Manual of Petroleum Measurement Standards Chapter 6—Metering Assemblies

Section 3—Service Station Metered Fuel–Dispensing Systems

SECOND EDITION, JULY 1994

American Petroleum Institute
1220 L Street, Northwest
Washington, D.C. 20005

Manual of Petroleum Measurement Standards
Chapter 6—Metering Assemblies

Section 3—Service Station Metered Fuel–Dispensing Systems

Measurement Coordination

SECOND EDITION, JULY 1994

American
Petroleum
Institute

SPECIAL NOTES

1. API PUBLICATIONS NECESSARILY ADDRESS PROBLEMS OF A GENERAL NATURE. WITH RESPECT TO PARTICULAR CIRCUMSTANCES, LOCAL, STATE, AND FEDERAL LAWS AND REGULATIONS SHOULD BE REVIEWED.

2. API IS NOT UNDERTAKING TO MEET THE DUTIES OF EMPLOYERS, MANUFACTURERS, OR SUPPLIERS TO WARN AND PROPERLY TRAIN AND EQUIP THEIR EMPLOYEES, AND OTHERS EXPOSED, CONCERNING HEALTH AND SAFETY RISKS AND PRECAUTIONS, NOR UNDERTAKING THEIR OBLIGATIONS UNDER LOCAL, STATE, OR FEDERAL LAWS.

3. INFORMATION CONCERNING SAFETY AND HEALTH RISKS AND PROPER PRECAUTIONS WITH RESPECT TO PARTICULAR MATERIALS AND CONDITIONS SHOULD BE OBTAINED FROM THE EMPLOYER, THE MANUFACTURER OR SUPPLIER OF THAT MATERIAL, OR THE MATERIAL SAFETY DATA SHEET.

4. NOTHING CONTAINED IN ANY API PUBLICATION IS TO BE CONSTRUED AS GRANTING ANY RIGHT, BY IMPLICATION OR OTHERWISE, FOR THE MANUFACTURE, SALE, OR USE OF ANY METHOD, APPARATUS, OR PRODUCT COVERED BY LETTERS PATENT. NEITHER SHOULD ANYTHING CONTAINED IN THE PUBLICATION BE CONSTRUED AS INSURING ANYONE AGAINST LIABILITY FOR INFRINGEMENT OF LETTERS PATENT.

5. GENERALLY, API STANDARDS ARE REVIEWED AND REVISED, REAFFIRMED, OR WITHDRAWN AT LEAST EVERY FIVE YEARS. SOMETIMES A ONE-TIME EXTENSION OF UP TO TWO YEARS WILL BE ADDED TO THIS REVIEW CYCLE. THIS PUBLICATION WILL NO LONGER BE IN EFFECT FIVE YEARS AFTER ITS PUBLICATION DATE AS AN OPERATIVE API STANDARD OR, WHERE AN EXTENSION HAS BEEN GRANTED, UPON REPUBLICATION. STATUS OF THE PUBLICATION CAN BE ASCERTAINED FROM THE API AUTHORING DEPARTMENT [TELEPHONE (202) 682-8000]. A CATALOG OF API PUBLICATIONS AND MATERIALS IS PUBLISHED ANNUALLY AND UPDATED QUARTERLY BY API, 1220 L STREET, N.W., WASHINGTON, D.C. 20005.

FOREWORD

This section of Chapter 6 of the API Manual of Petroleum Measurement Standards is a guide to the selection, installation, performance, and maintenance of two common types of metered motor-fuel-dispensing systems: the submersible pump system and the self-contained-pump system.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any federal, state, or municipal regulation with which this publication may conflict.

Suggested revisions are invited and should be submitted to Measurement Coordination, Industry Services Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

CONTENTS

Chapter 6—Metering Assemblies

SECTION 3—SERVICE STATION METERED FUEL–DISPENSING SYSTEMS

6.3.1 Introduction

This section of Chapter 6 of the API *Manual of Petroleum Measurement Standards* pertains to service station metering systems used for dispensing motor fuels (except liquefied petroleum gas fuels) to road vehicles at relatively low flow and pressure. Since these systems are used in custody-transfer service, they must meet certain performance requirements and may be required to conform to federal, state, and municipal regulations, codes, and laws. The regulations, codes, and laws may have specific restrictions that must be taken into account in the design and installation of service station metered fuel-dispensing systems.

This section does not focus on service station design as such. It focuses instead on the meter, its appurtenances, and the associated elements that may have a bearing on measurement accuracy.

6.3.2 Scope

This section of Chapter 6 of the API *Manual of Petroleum Measurement Standards* offers guidance on the selection, installation, performance, and maintenance of two common types of metered motor-fuel-dispensing systems: the submersible pump system (often called *a remote pump system, a pressurized pump system,* or *a submerged pump system*) and the self-contained-pump system (often called *a suction-pump system* or *a self-contained system*).

6.3.3 Pertinent Publications

6.3.3.1 REFERENCED PUBLICATIONS

The most recent editions of the following recommended practice and handbook are cited in this section of Chapter 6 of the API *Manual of Petroleum Measurement Standards.*

API

RP 1615 *Installation of Underground Petroleum Product Storage Systems*

NIST[1]

Handbook 44 *Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices*

[1]National Institute of Standards and Technology, U.S. Department of Commerce, Gaithersburg, MD 20899.

6.3.3.2 OTHER PERTINENT PUBLICATIONS

Many aspects of metering are dealt with at length in parts of the API *Manual of Petroleum Measurement Standards* other than this one. Please refer to the following chapters of the *Manual* for more information. Please also refer to the following recommended practice for more information.

API

Manual of Petroleum Measurement Standards (MPMS)
Chapter 4, "Proving Systems"
Chapter 5, "Metering"

RP 1621 *Bulk Liquid Stock Control at Retail Outlets*

6.3.4 Field of Application

The systems described in this section of Chapter 6 of the Manual are meant primarily for use in small-to-medium-capacity service stations, large multipump stations, convenience stores, and truck stops or for use in relatively low-flow aircraft-and-marine-motor-fuel-dispensing systems. To a lesser extent, they can apply to fleet-fueling systems, although these are generally outside the jurisdiction of the weights-and-measures authorities.

6.3.5 Dispensing Systems

6.3.5.1 BASIC DISPENSING SYSTEM

A basic dispensing system consists of a fuel reservoir, a pump, a meter and register, provision for air elimination and thermal expansion, miscellaneous valves and piping, and a discharge hose and nozzle. The system may also include other enhancements, such as leak detection, vapor recovery, and safety devices.

6.3.5.2 TYPES OF DISPENSING SYSTEMS

The two most common types of dispensing systems are the submersible pump system (often called *a remote pump system, a pressurized pump system,* or *a submerged pump system*) and the self-contained-pump system (often called *a suction-pump system* or *a self-contained system*). Both are wet hose systems that include an antidrain valve inside the delivery nozzle to prevent the hose from being drained when the system is inoperative. Without the antidrain valve, the meter could creep ahead before the next delivery, thereby overstating the delivered volume.

6.3.6 Submersible Pump System

In a submersible pump system, the pump is located at the bottom of the fuel reservoir, and it pushes the fuel under pressure through the complete system. A single submersible pump may serve one or several dispensing hoses simultaneously.

An important advantage of this system is that during operation, fuel is under pressure and little possibility exists for the fuel to vaporize and have an adverse effect on measurement accuracy. Once the piping system is purged, the submerged pump cannot pump air into the system. A check valve at the pump discharge head prevents backflow in the piping when the system is inoperative. If backflow or emptying does occur—allowing air to enter the pipe connecting the pump to the pump discharge head—the air will be purged from the pipe when the pump is activated for subsequent dispensing and the pipe is repressurized with fuel.

Since submersible pump systems are pressurized, a means for detecting leaks in the piping is usually provided. The systems also include an impact safety valve beneath each dispenser to stop the flow of fuel if a dispenser is struck or damaged. Pressure from thermal expansion is relieved through a thermal relief valve in or near the check valve in the pump discharge head.

Figure 1 illustrates a typical submersible pump system.

6.3.7 Self-Contained-Pump System

A self-contained-pump system is a dispensing system whose dispenser contains the pump that draws its fuel. In this system, fuel is drawn from the fuel reservoir up through piping to the pump within the island dispenser. From that point on, the pump pushes the fuel through the balance of the system. In this system—unlike a submersible pump system—no dispenser impact valve is utilized in suction piping since a break usually terminates fuel flow. Although self-contained-pump systems are less costly in certain applications, they tend to vaporize fuel as it is sucked upwards by the pump from underground storage.

Note: Caution must be exercised not to exceed the manufacturer's recommendations for vertical lift and overall horizontal length of piping during installation and application. Otherwise, an operational problem might follow.

In self-contained-pump systems, air is allowed to enter the piping because the system's positive displacement pump can

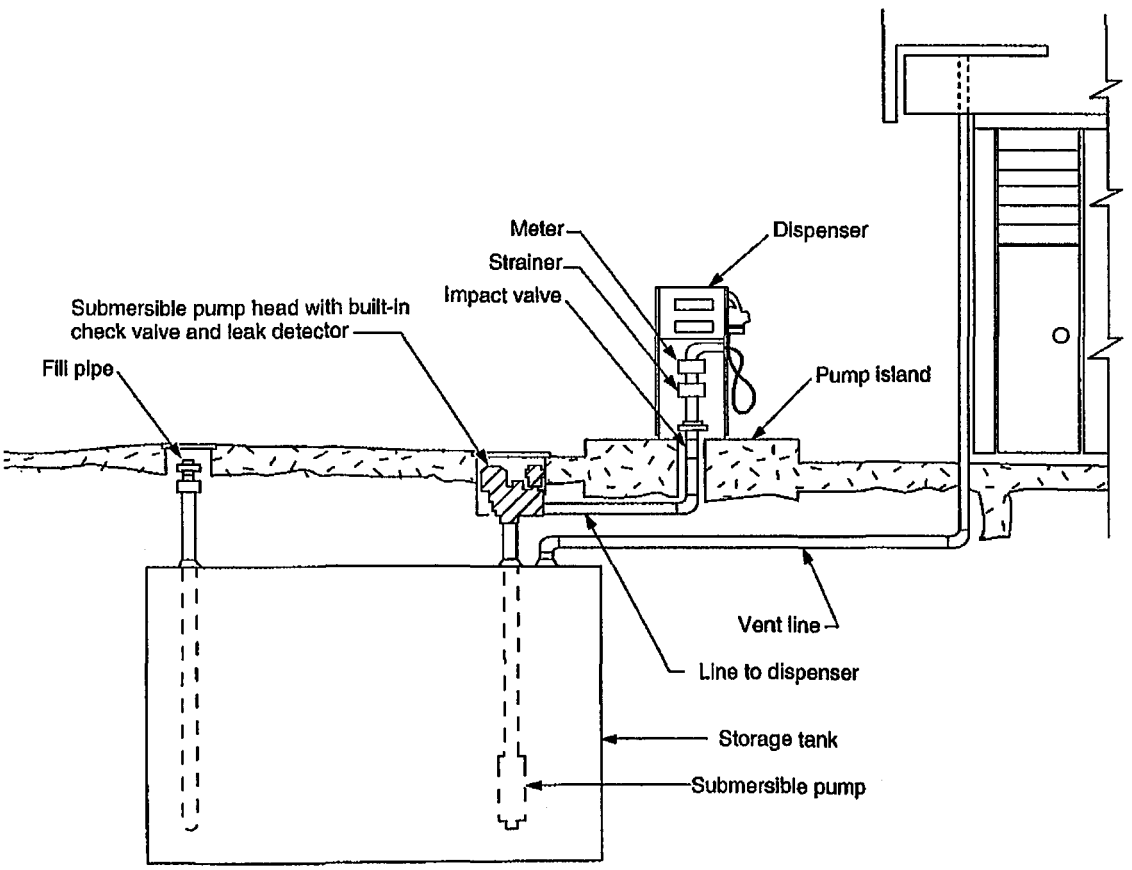

Figure 1—Metering System With Submersible Pump

effectively pump air. However, a foot valve on the suction pipe near the bottom of the fuel reservoir prevents backflow when the pump is deactivated. To remove air, the fuel is passed through an air eliminator, located on the discharge side of the pump in the dispenser. The air eliminator allows air entrained in the fuel to settle out after passing from the high-pressure chamber to the low-pressure chamber of the eliminator. Once air is separated from the fuel, it is vented to the atmosphere. The vent must never be plugged or restricted, because if it is, air will enter the meter.

Unlike submersible pump systems, which have thermal relief for fuel expansion built into the pump head, self-contained-pump systems relieve into the low-pressure chamber of the air eliminator. The excess fluid is fed back into the system when the pump is operated.

Figure 2 illustrates a typical self-contained-pump system.

6.3.8 System Selection

In adverse conditions such as long underground lines, high vertical lift, relatively high ambient temperatures, and high geographic elevations, submersible pump systems have an advantage over self-contained-pump systems. These conditions may cause poor performance in a self-contained-pump system. In addition, fuel vaporization could cause the meter of a self-contained-pump system to behave erratically.

Self-contained-pump systems perform very well where lines are relatively short and buried to a satisfactory depth, temperature limits are not exceeded, and barometric pressure is never low.

6.3.9 Meter and Register

6.3.9.1 METER

Generally, meters used in service station dispensing systems are of the sealed piston type, which is accurate over a relatively broad flow range—typically 2–15 gallons per minute. The accuracy requirement for a new installation is approximately 0.25 percent. Strainers installed upstream of the meter should be cleaned periodically to protect the meter.

The meter is equipped with an adjustable calibration mechanism for use when the meter is proved against a standard test volume. Tampering with the calibration mechanism

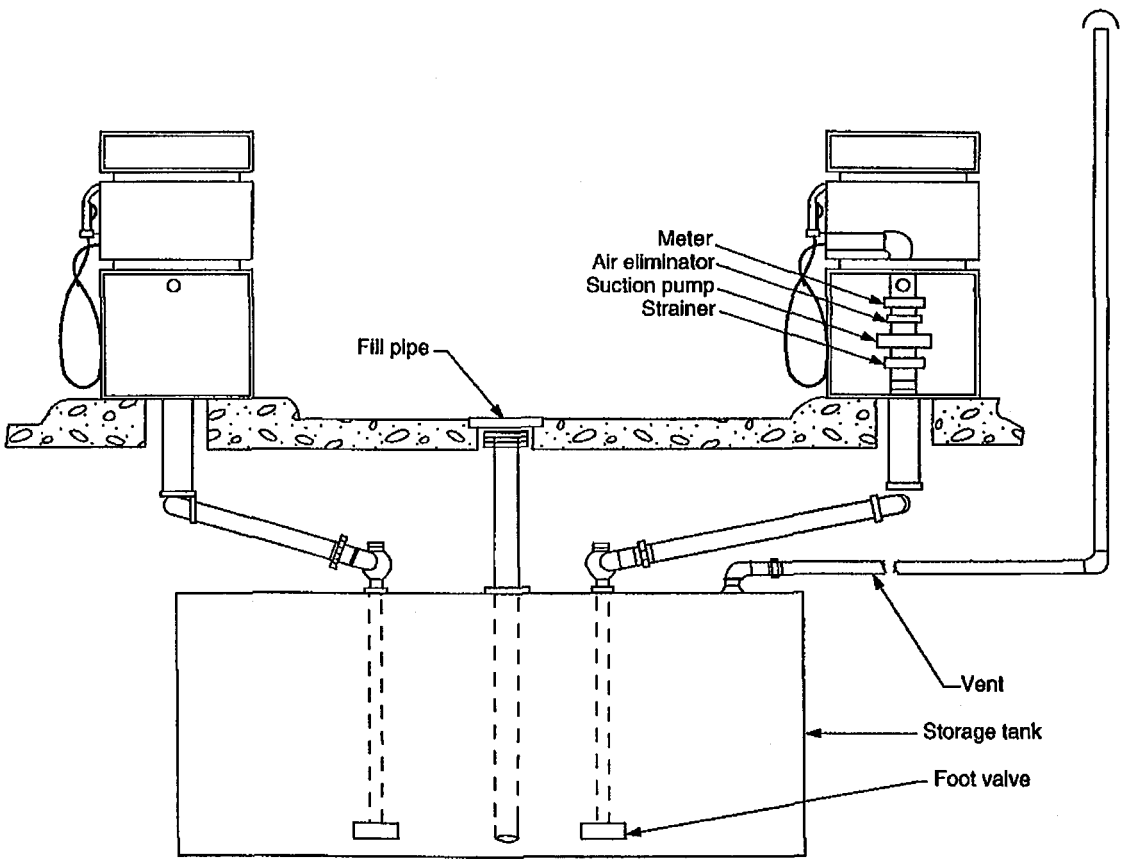

Figure 2—Metering System With Self-Contained Pumps

is indicated by broken seals. The calibration mechanism must be sealed by authorized weights-and-measures personnel.

6.3.9.2 INDICATING REGISTER

The register may be of the mechanical type or the digital electronic type. In either type, the register computes the total sales by multiplying the posted price per gallon of the particular fuel delivered times the number of gallons (with any fraction thereof) of fuel delivered.

The register is interlocked to the delivery hose to the extent that a subsequent delivery cannot be made until the register is reset to zero gallons and zero dollars.

Registers should display both the transaction gallonage and the totalizer reading of all gallons dispensed through the register. All information displayed should be as defined by NIST Handbook 44.

6.3.10 Installation

Underground piping associated with self-contained-pump systems should be kept as short as possible and installed at an appropriate depth to prevent or minimize fuel vaporization. Underground product tanks should be maintained in a secure environment; this can be done by providing facilities for locking or sealing the fill pipe cover. API Recommended Practice 1615 recommends procedures for the installation of underground gasoline tanks and piping at service stations. Authorized weights-and-measures personnel must prove and seal the meters in a new installation before the dispensing system can be placed in service.

6.3.11 Meter Proving

Motor fuel dispenser meters are proved on a regular basis, generally annually. Proving is performed by authorized weights-and-measures personnel by dispensing a discrete quantity—usually 5 gallons—into a field test measure. The quantity indicated on the dispenser register must compare with the quantity deposited in the test measure within the designated tolerance for the flow rate used. Acceptance tolerances may vary slightly among the various local approval authorities. (Refer to NIST Handbook 44 for nationally specified tests and tolerances.) A security seal must be applied to the meter calibrator and a seal of approval must be applied to the dispenser before the dispenser is placed in custody-transfer service.

6.3.12 Maintenance

Line filters and strainers must be cleaned or replaced frequently to prevent unnecessary flow restrictions and to protect the meter.

Flow nozzles must be tested periodically to determine whether antidrain valves successfully retain product in the wet hose.

Delivery hoses and retraction mechanisms must be examined to ensure that they are in good condition and functioning properly.

Periodic inventory reconciliation should be performed by checking whether computed sales totals balance against existing inventory plus the actual product delivered.

CAUTION: Care must be taken to ensure that all equipment components (gaskets, seals, valve trim, hoses, and the like) and construction materials are compatible with today's product additives, oxygenates, and octane improvers.

6.3.13 Additional Considerations

Recently, increased public concern for protection of the environment has generated new legislation and code regulations that require the following:

a. Corrosion protection for exposed underground metallic components.
b. Tank overfill protection.
c. Tank fill containment.
d. Underground monitoring to detect possible spills or leaks.
e. Vapor recovery.

Some jurisdictions have gone even further and now require secondary containment of the underground portions of a dispensing system. For further information, see API Recommended Practice 1615.

American Petroleum Institute
1220 L Street, Northwest
Washington, D.C. 20005

Order No. 852-06032