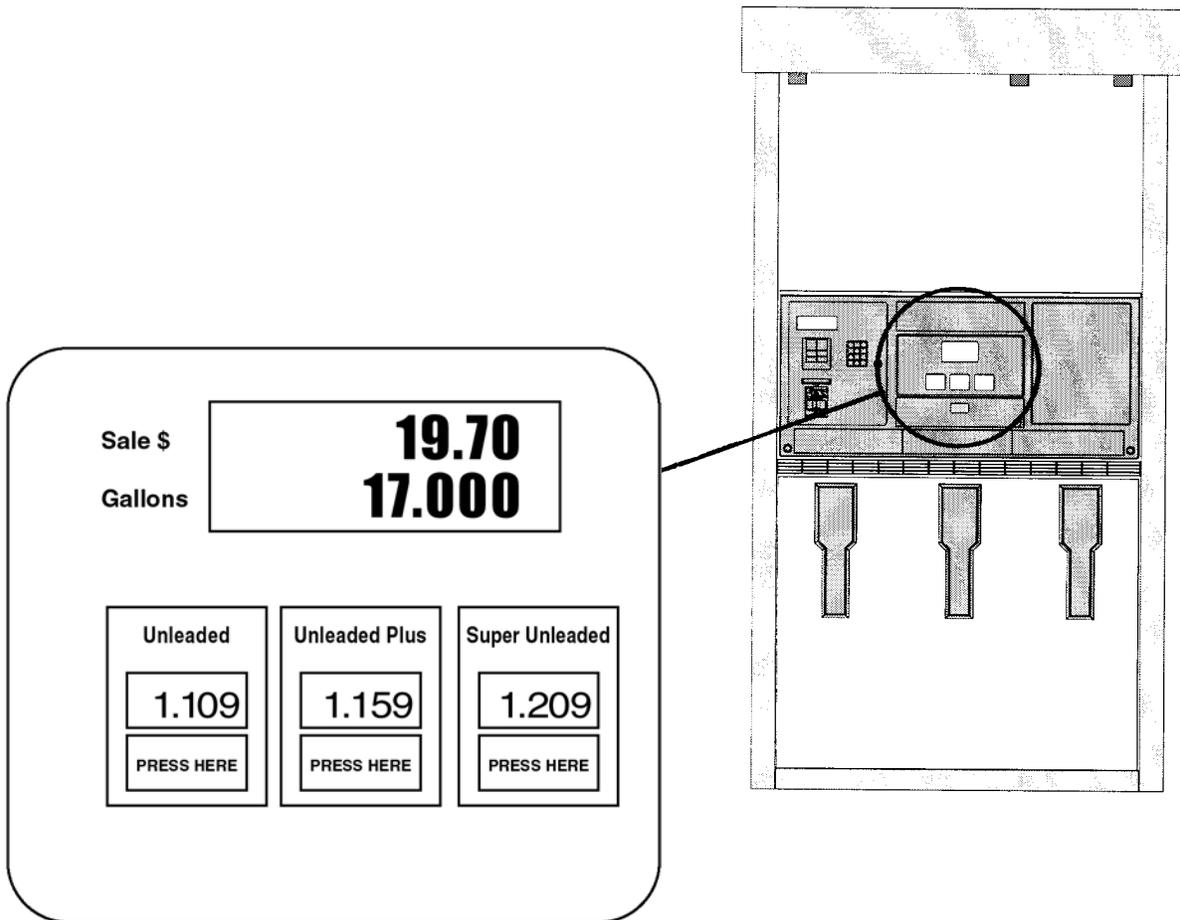


FIGURE 5-3. MULTI-PRODUCT DISPENSER GROUP WITH SHARED ELECTRONICS

Requirements in the LMD Code, which are described below, specify in some detail design features that are appropriate for retail motor-fuel devices. Note in G-S.5.1. the requirement that indications and recorded representations must be “clear, definite, accurate, and easily read under any conditions of normal service...”

Some mechanical gas pumps have subordinate graduations midway between the major, marked intervals on the right hand indicating wheels, that is, marking intervals of one-half cent and 0.05 gallon. These are useful for visual rounding of values, but are not required. However, in accordance with G-S.5.2.3., the subordinate character of these graduations must be clear. They should be distinctly different in length and/or thickness from the whole-unit graduations. If they are marked by numbers (they usually are not), the numbers should clearly and unambiguously reflect that they are subdivisions of major graduated intervals.

Explanatory words, figures, and symbols (see G-S.5.2.4.) must be used with indications or recorded representations associated with gas pumps to clearly identify their intended values. Appropriate designations of the units such as gallons, gal, liter, L, and \$ are used to denote units of measure and money.

G-S.5. Indicating and Recording Elements.

G-S.5.1. General. - All weighing and measuring devices shall be provided with indicating or recording elements appropriate in design and adequate in amount. Primary indications and recorded representations shall be clear, definite, accurate, and easily read under any conditions of normal operation of the device.

G-S.5.2. Graduations, Indications, and Recorded Representations.

* * *

G-S.5.2.3. Size and Character. - In any series of graduations, indications, or recorded representations, corresponding graduations and units shall be uniform in size and character. Graduations, indications, or recorded representations that are subordinate to or of a lesser value than others with which they are associated shall be appropriately portrayed or designated. (Made retroactive as of January 1, 1975)

G-S.5.2.4. Values. - If graduations, indications, or recorded representations are intended to have specific values, these shall be adequately defined by a sufficient number of figures, words, symbols, or combinations thereof, uniformly placed with reference to the graduations, indications, or recorded representations and as close thereto as practicable, but not so positioned as to interfere with the accuracy of reading.

G-S.5.2.5. Permanence. - Graduations, indications, or recorded representations and their defining figures, words, and symbols shall be of such character that they will not tend easily to become obliterated or illegible.

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

Indicators are usually (though not always) protected by a glass or plastic face plate. Manufacturers must design devices so that their graduations, indications, recorded representations, and their defining figures, words, and symbols will not tend to easily become illegible. In the case of recorded representations (receipts, delivery tickets, invoices, etc.), permanent ink should be used. Requirements for indicating and recording elements apply, wherever appropriate, to such printed records of a transaction, according to G-S.5.6., which states, in addition, that recorded representations must be digital: that is, it must use numbers. For example, a sales receipt bearing a printed representation of the dispenser's graduated indicating wheels with a pointer would not meet this requirement.

Additional requirements in the General Code relate to required markings, including those used to identify the device and its limitations of use (described previously in the section on **Marking**), and also to markings used to identify controls, and to instructions. In accordance with G-S.6. and G-S.7., if a dispenser is equipped with push buttons for selecting cash or credit method of payment, they would have to be clearly identified, for example, by lettering (G-S.6.). If the dispenser is self-service, instructions would also have to be provided to direct the customer to make the cash/credit selection before operating the pump (see Figure 3-18 for an illustration of these controls and markings). The markings would have to be readable and permanent (G-S.7.).

Specific requirements relating to the size, proportion, and spacing of graduations and their indicators (for gas pumps, the fixed pointers adjacent to the right-hand quantity and total price wheels) are included in the LMD Code. (Obviously, these requirements do not apply to electronic displays, which do not have graduations.)

G-S.6. Marking Operational Controls, Indications, and Features. - *All operational controls, indications, and features, including switches, lights, displays, push buttons, and other means, shall be clearly and definitely identified. The use of approved pictograms or symbols shall be acceptable. [Nonretroactive as of January 1, 1977.]* (Amended 1978, 1995)

G-S.7. Lettering. - All required markings and instructions shall be distinct and easily readable and shall be of such character that they will not tend to become obliterated or illegible.

For a routine field examination it is neither practical nor necessary to check each of the specified measurements set forth in paragraphs S.1.4 and S.1.5 (quoted on the next page). If indications are clearly readable from a “reasonable customer position” and are not obviously outside the limitations, the inspector may presume that the requirements are met.

All primary indicating and recording elements should be observed, with special attention paid to dirt or grease, damage, or wear that might obscure indicators or identifying letters or diminish their readability under normal operating conditions. If you suspect that nonapproved modifications have been made, consult your supervisor for guidance.

S.1.4. Graduations

S.1.4.1. Length. - Graduations shall be varied in length so that they may be conveniently read.

S.1.4.2. Width. - In a series of graduations, the width of:

- (a) every graduation shall be at least 0.008 inches but not greater than the minimum clear interval between graduations, and
- (b) main graduations shall be not more than 50 percent greater than the width of subordinate graduations.

S.1.4.3. Clear Interval Between Graduations. - The clear interval between graduations shall be not less than 0.04 inch. If the graduations are not parallel, the measurement shall be made:

- (a) along the line of movement of the tip of the index of the indicator as it passes over the graduations, or
- (b) if the indicator extends over the entire length of the graduations, at the point of widest separation of the graduations.

S.1.5. Indicators.

S.1.5.1. Symmetry. - The portion of the index of an indicator associated with the graduations shall be symmetrical with respect to the graduations.

S.1.5.2. Length.

- (a) If the indicator and the graduations are in different planes, the index of the indicator shall extend to each graduation with which it is to be used.
- (b) If the indicator is in the same plane as the graduations, the distance between the index of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 0.04 inch.

S.1.5.3. Width.

- (a) *The index of an indicator shall not be wider than the width of the narrowest graduation.*
[Nonretroactive as of January 1, 2002.]
(Amended 2000)
- (b) If the index of an indicator extends over the entire length of a graduation, it shall be of uniform width throughout the portion that coincides with the graduation.

S.1.5.4. Clearance. - If the indicator and the graduations are in different planes, the clearance between the index of an indicator and the plane of the graduations shall be no greater than 0.06 inch.

S.1.5.5. Parallax. - Parallax effects shall be reduced to the practical minimum.

Values of Intervals

For analog devices, a graduated interval is the distance from the center of one graduation to the center of the next graduation in the series, as illustrated in Figure 5-4.

This interval represents a certain value, in the example shown in Figure 5-4, this value is one-tenth of a gallon. This value must be uniform throughout the series. Again in the example shown, the passage of the indicator across the graduated interval must always represent one-tenth of a gallon.

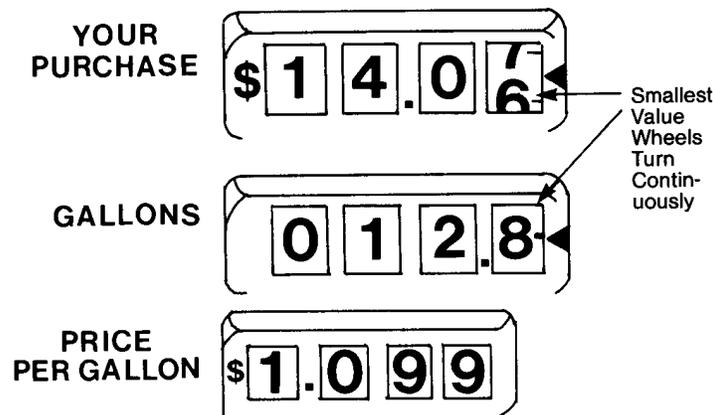


FIGURE 5-4. GRADUATED INTERVALS

G-S.5.3. Values of Graduated Intervals or Increments. - In any series of graduations, indications, or recorded representations, the values of the graduated intervals or increments shall be uniform throughout the series.

G-S.5.3.1. On Devices that Indicate or Record in more than One Unit. - On devices designed to indicate or record in more than one unit of measurement, the values indicated and recorded shall be identified with an appropriate word, symbol, or abbreviation. (Amended 1978 and 1986) (Made retroactive 1990)

For digital indicators, the increment corresponds to the value of the graduated interval. The increment is the smallest change in value that can be recorded or indicated. For example, consider a digital indicator that is capable of displaying hundredths of a gallon. If at the beginning of a delivery the first indicated quantity is 0.01 gal, the next 0.02 gal, the next 0.03 gal, and so on, the increment is 0.01 gal. However, if the first indicated quantity is 0.02 gal, the next 0.04 gal, the next 0.06 gal, etc., the increment is 0.02 gal—the smallest change that can be displayed.

For devices that are capable of indicating and/or recording both U.S. inch-pound and metric units, either mode can be used provided that the units are clearly labeled and that the customer has all the information necessary to understand the transaction. This option has been allowed in order not to discourage conversion to the metric system.

Most motor-fuel devices with analog indicators utilize revolving quantity and price wheels driven by a mechanical computer (as described in Chapter 3). The uniformity of values represented by graduated intervals can be observed directly on these wheels without operating the device if the wheels can be exposed: if the graduated intervals are equal and the difference between each pair of successive values is equal, the values are uniform.

To test a digital indicator would require observing indications through an entire cycle (10,000 or more individual indications!) or dismantling of the device and use of special test equipment. Such tests can not practically be performed in the field.

For a routine examination, and in the absence of complaints or other evidence pointing to tampering or unapproved modifications, you may be satisfied by spot checking the agreement of quantity and price indications with mathematical computations for several different indicated values. This technique is described in Chapter 6.

Indication of Delivery

The indicator must display the quantity throughout the delivery, from an initial zero to the final quantity.

S.1.6.1. Indication of delivery. - The device shall automatically show on its face the initial zero condition and the quantity delivered (up to the nominal capacity).

However, the first 0.009 gallon (or 0.03 liter) of a delivery and its associated total sales price need not be indicated.

The allowance that the first 0.009 gallon (or 0.03 liter) and its associated sales price need not be indicated is intended for digital indicators that have a smallest unit of indicated delivery of less than 0.01 gallon. It permits suppression of the indication of a small quantity (0.009 gallon is slightly more than 2 cubic inches) and its associated price (slightly more than 1 cent at a unit price of \$1.25/gal) when the dispenser is switched on. As will be explained in detail in Chapter 6 (under Normal Test), this small amount is usually due to “computer jump,” which occurs normally under certain operating conditions in this type of equipment.

Note that only the display of this quantity may be suppressed, not the registration: both the quantity and price must be included in the total delivery. In effect, this allowance simply permits such a device to display zero indications until 0.009 gal or 0.03 liter has been delivered. Since computer jump normally occurs between the time the dispenser is switched on and the time the discharge valve is opened, suppression of the indicated values avoids confusion and misunderstanding on the part of the customer.

Because compliance with S.1.6.1. can only be verified by operating the dispenser, the EPOs also cite this paragraph under the Test. Again, see Chapter 6 for additional discussion.

Money-Value Divisions

The money-value division is the smallest computed price that can be indicated. For analog indicating devices, this is equivalent to the value of the graduated interval that represents the smallest price (usually on the cents wheel, see Figure 5-5). For digital indicators, it is the smallest increment of price that can be displayed. In earlier versions of electronic dispensers the volume indication was 0.01 gallons and there were unit price selections where the total sale for some volumes delivered would increment in \$0.02 intervals. Today, with the exception of some dispensers where the unit price is less than \$1.00 per gallon, there will be few occasions where you will encounter a digital electronic dispenser indicating in 0.01 gallons. With modern

electronic dispensers which indicate in 0.001 gallons the money value division and money value increment will be the same up to a unit price of \$9.999. A typical electronic display is shown in Figure 5-6.

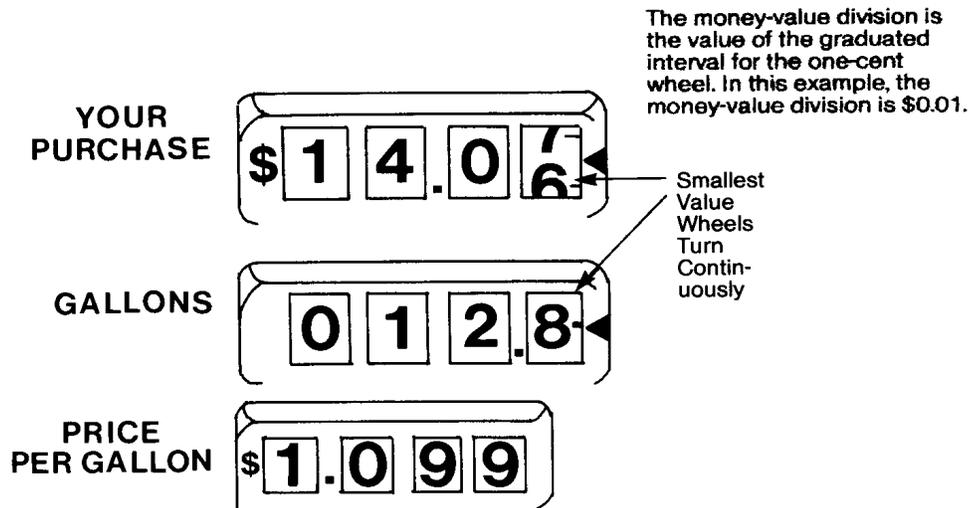


FIGURE 5-5. MONEY-VALUE DIVISIONS MECHANICAL ANALOG INDICATOR

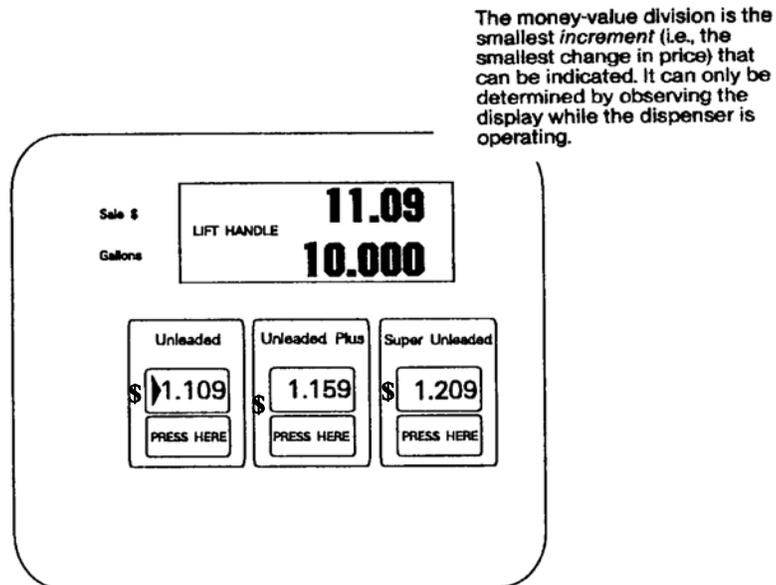


FIGURE 5-6. MONEY-VALUE DIVISIONS ELECTRONIC DIGITAL INDICATOR

In the late 1970s the price of gasoline exceeded \$1.00 per gallon. Mechanical computers in use at that time could not compute at unit prices above \$0.999 per gallon. The price rise happened so quickly that industry could not respond fast enough with new equipment to meet the market place needs. Stop gap measures gave industry time to respond and Handbook 44 was amended to allow money value divisions as can be seen in paragraph S.1.6.5.1. and Table 1. Had prices continued to spiral as predicted, the amendment and greater money value divisions of \$0.02 and \$0.05 would have been needed. With the increase in the number of electronic devices in use there is only a remote possibility that we will see a proliferation of \$0.02 and \$0.05 unit price divisions on mechanical computers. As inspectors, however, you need to be aware of the Handbook 44 provision for this eventuality.

S.1.6.5.1. Money-Value Divisions, Analog. - The values of the graduated intervals representing money values on a computing type device shall be those in Table 1. (Amended 1991)

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

Money-value divisions for digital devices are not specified in the same way as they are for analog devices. In accordance with S.1.6.5.2., they are a function of the quantity-value increment and the unit price.

S.1.6.5.2. Money-Value Divisions, Digital. - A computing type device with digital indications shall comply with the requirements of paragraph G-S.5.5. Money Values, Mathematical Agreement, and the total price computation shall be based on quantities not exceeding 0.01-gallon intervals for devices indicating in inch-pound units and 0.05 liter for devices indicating in metric units. (Added 1980)

While Handbook 44 allows digital, quantity-value increments of 0.01 gallon, few retail motor fuel dispensers remain in service with 0.01 increments. Most, if not all, dispensers placed in service over the past several

years have 0.001 gallon quantity-value increments. However, the following is offered to give some explanation of situations encountered at various unit prices for equipment with quantity-value increments of 0.01 gallon.

For a given dispenser, the money-value division will thus vary with the unit price. For example, consider a digital indicator whose quantity-value increment is 0.01 gal. If the unit price is \$1.00/gal, the following progression of money-values would be displayed:

<u>Quantity</u>		<u>Price</u>
1.00 gal		\$1.00
1.01	@ \$1.00/gal	\$1.01
1.02		\$1.02

The money-value division in this example would, thus, be \$0.01. However, if the unit price is changed to \$1.50/gal, the following progression would occur:

<u>Quantity</u>		<u>Price</u>
1.00 gal		\$1.50
1.01	@ \$1.50/gal	\$1.52 (\$1.515 rounded up)
1.02		\$1.53
1.03		\$1.55 (\$1.545 rounded up)

In this example, the money-value division could be considered to be \$0.015 (the unit price times the quantity increment). However, the effective money-value division is either \$0.01 or \$0.02, because the increment is always rounded to the nearest whole cent. If the unit price is changed again, this time to \$2.00/gal, the money-value division will then be \$0.02 (the quantity increment times the unit price).

An effective money-value division of more than 1 cent will obviously cause some problem if the customer wants to purchase a dollar amount of gas that cannot be displayed (for example, in the last example shown above the pump would not be capable of displaying a sale of exactly \$1.51 worth of product). This problem is avoided if the dispenser is designed to display quantity increments of thousandths of a gallon, since the money-value division will then not exceed 1 cent for any unit price up to \$10.00/gal.

(Note that a digital device must also comply with paragraph G-S.5.5., according to which any money value displayed must agree with the mathematically computed value to the nearest one cent of money value. This requirement will be described in the next chapter, under **Test Notes**.)

If the dispensing system is equipped with auxiliary indicating or recording elements, such as a control console, paragraph S.1.6.5.3. requires that the money-value divisions on the auxiliary indicator be the same as on the primary element.

S.1.6.5.3. Auxiliary Elements. - *If a system is equipped with auxiliary indications, all indicated money-value divisions of the auxiliary element shall be identical with those of the primary element. [Nonretroactive and enforceable as of January 1, 1985.]*

For example, if a dispenser with an analog indicator has money-value divisions of \$0.02, the money-value divisions of the digital control console must also be \$0.02.

Because inspection of the money-value divisions for a digital dispenser requires operating the device and observing computed values, the most efficient way of performing this procedure is during the Test, when related procedures are performed with the system in operation as described in Chapter 6. Chapter 6 also describes the requirements of S.1.6.6. Agreement Between Indications, which addresses the agreement between the indications on the console (or other auxiliary element) and the retail motor-fuel dispenser.

Unit Price and Product Identity

The customer must be provided with the basic information required to select the product he or she wishes to purchase; consequently, the LMD Code includes several requirements intended to ensure that this information is available and is displayed prominently and conspicuously. Subparagraph S.1.6.4.1.(a) requires that the unit price at which the device is set to compute or dispense be displayed by the device. When a dispenser is designed to be operated from either side of a service island, this information must be displayed on each face of the device. [The LMD Code makes a distinction between the “face” and the “side” of a device. The “side” is that part of the device that faces the consumer during normal delivery. The “face” is that part of the device that displays the computation of the price per unit, delivered quantity, and total sale price; in some electronic systems, the face may be separate from the pump or dispenser.]

S.1.6.4.1. Unit Price

- (a) A computing or money-operated device shall be able to display on each face the unit price at which the device is set to compute or to dispense.

* * *

S.1.6.4.2. Product Identity

- (a) A device shall be able to conspicuously display on each side the identity of the product being dispensed.
- (b) A device designed to dispense more than one grade, brand, blend, or mixture of product also shall be able to display on each side the identity of the grade, brand, blend, or mixture being dispensed.

Subparagraph S.1.6.4.2.(a) requires that a device must be able to display on each side the identity of the product being dispensed (e.g., the grade, brand, blend, or mixture) while subparagraph S.1.6.4.2.(b) requires that if a device is designed to dispense more than one subcategory of product (e.g., different grades, brands, etc.) it must be able to display on each side the identity of each product or blend of product available from that dispenser.

The LMD Code also includes a user requirement, which requires the owner or operator of the dispenser to provide and maintain the correct information.

Note that UR.3.2.(a) states that it is not necessary for unit prices for all grades, brands, blends, or mixtures available from a dispenser to be displayed simultaneously, provided that the dispenser complies with S.1.6.4.1. [this reference relates to the special requirement for multiple unit price dispensers in S.1.6.4.1.(b), which is discussed below under the heading **Multiple Unit Price Dispensers**.]

Inspect each side and face of each dispenser to determine compliance with the unit price and product identity requirements.

UR.3.2. Unit Price and Product Identity.

- (a) The following information shall be conspicuously displayed or posted on the face of a retail dispenser used in direct sale:
 - (1) except for dispensers used exclusively for fleet sales, other price contract sales, and truck refueling (e.g., truck stop dispensers used only to refuel trucks), all of the unit prices at which the product is offered for sale; and
 - (2) in the case of a computing type or money-operated type, the unit price at which the dispenser is set to compute.

Provided that the dispenser complies with S.1.6.4.1., it is not necessary that all the unit prices for all grades, brands, blends, or mixtures be simultaneously displayed or posted.
- (b) The following information shall be conspicuously displayed or posted on each side of a retail dispenser used in direct sale:
 - (1) the identity of the product in descriptive commercial terms, and
 - (2) the identity of the grade, brand, blend, or mixture that a multi-product dispenser is set to deliver.

(Amended 1972, 1983, 1987, 1989, 1992, and 1993)

Advancement and Return to Zero

In most gas stations, the transaction between buyer and seller occurs at the time when the product is delivered to the vehicle's tank. To protect the consumer and assure an accurate basis for the sale, all primary indicating and recording elements must be reset to zero before each delivery begins. In addition, it must not be possible to return indicating or recording elements past their zero indication, since to do so, either by accident or design, would result in an indication of more product than had actually been delivered.

Section S.1.6.3 of the LMD Code requires that retail motor-fuel dispensers be equipped with means to reset primary indicating and recording elements to zero between deliveries.

In most cases, the quantity and price indicated when the transaction is concluded represent a single delivery of product. However, certain self-operated devices, such as those that use key locks and card acceptors, permit individual customers to purchase fuel through specially equipped dispensers. The user has a key or coded card which must be inserted to actuate the dispenser. Payment is commonly made monthly and based upon totals from cumulative indicating or recording elements, called totalizers, which are assigned individually to customers. In addition to these elements, self-operated pumps are required to be equipped with elements that can be returned to zero. This allows the customer to determine the amount and cost of a purchase at the time of delivery, without having to record beginning and ending readings from the totalizers.

S.1.3. Advancement of Indicating and Recording Elements. - It shall not be possible to advance primary indicating and recording elements except by the mechanical operation of the device. Clearing a device by advancing its elements to zero is permitted, but only if:

- (a) once started, the advancement movement cannot be stopped until zero is reached, and
- (b) in the case of indicating elements only, such elements are automatically obscured until the elements reach the correct zero position.

The advancement of indicating and recording elements is required to be accomplished by operation of the dispenser—that is, only while fuel is actually being delivered. This requirement (S.1.3.) helps insure that no amount other than that actually delivered can be indicated, either by accident or as the result of tampering (although this, by itself, is not sufficient, since metering or computing components that do not function correctly can effectively nullify this assurance). However, mechanical indicating and recording elements are usually reset by turning the individual digits forward, that is, by advancing them.

Paragraph S.1.3. does permit a retail motor-fuel device to be cleared by advancing its indicating elements to zero, provided that the movement cannot be stopped until it has reached zero, and that all indications are obscured until the element reaches zero. These provisions help to ensure that neither operator nor customer will be able to read or record an amount during the resetting process.

On most electronic indicators, this is accomplished by blanking out the display during the reset. Before displaying zero, however, the figure 8 is displayed momentarily for all digits. This is a test of the display; the figure 8 contains all the independently activated segments that are used to display the other numbers, thus, if all the segments of the 8 appear, all other numbers can be displayed correctly.

Of course, the fact that a dispenser is capable of being reset to zero between deliveries does not assure that it will be. Retail motor-fuel devices are therefore also required to be equipped with interlocking devices, either mechanical or electronic, which automatically reset the dispenser before a delivery is begun.

S.2.5. Zero-Set-Back Interlock, Retail Motor-Fuel Devices. - A device shall be constructed so that:

- (a) after a delivery cycle has been completed by moving the starting lever to any position that shuts off the device, an automatic interlock prevents a subsequent delivery until the indicating elements, and recording elements if the device is equipped and activated to record, have been returned to their zero positions;
 - (b) the discharge nozzle cannot be returned to its designed hanging position (that is, any position where the tip of the nozzle is placed in its designed receptacle and the lock can be inserted) until the starting lever is in its designed shut-off position and the zero-set-back interlock has been engaged; and
 - (c) in a system with more than one dispenser supplied by a single pump, an effective automatic control valve in each dispenser prevents product from being delivered until the indicating elements on that dispenser are in a correct zero position.
- (Amended 1981 and 1985)

Generally, the system is interlocked through the on/off mechanism. Note that subparagraph (b) requires that the dispenser be designed so that the nozzle can not be replaced in the dispenser until this lever is placed in the off position (see Figure 3-17 for an illustration). Note, also, that in systems in which more than one dispenser is supplied by a single pump, the control valves must be interlocked to prevent delivery before resetting.

In the next chapter you will learn how to test the zero-set-back interlock to determine whether or not it is functioning properly.

Unfortunately, all of these safeguards can be circumvented. For example, suppose that an unscrupulous attendant at a busy station makes a relatively small delivery to one motorist, collects the indicated price, and then simply puts the nozzle in the fill pipe of the next vehicle and begins pumping, without turning the dispenser off first. He or she could then charge an unobservant second customer for both deliveries, based upon the indicated quantity at the end of the delivery. The LMD Code includes a user requirement (UR.3.1.) which requires resetting between deliveries for all dispensers for which zero set-back is required by S.1.6.3.

UR.3.1. Return of Indicating and Recording Elements to Zero. - On any dispenser used in making retail deliveries, the primary indicating element, and recording element if so equipped, shall be returned to zero before each delivery.

Exceptions to this requirement are totalizers on key-lock-operated or other self-operated dispensers and the primary recording element if the device is equipped to record.

When inspecting self-operated devices, keep in mind that all indicating and recording elements used by the customer or the operator to determine the amount or price of a delivery are primary elements and must meet the requirements for design, readability, values of intervals, money-value divisions, and unit price and product identity discussed in this section.

Provision for Sealing

Paragraph G-S.8. in the General Code of Handbook 44 requires that an electronic weighing or measuring device be designed so that a security seal can be applied to any electronic adjustable mechanism that affects the measurement capability of the device or that “other approved means” be used to prevent or discourage tampering.

G-S.8. Provision for Sealing Electronic Adjustable Components. - *A device shall be designed with provision(s) for applying a security seal that must be broken, or for using other approved means of providing security (e.g., data change audit trail available at the time of inspection), before any change that detrimentally affects the metrological integrity of the device can be made to any electronic mechanism. [Nonretroactive as of January 1, 1990.]*

A device may be fitted with an automatic or a semi-automatic calibration mechanism. This mechanism shall be incorporated inside the device. After sealing, neither the mechanism nor the calibration process shall facilitate fraud.

(Added 1985)(Amended 1989 and 1993)

For an electronic motor-fuel dispenser, this means that a mechanism, such as a gallon to liter conversion switch, that has a direct impact on the ultimate transaction should be protected in some manner. This usually involves providing a way to attach a physical seal such as a lead-and-wire or pressure sensitive seal; however, manufacturers may now use other approved types of security measures.

One example of another approved means of security is a data change audit trail incorporated in the device's software to make it possible for the weights and measures inspector to determine how many times a particular calibration factor or feature has been accessed since his or her last inspection. Any electronic audit trail used must at a minimum meet three requirements:

- a code or password is needed to access the part of the software that permits access to the operating parameters, features, and accuracy adjustment;
- the system must automatically maintain (even during a power failure) a count of the number of times the calibration or parameter selection software has been accessed and a change(s) made; and
- the device must be equipped with a means by which the enforcement official can easily access this information during an inspection of the device.

While security seals are usually affixed by the weights and measures inspector, a user requirement in the General Code makes it the responsibility of the device owner or operator to make sure that adjustable elements are properly sealed at all times.

G-UR.4.5. Security Seal. - A security seal shall be appropriately affixed to any adjustment mechanism designed to be sealed.

This requirement is also interpreted as requiring that non-physical seals, such as audit trails, be kept operative at all times. Audit trails, as specified in paragraph S.2.2. and Table S.2.2. are discussed in greater detail later in this chapter under the section “Security Seal on Adjustment Mechanism.” While audit trails may be used for any sealable parameter, the full discussion seems more appropriate within that section.

Multiple Unit Price Dispensers

Several requirements in the LMD Code relate specifically to multiple unit price dispensers, that is, dispensers which offer a product (or products) at more than one unit price, in contrast to single unit price dispensers, from which products are offered at only one unit price. At the present time, by far the most prevalent application for multiple unit price dispensers is at stations which offer a discount for cash purchases.

When oil companies first instituted discount-for-cash programs, most service stations did not have dispensers that were capable of computing at more than one unit price. Many stations adopted the practice of setting standard dispensers to the higher (credit purchase) unit price, and posting a sign indicating the discount, usually in cents per gallon, for cash purchases. If a customer paid in cash, the attendant would then compute the discount, often manually. If the customer did not notice or understand the sign and did not ask for the discount, an unscrupulous (or simply negligent) attendant could collect the non-discounted sale price. This practice clearly facilitated fraud and constituted use of equipment that was unsuitable to its application.

Dispensers that did have the capability of computing more than one preset unit price were soon available. Typically, the customer selects the method of payment (cash or credit) prior to the delivery; the dispenser then displays the unit price for the selected method of payment and during the delivery computes the total sales price based upon the selected unit price. This type of dispenser has been installed in most new facilities and in many older facilities when equipment was routinely replaced. However, many stations could not afford to replace existing pumps that would not otherwise have needed replacement simply to provide multiple unit pricing capability. At the same time, competitive pressure to participate in discount-for-cash programs was strong. This combination of factors made strict regulation impractical.

In 1989, specific requirements were added to Handbook 44 that were intended to assure that new equipment used in multiple unit price applications would be suitable and would not facilitate fraud. These specifications cover the computing capability, display of unit price, and price selection features of these dispensers. To avoid placing an excessive burden on station owners, these requirements were made nonretroactive. In addition, a user requirement was added to the LMD Code that prohibited placing into service dispensers with only single unit price computing capability in multiple unit price applications after January 1, 1990. This requirement applies to existing equipment as well as new installations. In 1990, another requirement was adopted, which established a date after which all dispensers used in multiple unit price applications would have to have suitable computing capability.

In accordance with S.1.6.4.1.(b), a multiple unit price dispenser must be capable of displaying all unit prices for all grades, brands, blends, or mixtures offered for sale from that dispenser. (S.1.6.4.1.(a), which includes the basic requirement for display of the unit price on any computing or money-operated liquid-measuring device, was discussed above, under **Unit Price and Product Identity**.)

Note that all prices are not required to be displayed simultaneously prior to delivery, provided that the prices can be displayed by using controls that are available to the customer at the dispenser. If, for example, the dispenser is designed so that when the customer presses a cash or credit selector button the unit price for the selected product appears in a display, it would meet the requirement. Note also the exemption for fleet, contract, and truck sales where the unit price is determined by contractual arrangement between the buyer and seller.

New dispensers used in multi-tier pricing applications after January 1, 1991 are also required to have user-operated controls for selecting the unit price.

S.1.6.4. Display of Unit Price and Product Identity.

S.1.6.4.1. Unit Price -

* * *

- (b) *If a grade, brand, blend, or mixture is offered for sale from a device at more than one unit price, then all of the unit prices at which that product is offered for sale shall be displayed or shall be capable of being displayed on the dispenser using controls available to the customer prior to the delivery of the product. It is not necessary that all of the unit prices for all grades, brands, blends, or mixtures be simultaneously displayed prior to the delivery of the product.*

(Effective and nonretroactive as of January 1, 1991.)

(Amended 1989)

S.1.6.5.4. Selection of Unit Price. - *Except for dispensers used exclusively for fleet sales, other price contract sales, and truck refueling (e.g., truck stop dispensers used only to refuel trucks), when a product or grade is offered for sale at more than one unit price through a computing device, the selection of the unit price shall be made prior to delivery using controls on the device or other customer-activated controls. A system shall not permit a change to the unit price during delivery of product.*

[Effective and nonretroactive as of January 1, 1991.]

(Added 1989)(Amended 1991, 1992, 1993, and 1996)

This requirement is intended to eventually eliminate the practice of having the actual selection of a unit price performed by an attendant at a separate console, for example, a practice which could obviously facilitate fraud if the customer did not inform the attendant of a selection (either because the customer did not know that there was a selection to be made or through forgetfulness) or did not verify the selection entered by the attendant.

After January 1, 1991, dispensers must be designed so that the selection of unit price is made at the pump (by the customer) before delivery can begin. Some systems installed prior to 1991 are designed so that if the customer does not make a selection the higher unit price (usually the credit purchase price) is automatically selected and the delivery proceeds. When the customer presents payment, however, the attendant must enter the method of payment, and if this differs from the selection entered prior to delivery, the system will not permit the transaction to be completed electronically until the difference is reconciled. Generally, the system will also recompute the total sale price, based upon the correct unit price, once that has been established. This type of system is not acceptable for new multi-tier pricing installations after January 1, 1991.

Finally, any dispenser in use after January 1, 1999, must also be able to compute the total sale price of deliveries at all unit prices offered from that dispenser (with the exception of fleet, contract, and truck sales).

S.1.6.5. Money-Value Computations.

- (a) *A computing device shall compute the total sales price at any single-purchase unit price (i.e., excluding fleet sales and other contract sales) for which the product being measured is offered for sale at any delivery possible within either the measurement range of the device or the range of the computing elements, whichever is less.*

(Effective and nonretroactive as of January 1, 1991).

Although S.1.6.5.(a), like the other design requirements relating to multiple unit price dispensers is nonretroactive, a user requirement, added to the Handbook in 1989 and later amended, establishes successive dates after which:

- any dispenser (with limited exceptions) placed in use in a multi-tier pricing application must compute and display total sale prices for deliveries at all unit prices offered from that dispenser; and
- all dispensers, regardless of when installed, must be used only for sales for which they compute and display the sales price.

UR.3.3. Computing Device.

- (a) Any computing device used in an application where a product or grade is offered for sale at more than one unit price (excluding fleet sales and other price contract sales), shall be used only for sales for which the device computes and displays the sales price for the selected transaction.
(Added 1989) (Amended 1992)
(Became Retroactive 1999)
- (b) A truck stop dispenser used exclusively for refueling trucks is exempt from the requirements in (a) if all purchases of fuel are accompanied by a printed receipt of the transaction containing the applicable price per gallon, the total gallons delivered, and the total price of the sale.
(Added 1993)
- (c) Unless a truck stop dispenser used exclusively for refueling trucks complies with S.1.6.4.1. (Display of Unit Price), the price posted on the dispenser and the price at which the dispenser is set to compute shall be the highest price for any transaction which may be conducted.
(Added 1993)

In accordance with UR.3.3.(a), if a station is using dispensers in a multi-tier pricing application, all dispensers, whether new or old, must compute and display total sales prices for all unit prices for which product is sold through the dispenser.

It is important to keep in mind that these requirements apply to individual dispensers and that their specific applicability depends upon the way in which a dispenser is used. The fact that a product may be offered for sale at different prices at a station does not necessarily mean that *every* dispenser must display all unit prices, provide means for selecting all unit prices, or have computing capability for all unit prices.

Consider, for example, a station that offers self or full service and a discount for cash. As at most stations, dispensers are dedicated to either self or full service: some dispensers offer full service, others self service, but no dispenser offers both self and full service. In contrast, the customer can choose the method of payment (cash or credit) at any dispenser. So, any given product may be offered at four different unit prices at this station: full service/credit, full service/cash, self service/credit, self service/cash. However, a given dispenser will only offer two unit prices, one for credit, one for cash. Requirements for display of unit price, unit price selection, and computing capability apply only to individual dispensers. So, in this example, a full service dispenser would be required to display full service credit and cash purchase unit prices only, since self service is not offered from that dispenser. [UR.3.3.(c) and (d), like S.1.6.4.1., make special provisions for truck stop dispensers.]

Recorded Representations, Point of Sale Systems

Recorded representations in the form of printed receipts or delivery tickets are not required for retail motor-fuel devices. However, if they are provided, they must include specific information about the transaction. 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, it must show the volume, unit price, total computed price, and the product identity.

S.1.6.7. Recorded Representations. - *Except for fleet sales and other price contract sales, a printed receipt providing the following information shall be available through a built-in or separate recording element for all transactions conducted with point-of-sale systems or devices activated by debit cards, credit cards, and/or cash:*

- (a) *the total volume of the delivery,*
- (b) *the unit price,*
- (c) *the total computed price, and*
- (d) *the product identity by name, symbol, abbreviation, or code number.*
[Nonretroactive as of January 1, 1986.]
(Added 1985) (Amended 1997)

As will be explained in the next chapter, a ticket should be printed after each test draft (if the system is equipped with a printer or printing cash register). The inspector should check these tickets to make sure that all required items are included. Additional requirements for printed tickets issued by the device are covered under Liquid-Measuring Devices Code paragraph UR.3.4., which is discussed in Chapter 6.

MEASURING ELEMENTS

Air Eliminator Vent

To assure that the customer receives the full measure of product that he or she is paying for, all liquid-measuring devices are required to be equipped with means of removing air and/or vapor from the liquid flow before it enters the meter.

S.2.1. Vapor Elimination.

- (a) A liquid-measuring device shall be equipped with a vapor or air eliminator or other automatic means to prevent the passage of vapor and air through the meter.
- (b) Vent lines from the air or vapor eliminator shall be made of metal tubing or other rigid material.
(Amended 1975)

As you learned in Chapter 3, the air eliminator in a submerged-pump system is located in the discharge head, and gases are vented directly into the storage tank. Because these units are relatively inaccessible and less subject to damage or tampering, they need not be inspected in the course of a routine field examination.

You will also recall from the discussion in Chapter 3 that suction-pump dispensers are designed with a special chamber where air and vapor are continuously separated from the liquid fuel and vented to the atmosphere by means of a tube that passes from the chamber to the outside of the cabinet. If the vent tube becomes blocked or damaged in some way that obstructs the escape of air and vapor, these gases no longer separate from the fuel, and may pass through the meter, causing incorrect measurement. A break or puncture in the tube can also result in buildup of vapor within the cabinet, thereby creating a hazard of fire and/or explosion.

The vent tube serving a suction-pump dispenser is therefore required to be made of metal or some other rigid material to reduce the risk of kinking, crimping, cracking, or accidental rupture.

When performing the inspection for this item and the next, the dispenser cabinet will have to be open. This will generally require a key, which should be provided by the station attendant or proprietor.

Inspect the vent tube carefully to determine that it is made of appropriate material and that there are no signs of damage that might cause obstruction or breaks in the tube that could allow vapor buildup in the cabinet.

Security Seal on Adjusting Mechanism

No security seal can prevent tampering with the meter adjustment mechanism. But if installed properly, the seal will provide clear evidence of tampering if it has occurred. In order to accomplish this, the device must be designed in such a way that a seal can be applied and, once in place, no adjustment can be made without destroying the seal.

S.2.2. Provision for Sealing. - Adequate provision shall be made for an approved means of security (e.g., data change audit trail) or physically applying security seals in such a manner that no adjustment may be made of:

- (a) any measurement element, or
- (b) any adjustable element for controlling delivery rate when such rate tends to affect the accuracy of deliveries.

When applicable, the adjusting mechanism shall be readily accessible for purposes of affixing a security seal.

- (c) *Audit trails shall use the format set forth in Table S.2.2. [Nonretroactive and enforceable as of January 1, 1995.]* (Amended 1991, 1993, and 1995)

Table S.2.2. Categories of Device and Methods of Sealing

<i>Categories of Device</i>	<i>Method of Sealing</i>
<p><i>Category 1: No remote configuration capability</i></p>	<p><i>Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.</i></p>
<p><i>Category 2: Remote configuration capability, but access is controlled by physical hardware.</i></p> <p><i>Device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode.</i></p> <p><i>[Category 2 applies only to devices manufactured prior to January 1, 2005. Devices with remote configuration capability manufactured after that date must meet the sealing requirements outlined in Category 3. Devices without remote configuration capability manufactured after that date will be required to meet the minimum criteria outlined in Category 1.]</i></p>	<p><i>[The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.]*</i></p> <p><i>[*Nonretroactive as of January 1, 1996]</i></p>
<p><i>Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).</i></p> <p><i>The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode. [Nonretroactive as of January 1, 2001]</i></p> <p><i>Nonretroactive as of January 1, 2005, all devices with remote configuration capability must comply with the sealing requirements of Category 3.</i></p>	<p><i>An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to ten times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: Does not require 1000 changes to be stored for each parameter.)</i></p>

[Nonretroactive as of January 1, 1995.] (Table Added 1993) (Amended 1995, 1998, and 1999)

As explained previously (under **Provision for Sealing**), paragraph G-UR.4.5. of the General Code makes it the responsibility of the owner or operator of the device to make sure that adjustable elements are properly sealed at all times.

Inspect the existing seal carefully to determine that it is installed properly and that it shows no evidence of tampering. If it is properly installed and secure, there is no need to remove it at this stage. The procedure for installing the security seal will be presented in Chapter 7.

Audit trails are a relatively new method of sealing. While Handbook 44 has allowed their use since 1990, Table S.2.2. was not added until 1993. At the present time most retail motor-fuel dispensers fall under the definition of a Category 1 or Category 2 device, as explained in table S.2.2. Unlike a physical seal, the audit trail method of sealing is not visually apparent when observing the device or a device component like the measuring element. Blend settings on a variable ratio or an adjustable ratio blender are the most common elements of a retail motor-fuel dispenser that are secured with an audit trail method of sealing. Here the inspector, if unfamiliar with checking audit trail details, must rely on the NTEP Certificate of Conformance for the device, or contact the manufacturer or service company for instructions for accessing audit trail information. Gaining access to the audit trail information is relatively simple, and manufacturers have protected you and the system with safeguards to prevent your actions from altering system settings. When inspecting a device equipped with an audit trail, the inspector should record the values indicated for reference during future inspections or in response to consumer complaints. If the event counters show a significant number of changes since the last inspection, the inspector should attempt to determine whether or not the changes were for legitimate reasons. The inspector should also contact his or her supervisor for guidance on whether or not additional investigation might be warranted.

Changes made to Table S.2.2. allow a wider definition of Category 2 devices. However, for devices manufactured **after** January 1, 2005, there will only be provisions for Category 1 and Category 3 devices.

DISCHARGE HOSE

In order to assure that all product that passes through the meter is delivered to the customer who is being charged for it, there must be no means for diverting fuel to any other destination. Any bypass line from the meter outlet back to supply lines or the system storage tank is obviously prohibited. Multiple discharge outlets could be used to facilitate fraud, so they are permitted only to provide for special circumstances, and then only with specified safeguards.

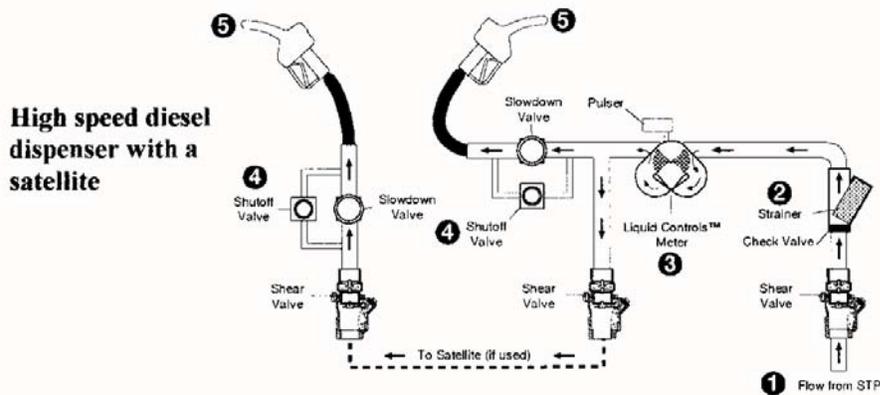
The gasoline pumps installed at most filling stations are designed to service vehicles which have only one fuel tank and which can be parked in relatively close proximity to the dispenser for fueling. Units equipped with multiple discharge outlets are generally not suitable to such service.

Many large trucks, however, have two fuel tanks. To service them more efficiently, some truck stops have installed "satellite" dispenser systems. Under this scenario, the truck is parked between two service islands. On one island is the main dispenser. The dispenser is equipped with a meter and computer, and it is just like any other dispenser except that two discharge lines lead from the meter outlet. One line serves the hose connected to the main dispenser; the other line runs under the driveway separating the two islands and is connected to the satellite dispenser on the second island. The satellite consists simply of a chassis and a discharge hose. It has no measuring or indicating components of its own because all product delivered through it has already passed through the meter at the main dispenser.

Paragraph S.3.3 of the LMD Code allows such installations when they are used for fueling trucks and when adequate means are provided to prevent simultaneous delivery to more than one vehicle. Examples of such means of preventing diversion of metered product include physical barriers to driveways adjacent to the service islands and visible flow indicators that can be monitored from the customer position. Explanatory signs must also be provided. The operation of a dispenser/satellite system is depicted in Figure 5-7.

These models are for applications requiring higher flow rates. They can operate as a master when teamed with a satellite or alone. A master meters and controls the satellite. This configuration can deliver up to 60 gpm.*

- 1 Fuel passes through a shear valve then enters dispenser.
- 2 Fuel flows through a check valve and strainer.
- 3 Fuel flows through a Liquid Controls™ meter.
- 4 Metered fuel passes through a single-stage shutoff valve and slowdown valve in parallel and through piping to the satellite.
- 5 Fuel discharges through the nozzle.



* Actual flow rate depends on installation and accessories used. Some local codes do not allow simultaneous operation of master and satellite.

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Master

The valve in a master unit is located after the meter; this allows for a higher flow rate in the master and satellite units when operating simultaneously.

Note: Refer to NFPA 30A, local and state regulations to determine what type of operation is allowed in your area.

Types of Operation

- Simultaneous Operation - Allows customer to fuel saddle-tank vehicle with master and satellite unit at same time.
Note: Some regulatory agencies require a physical barrier.
- Independent Operation - Allows customer to fuel a saddle-tank vehicle one side at a time.

Satellite

The satellite unit operates in conjunction with a master unit which meters the fuel.

FIGURE 5-7. OPERATION OF A DIESEL DISPENSER/SATELLITE SYSTEM

S.3. Discharge Lines and Valves.

S.3.1. Diversion of Measured Liquid. - No means shall be provided by which any measured liquid can be diverted from the measuring chamber of the meter or its discharge line. Two or more delivery outlets may be installed only if automatic means are provided to ensure that:

- (a) liquid can flow from only one outlet at a time, and
- (b) the direction of flow for which the mechanism may be set at any time is clearly and conspicuously indicated.

A manually controlled outlet that may be opened for purging or draining the measuring system or for recirculating product in suspension shall be permitted only when the system is measuring food products or agri-chemicals. Effective means shall be provided to prevent passage of liquid through any such outlet during normal operation of the measuring system and to inhibit meter indications (or advancement of indications) and recorded representations while the outlet is in operation.
(Amended 1991, 1995, and 1996)

You may also encounter situations where a satellite system has been installed to facilitate access to a dispenser from different vehicle positions. However, delivery is permitted from only one discharge hose at any time, and means must be provided to prevent simultaneous delivery and to indicate which outlet is operative at any given time.

S.3.2. Exceptions. - The provisions of S.3.1. Diversion Prohibited shall not apply to truck refueling devices when diversion of flow to other than the receiving vehicle cannot readily be accomplished and is readily apparent. Allowable deterrents include, but are not limited to, physical barriers to adjacent driveways, visible valves, or lighting systems that indicate which outlets are in operation, and explanatory signs.
(Amended 1982, 1990, 1991, and 2002)

All retail motor-fuel devices are pump-discharge devices with flexible discharge hoses, and so must be of the wet-hose type. That is, they are designed so that the discharge hose is always completely filled with liquid fuel. As described earlier in this course, this ensures that the amount of fuel that passes through the meter during any single delivery will actually be delivered to the vehicle.

S.3.3. Pump-Discharge Unit. - A pump-discharge unit equipped with a flexible discharge hose shall be of the wet-hose type.

A discharge hose that is not properly reinforced will tend to “give” and may thereby contribute to the condition known as “computer jump.” Computer jump occurs when fuel on the discharge side of the meter is not pressurized as quickly as fuel on the pump side, causing the computer to move slightly and register a small amount, even though no fuel has actually been delivered. This most often occurs as the result of expansion and contraction resulting from fluctuations in temperature, exposure to the sun or wind, and periods of rest (e.g., while the station is closed overnight). The LMD Code requires that discharge hoses be sufficiently rigid to minimize these effects.

S.3.5. Discharge Hose. - A discharge hose shall be reinforced so that the performance of the device is not affected by the expansion or contraction of the hose.

Another important reason for reinforcing the discharge hose is to minimize the risk of rupture if it is run over by a vehicle moving into or away from the service island. An adequately reinforced hose is also less likely to kink when extended to reach the vehicle fill opening.

UR.1.1. Discharge Hose.

UR.1.1.1. Length. - The length of the discharge hose on a retail motor-fuel device:

- (a) shall be measured from its housing or outlet of the discharge line to the inlet of the discharge nozzle;
- (b) shall be measured with the hose fully extended if it is coiled or otherwise retained or connected inside a housing; and
- (c) shall not exceed 18 feet unless it can be demonstrated that a longer hose is essential to permit deliveries to be made to receiving vehicles or vessels.

An unnecessarily remote location of a device shall not be accepted as justification for an abnormally long hose.

(Amended 1972 and 1987)

UR.1.1.2. Marinas and Airports.

UR.1.1.2.1. Length. - The length of the discharge hose shall be as short as practicable, and shall not exceed 50 feet unless it can be demonstrated that a longer hose is essential.

UR.1.1.2.2. Protection. - Discharge hoses exceeding 26 feet in length shall be adequately protected from weather and other environmental factors when not in use.

(Made retroactive 1974 and amended 1984)

To reduce the risk of damage to the hose and minimize the effects of computer jump, the discharge hose should be no longer than necessary to reach vehicle fill openings.

Paragraph UR.1.1 generally requires that a discharge hose be no longer than 18 feet. But exceptions to this requirement are allowed in cases where additional length is required to reach the receiving vehicle. A general exception, in the form of a maximum length of 50 feet, is also provided for dispensers installed at airports and boat docks or marinas.

Check the length of the discharge hose. If a reeling device or retractor is employed, the hose should be measured when fully extended. Inspect the hose carefully for any signs of excessive wear, damage, or deterioration from exposure to the elements.

Since gas pumps are wet-hose devices, the discharge valve must be at the end of the discharge line, and there must be no other means for non-automatic regulation of flow between the meter and the discharge valve.

S.3.6. Discharge Valve. - A discharge valve may be installed in the discharge line only if the device is of the wet-hose type. Any other shutoff valve on the discharge side of the meter shall be of the automatic or semiautomatic predetermined-stop type or shall be operable only:

- (a) by means of a tool (but not a pin) entirely separate from the device, or
- (b) by mutilation of a security seal with which the valve is sealed open.

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

For example, a manual shutoff valve at the dispenser end of the discharge hose would be prohibited by S.3.6. and S.3.7. unless there is an anti drain means associated with the valve. The automatic overfill shutoff that is incorporated on many discharge nozzles is permitted, since it is automatic in operation, and because it cannot affect the accuracy of measurement. Safety regulations, specified in National Fire Protection Association (NFPA) 30A, prohibit the use of a manual (non-automatic) nozzle for motor fuel dispensers.

Additional Inspection Procedures

Your jurisdiction may require additional inspection procedures as part of a routine examination. For example, some jurisdictions require inspection of storage tanks for water contamination.

Your instructor will describe additional inspection procedures, along with applicable specifications and requirements.

SUMMARY

The Inspection is one of four components of an official field examination. Its general objective is to determine whether changes have occurred since the device was installed that might affect its conformance with specifications and requirements relating to design, installation, maintenance, and use. Examination Procedure Outlines (EPOs) organize the requirements set forth in Handbook 44 in a systematic way, suited to efficient field procedures. EPO 21 for single-, dual-, and multi-product retail motor-fuel dispensers and EPO 22 for blended-product retail motor-fuel devices classify requirements in five areas:

- General considerations;
- Marking requirements;
- Indicating and recording elements;
- Discharge hose; and
- Measuring elements.