

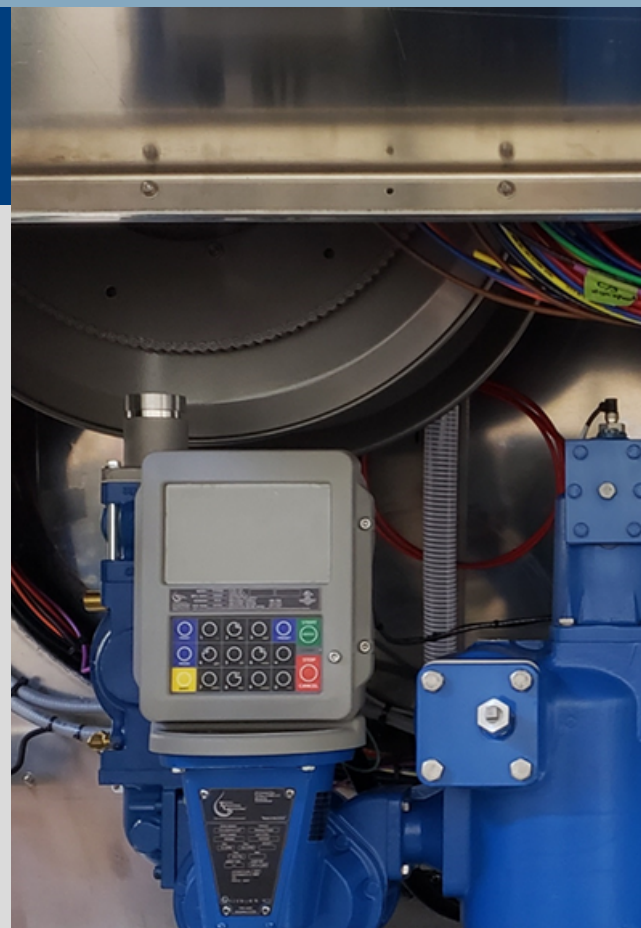


# FIELD TRAINING MANUAL

## Vehicle-Tank Meters

NATIONAL CONFERENCE ON  
WEIGHTS AND MEASURES

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# NCWM Field Training Manual

## Vehicle-Tank Meters

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## Table of Contents

<b><i>ABOUT THE NATIONAL CONFERENCE ON WEIGHTS AND MEASURES .....</i></b>	<b><i>5</i></b>
<b><i>PREAMBLE .....</i></b>	<b><i>6</i></b>
<b><i>INTRODUCTION TO HB-44.....</i></b>	<b><i>7</i></b>
<b><i>PURPOSE OF NCWM VTM HANDBOOK.....</i></b>	<b><i>11</i></b>
<b><i>GENERAL CONSIDERATIONS AND PRINCIPLES .....</i></b>	<b><i>11</i></b>
<b><i>FUNDAMENTAL CONSIDERATIONS HANDBOOK 44 .....</i></b>	<b><i>12</i></b>
<b><i>GENERAL CODE Section 1.10 .....</i></b>	<b><i>24</i></b>
<b><i>HB-44 VTM CODE .....</i></b>	<b><i>43</i></b>
S.1.    Design of Indicating and Recording Elements and of Recorded Representations. ....	43
<b><i>Section 3.31.    Vehicle-Tank Meters .....</i></b>	<b><i>43</i></b>
S.1.    Design of Indicating and Recording Elements and of Recorded Representations. ....	44
S.2.    Design of Measuring Elements. ....	47
S.3.    Design of Discharge Lines and Discharge Line Valves.....	52
S.4.    Design of Intake Lines (for Milk-Metering Systems).....	54
S.5.    Marking Requirements. ....	54
<b><i>N.    Notes.....</i></b>	<b><i>55</i></b>
N.1.    Test Liquid.....	55
N.4.    Testing Procedures.....	55
(Added 2007) .....	57
<b><i>T.    Tolerances .....</i></b>	<b><i>57</i></b>
T.1.    Application. ....	57
T.4.    Product Depletion Test. ....	59
<b><i>UR.    User Requirements .....</i></b>	<b><i>60</i></b>
UR.1.    Installation Requirements. ....	60
UR.2.    Use Requirements.....	60
UR.3.    Maintenance Requirements.....	62
<b><i>2023 VTM Examination Procedure Outline .....</i></b>	<b><i>63</i></b>
<b><i>VTM Checklist .....</i></b>	<b><i>71</i></b>
<b><i>APPENDIX A .....</i></b>	<b><i>77</i></b>
<b><i>KEY POINTS OF AN INSPECTION .....</i></b>	<b><i>77</i></b>
<b><i>Appendix B .....</i></b>	<b><i>79</i></b>
<b><i>Quantity Versus Quality of Inspections – Taking Shortcuts.....</i></b>	<b><i>79</i></b>
<b><i>Appendix C .....</i></b>	<b><i>80</i></b>
<b><i>Tolerances.....</i></b>	<b><i>80</i></b>
<b><i>Pretest determinations .....</i></b>	<b><i>81</i></b>

<b><i>Set up for Trailer-Mounted Prover .....</i></b>	<b><i>81</i></b>
<b><i>Wet Down Run .....</i></b>	<b><i>81</i></b>
<b><i>As Found Normal Test.....</i></b>	<b><i>82</i></b>
<b><i>Slow Flow Test.....</i></b>	<b><i>82</i></b>
<b><i>Product Depletion Test.....</i></b>	<b><i>82</i></b>
<b><i>Antidrain Valve Test.....</i></b>	<b><i>83</i></b>
<b><i>Appendix D .....</i></b>	<b><i>85</i></b>
<b><i>Introduction to Weights and Measures Regulation in the United States .....</i></b>	<b><i>85</i></b>
<b><i>Introduction .....</i></b>	<b><i>85</i></b>
<b><i>United States Weights and Measures Organizations .....</i></b>	<b><i>85</i></b>
<b><i>National Conference on Weights and Measures (NCWM).....</i></b>	<b><i>86</i></b>
<b><i>NCWM Committees .....</i></b>	<b><i>86</i></b>
<b><i>National Type Evaluation Program .....</i></b>	<b><i>87</i></b>
<b><i>Other Federal Agencies .....</i></b>	<b><i>89</i></b>
<b><i>The American Petroleum Institute .....</i></b>	<b><i>90</i></b>
<b><i>ASTM International .....</i></b>	<b><i>90</i></b>

## ABOUT THE NATIONAL CONFERENCE ON WEIGHTS AND MEASURES

### **Setting the United States Standards for Weights and Measures**

The National Conference on Weights and Measures (NCWM) is a professional nonprofit association of state and local Officials, federal agencies, manufacturers, retailers, and consumers. NCWM has developed national weights and measures standards since 1905. The organization brings the right interests together to keep pace with innovative advancements in the marketplace.

### **Our Mission**

Ensuring Equity and Uniform Standards in a Changing Marketplace

We develop uniform and equitable weights and measures standards to:

- Promote commerce and fair competition by leveling the playing field
- Ensure consumers “get what they pay for”
- Foster confidence in marketplace transactions
- Advance economic growth

### **Our Vision**

Making Every Marketplace Transaction Fair and Equitable

## PREAMBLE

The National Conference on Weights and Measures, Inc. (NCWM) Vehicle-Tank Meter (VTM) Handbook is based on the 2023 Edition of the National Institute of Standards and Technology Handbook 44 (HB-44).

This Handbook does not replace HB-44. It serves as a training tool and reference handbook for Weights and Measures Officials (Officials) when inspecting or placing commercial devices into service. It provides key elements of HB-44 and explanations that enable uniform interpretation.

The Handbook details applicable HB-44 code requirements followed by key points when helpful, to provide additional instruction and information.

Not all agencies adopt the most current edition of HB-44 or in its entirety. Refer to the edition of HB-44, statutes and regulations adopted by your agency when considering enforcement action.



## INTRODUCTION TO HB-44

**Note: The bolded blue text in brackets [ ] appearing within this manual is not part of HB-44 but additional information to assist the user in understanding and applying the applicable requirements of HB-44.**

**[The Introduction section of HB-44 contains valuable information about using the handbook and is reproduced here. The Official is recommended to read the introduction before conducting inspections.]**

### **A. Source.**

The specifications, tolerances and other technical requirements in this handbook comprise all of those adopted by the National Conference on Weights and Measures, Inc. (NCWM). Contact NCWM at:

1135 M Street, Suite 100  
E-mail: **info@ncwm.com**  
Lincoln, NE 68508  
URL: **www.ncwm.com**

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The NCWM is supported by the National Institute of Standards and Technology (NIST), which provides its Executive Secretary and publishes some of its documents. NIST also develops technical publications for use by weights and measures agencies; these publications may subsequently be endorsed or adopted by NCWM or its members.

All of the specifications, tolerances, and other technical requirements given herein are recommended by NCWM for official promulgation in and use by the states in exercising their control of commercial weighing and measuring apparatus. A similar recommendation is made with respect to the local jurisdictions within a state in the absence of the promulgation of specifications, tolerances, and other technical requirements at the state level.

(Amended 2015)

### **B. Purpose.**

The purpose of these technical requirements is to eliminate from use, weights and measures and weighing and measuring devices that give readings that are false, that are of such construction that they are faulty (that is, that are not reasonably permanent in their adjustment or will not repeat their indications correctly), or that facilitate the perpetration of fraud, without prejudice to apparatus that conforms as closely as practicable to the official standards.

### **C. Amendments.**

Proposed amendments to NIST Handbook 44 are deliberated and developed by NCWM's Committee on Specifications and Tolerances before presentation to the general membership for a vote. In some instances, amendments that significantly affect other NIST Handbooks may be processed jointly by two or more committees.

Amendments to the handbooks are made in accordance with NCWM procedures and policies. The process begins at the regional weights and measures association meetings in the fall of each year and is culminated at the NCWM Annual Meeting in July. After passing through one or more of the regional associations the proposed amendment is placed on the agenda of the appropriate NCWM committee for consideration at NCWM's Interim Meeting in January and after final deliberation and development by the committee the amendment may be presented to the membership for a vote at the annual NCWM meeting in July. NCWM policy provides for exceptions to the process to accommodate urgent or priority items. NIST staff provides technical assistance and advice throughout the process.

The policy is available on the NCWM website at [www.ncwm.com](http://www.ncwm.com). For information on the regional weights and measures associations, visit [www.ncwm.com/meetings/regions](http://www.ncwm.com/meetings/regions).

(Amended 2015)

#### **D. System of Paragraph Designation.**

In order that technical requirements of a similar nature, or those directed to a single characteristic, may be grouped together in an orderly fashion, and to facilitate the location of individual requirements, the paragraphs of each code are divided into sections. Each section is designated by a letter and a name, and each subsection is given a letter-number designation and a side title.

The letter that appears first in a paragraph designation has a specific meaning, as follows:

- G.** The letter G is a prefix and indicates that the requirement is part of the General Code.
- A. Application.** These paragraphs pertain to the application of the requirements of a code.
- S. Specification.** These paragraphs relate to the design of equipment. Specification paragraphs are directed particularly to manufacturers of devices.
- N. Note.** These paragraphs apply to the official testing of devices.
- T. Tolerance.** Tolerances are performance requirements. They fix the limit of allowable error or departure from true performance or value.  
  
**Sensitivity.** The sensitivity requirements, applicable only to nonautomatic-indicating scales, are performance requirements and are lettered with a "T."
- UR. User Requirement.** These paragraphs are directed particularly to the owner and operator of a device. User requirements apply to the selection, installation, use, and maintenance of devices.
- D. Definitions of Terms.** A definitions section appears in Appendix D to provide the definition of the terms having a special meaning.

The numerical designation after a letter follows the decimal system of paragraph identification that fixes both the relationship and the limitation of the requirements of the paragraph. For example, in the Scales Code, under Specifications, the following numerical designations occur:

## S. Specifications

### S.1. Design of Indicating and Recording Elements and of Recorded Representations.

#### S.1.1. Zero Indication.

##### S.1.1.1. Digital Indicating Elements.

##### S.1.1.2. No-Load Reference Value.

#### S.1.2. Value of Scale Division Units.

##### S.1.2.1. Digital Indicating Scales.

#### S.1.3. Graduations.

##### S.1.3.1. Length.

##### S.1.3.2. Width.

##### S.1.3.3. Clear Space Between Graduations.

In this example, paragraphs S.1.1., S.1.2., and S.1.3. are directed and limited to paragraph S.1., which pertains to the design of indicating and recording elements and of recorded representations. Paragraphs S.1.1.1. and S.1.1.2. are directly related to each other, but they are limited to the design of zero indication. Likewise, paragraphs S.1.3.1., S.1.3.2., and S.1.3.3. are directly related to each other, but they are limited to the design of graduations.

This handbook conforms to the concept of primary use of SI (metric) measurements recommended in the Omnibus Trade and Competitiveness Act of 1988 by citing SI metric units before U.S. customary units where both units appear together and placing separate sections containing requirements for metric units before corresponding sections containing requirements for customary units. Occasionally, a paragraph or table carries the suffix “M” because the requirement in SI units is shown as a separate statement, rather than combined with the U.S. customary units. In these few instances, separate requirements were judged to be more easily understood than attempting to combine SI and U.S. customary units in a single paragraph or table. In some cases, however, trade practice is currently restricted to the use of customary units; therefore, some requirements in this handbook will continue to specify only customary units until the Conference achieves a broad consensus on the permitted metric units.

## E. Classification of Requirements.

The classification of requirements into “retroactive” and “nonretroactive” status is made in order that the requirements may be put into force and effect without unnecessary hardship and without wholesale condemnation of apparatus. Retroactive requirements are enforceable with respect to all equipment and are printed in upright roman type. Nonretroactive requirements are those that, while clearly desirable, are not so vital that they should at once be enforced with respect to all apparatus. Nonretroactive requirements are printed in *italic type*.

It is not expected that, after their promulgation in a given jurisdiction, nonretroactive requirements will always remain nonretroactive. It is entirely proper that a Official, following a careful analysis of existing conditions, fix reasonable periods for the continuance of the nonretroactive application of particular requirements, after which such requirements will become retroactive. These periods should be long enough to avoid undue hardship to the owners or operators of apparatus and, in the case of some requirements, should approximate the average useful life of the apparatus in question.

In order that all interested parties may have timely and ample notice of impending changes in the status of requirements, the following procedure is suggested for the official who plans to change the classification of requirements. If sufficient data are available to make such action feasible, publish in combination with the codes themselves the date or dates at which nonretroactive requirements are to become retroactive. In other cases, give equally effective notice at the earliest practicable date.

A nonretroactive requirement, in italic type, will indicate the year from which it should be enforced and, in some cases, the date the requirement shall be changed to retroactive status. For example, *[Nonretroactive as of 1978 and to become retroactive on January 1, 1985]*. As a general rule, each nonretroactive requirement is reviewed after it has been in effect for 10 years to determine the appropriateness of its nonretroactive status.

#### **F. Using the Handbook.**

Handbook 44 is designed to be a working tool for federal, state, and local Officials, the equipment manufacturers, installers, and service agencies/agents. As noted in Section 1.10. General Code paragraph G-A.1. Commercial and Law-Enforcement Equipment, applicable portions of Handbook 44 may be used by the Official to test noncommercial weighing and measuring equipment upon request. Additionally, applicable language in Handbook 44 may be cited as a standard in noncommercial applications, for example, when the handbook is referenced or cited as part of a quality system or in multiple-party contract agreements where noncommercial weighing or measuring equipment is used.

The section on Fundamental Considerations (Appendix A) should be studied until its contents are well known. The General Code, with general requirements pertaining to all devices, obviously must be well known to a user of the handbook. The makeup of the specific codes, the order of paragraph presentation, and particularly paragraph designation are worthy of careful study. It is not deemed advisable for a user to attempt to commit to memory tolerances or tolerance tables, even though these are used frequently. For the handbook to serve its purpose, it should be available when any of its requirements are to be applied. Direct reference is the only sure way to apply a requirement properly and to check whether other requirements may be applicable.

This handbook supplies criteria which enable the user to determine the suitability, accuracy, and repetitive consistency of a weighing or measuring device, both in the laboratory and in the field. However, not all code sections can be appropriately applied in both settings. Since some sections are designed to be applied specifically to tests performed under laboratory conditions, it would be impractical or unrealistic to apply them to field tests. Not all tests described in the "Notes" section of the handbook are required to be performed in the field as an official test. An inspector may officially approve or reject a device which has been tested in accordance with those sections applicable to the type of test being conducted.

## PURPOSE OF NCWM VTM HANDBOOK

The purpose of this NCWM Handbook is to provide the technical requirements of HB-44 to properly test and inspect VTM. The Handbook is also intended to be used as a training tool for Officials to promote uniformity and strengthen weights and measures throughout the United States.

## GENERAL CONSIDERATIONS AND PRINCIPLES

**Mission** The mission of an Official should be to inspect and test weighing and measuring devices to ensure that the device is correct (accurate and meets all applicable HB-44 specifications) and every *marketplace transaction is fair and equitable*.

Protecting the consumer and ensuring equity in the marketplace is the cornerstone of a weights and measures program. Consumers depend on the Official to ensure they receive the amount of product for which they have paid, and businesses to ensure equity and fair competition.

**Inspection vs Test** This mission is accomplished through inspecting the entire chain of the transaction, and the entire measuring system. Enforcement and education are the two primary tools used by the Weights and Measures Agency and inspector in performing their duties.

(See appendix B for more information on inspecting vs testing).

**Documentation** During weights and measures training, the trainer, a seasoned Official, shared important and lasting wisdom with the group. He said, “when you write your report, keep in mind that your report one day may end up in court. Document thoroughly everything that would be important if you had to rely on that report to prove your case in court. *If you didn’t document it, it didn’t happen.*”

Documenting events and violations is not only important for legal reasons, but also because it creates a history for the business and other Officials.

**[Appendix A of NIST HB-44 contains the fundamental considerations associated with enforcement of HB-44 codes and other fundamental considerations. It is reproduced here, and Officials are highly encouraged to read this section before proceeding.]**

## **Fundamental Considerations Associated with the Enforcement of HB- 44 Codes]**

### **1. Uniformity of Requirements**

1.1. National Conference Codes. – Weights and measures jurisdictions are urged to promulgate and adhere to the National Conference codes, to the end that uniform requirements may be in force throughout the country. This action is recommended even though a particular jurisdiction does not wholly agree with every detail of the National Conference codes. Uniformity of specifications and tolerances is an important factor in the manufacture of commercial equipment. Deviations from standard designs to meet the special demands of individual weights and measures jurisdictions are expensive, and any increase in costs of manufacture is, of course, passed on to the purchaser of equipment. On the other hand, if designs can be standardized by the manufacturer to conform to a single set of technical requirements, production costs can be kept down, to the ultimate advantage of the general public. Moreover, it seems entirely logical that equipment that is suitable for commercial use in the “specification” states should be equally suitable for such use in other states.

Another consideration supporting the recommendation for uniformity of requirements among weights and measures jurisdictions is the cumulative and regenerative effect of the widespread enforcement of a single standard of design and performance. The enforcement effort in each jurisdiction can then reinforce the enforcement effort in all other jurisdictions. More effective regulatory control can be realized with less individual effort under a system of uniform requirements than under a system in which even minor deviations from standard practice are introduced by independent state action.

Since the National Conference codes represent the majority opinion of a large and representative group of experienced regulatory officials, and since these codes are recognized by equipment manufacturers as their basic guide in the design and construction of commercial weighing and measuring equipment, the acceptance and promulgation of these codes by each state are strongly recommended.

1.2. Form of Promulgation. A convenient and very effective form of promulgation already successfully used in a considerable number of states is promulgation by citation of National Institute of Standards and Technology Handbook 44. It is especially helpful when the citation is so made that, as amendments are adopted from time to time by the National Conference on Weights and Measures, these automatically go into effect in the state regulatory authority. For example, the following form of promulgation has been used successfully and is recommended for consideration:

The specifications, tolerances, and other technical requirements for weighing and measuring devices as recommended by the National Conference on Weights and Measures and

published in the National Institute of Standards and Technology Handbook 44, “Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices,” and supplements thereto or revisions thereof, shall apply to commercial weighing and measuring devices in the state.

In some states, it is preferred to base technical requirements upon specific action of the state legislature rather than upon an act of promulgation by a state officer. The advantages cited above may be obtained and may yet be surrounded by adequate safeguards to insure proper freedom of action by the state enforcing officer if the legislature adopts the National Conference requirements by language somewhat as follows:

The specifications, tolerances, and other technical requirements for weighing and measuring devices as recommended by the National Conference on Weights and Measures shall be the specifications, tolerances, and other technical requirements for weighing and measuring devices of the state except insofar as specifically modified, amended, or rejected by a regulation issued by the state (insert title of enforcing officer).

## **2. Tolerances for Commercial Equipment**

**2.1. Acceptance and Maintenance Tolerances.** – The official tolerances prescribed by a weights and measures jurisdiction for commercial equipment are the limits of inaccuracy officially permissible within that jurisdiction. It is recognized that errorless value or performance of mechanical equipment is unattainable. Tolerances are established, therefore, to fix the range of inaccuracy within which equipment will be officially approved for commercial use. In the case of classes of equipment on which the magnitude of the errors of value or performance may be expected to change as a result of use, two sets of tolerances are established: acceptance tolerances and maintenance tolerances.

Acceptance tolerances are applied to new or newly reconditioned or adjusted equipment and are smaller than (usually one-half of) the maintenance tolerances. Maintenance tolerances thus provide an additional range of inaccuracy within which equipment will be approved on subsequent tests, permitting a limited amount of deterioration before the equipment will be officially rejected for inaccuracy and before reconditioning or adjustment will be required. In effect, there is assured a reasonable period of use for equipment after it is placed in service before reconditioning will be officially required. The foregoing comments do not apply, of course, when only a single set of tolerance values is established, as is the case with equipment such as glass milk bottles and graduates, which maintain their original accuracy regardless of use, and measure-containers, which are used only once.

**2.2. Theory of Tolerances.** – Tolerance values are so fixed that the permissible errors are sufficiently small that there is no serious injury to either the buyer or the seller of commodities, yet not so small as to make manufacturing or maintenance costs of equipment disproportionately high. Obviously, the manufacturer must know what tolerances his equipment is required to meet, so that he can manufacture economically. His equipment must be good enough to satisfy commercial needs but should not be subject to such stringent tolerance values as to make it unreasonably costly, complicated, or delicate.

2.3. Tolerances and Adjustments. – Tolerances are primarily accuracy criteria for use by the regulatory official. However, when equipment is being adjusted for accuracy, either initially or following repair or official rejection, the objective should be to adjust as closely as practicable to zero error. Equipment owners should not take advantage of tolerances by deliberately adjusting their equipment to have a value, or to give performance, at or close to the tolerance limit. Nor should the repair or service personnel bring equipment merely within tolerance range when it is possible to adjust closer to zero error.<sup>1</sup>

### 3. Testing Apparatus

3.1. Adequacy.<sup>2</sup> – Tests can be made properly only if, among other things, adequate testing apparatus is available. Testing apparatus may be considered adequate only when it is properly designed for its intended use, when it is so constructed that it will retain its characteristics for a reasonable period under conditions of normal use, when it is available in denominations appropriate for a proper determination of the value or performance of the commercial equipment under test, and when it is accurately calibrated.

[The volumetric prover used for testing a VTM must be suitable, of sufficient capacity for the tests. It also must be certified and properly sealed. Be sure to check the certification date and that it is properly sealed.]



*Volumetric Prover with security seals*

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<sup>1</sup> See General Code, Section 1.10.; User Requirement G-UR.4.3. Use of Adjustments.

<sup>2</sup> Recommendations regarding the specifications and tolerances for suitable field standards may be obtained from the Office of Weights and Measures of the National Institute of Standards and Technology. Standards will meet the specifications of the National Institute of Standards and Technology Handbook 105-Series standards (or other suitable and designated standards). This section shall not preclude the use of additional field standards and/or equipment, as approved by the Director, for uniform evaluation of device performance.



3.2. Tolerances for Standards. – Except for work of relatively high precision, it is recommended that the accuracy of standards used in testing commercial weighing and measuring equipment be established and maintained so that the use of corrections is not necessary. When the standard is used without correction, its combined error and uncertainty must be less than one-third of the applicable device tolerance.

Device testing is complicated to some degree when corrections to standards are applied. When using a correction for a standard, the uncertainty associated with the corrected value must be less than one-third of the applicable device tolerance. The reason for this requirement is to give the device being tested as nearly as practicable the full benefit of its own tolerance.

3.3. Accuracy of Standards. – Prior to the official use of testing apparatus, its accuracy should invariably be verified. Field standards should be calibrated as often as circumstances require. By their nature, metal volumetric field standards are more susceptible to damage in handling than are standards of some other types. A field standard should be calibrated whenever damage is known or suspected to have occurred or significant repairs have been made. In addition, field standards, particularly volumetric standards, should be calibrated with sufficient frequency to affirm their continued accuracy, so that the official may always be in an unassailable position with respect to the accuracy of his testing apparatus. Secondary field standards, such as special fabric testing tapes, should be verified much more frequently than such basic standards as steel tapes or volumetric provers to demonstrate their constancy of value or performance.

Accurate and dependable results cannot be obtained with faulty or inadequate field standards. If either the service person or official is poorly equipped, their results cannot be expected to check consistently. Disagreements can be avoided and the servicing of commercial equipment can be expedited and improved if service persons and officials give equal attention to the adequacy and maintenance of their testing apparatus.

#### 4. Inspection of Commercial Equipment

4.1. Inspection Versus Testing. – A distinction may be made between the inspection and the testing of commercial equipment that should be useful in differentiating between the two principal groups of official requirements, i.e., specifications and performance requirements. Although the term inspection is frequently loosely used to include everything that the official has to do in connection with commercial equipment, it is useful to limit the scope of that term primarily to examinations made to determine compliance with design, maintenance, and user requirements. The term testing may then be limited to those operations carried out to determine the accuracy of value or performance of the equipment under examination by comparison with the actual physical standards of the official. These two terms will be used herein in the limited senses defined.

4.2. Necessity for Inspection. – It is not enough merely to determine that the errors of equipment do not exceed the appropriate tolerances. Specification and user requirements are as important as tolerance requirements and should be enforced. Inspection is particularly important and should be carried out with unusual thoroughness whenever the official examines a type of equipment not previously encountered.

This is the way the official learns whether or not the design and construction of the device conform to the specification requirements. But even a device of a type with which the official is thoroughly familiar and that he has previously found to meet specification requirements should not be accepted entirely on faith. Some part may have become damaged, or some detail of design may have been changed by the manufacturer, or the owner or operator may have removed an essential element or made an objectionable addition. Such conditions may be learned only by inspection. Some degree of inspection is therefore an essential part of the official examination of every piece of weighing or measuring equipment.

4.3. Specification Requirements. – A thorough knowledge by the official of the specification requirements is a prerequisite to competent inspection of equipment. The inexperienced official should have his specifications before him when making an inspection and should check the requirements one by one against the equipment itself. Otherwise, some important requirements may be overlooked. As experience is gained, the official will become progressively less dependent on the handbook, until finally observance of faulty conditions becomes almost automatic, and the time and effort required to do the inspecting are reduced to a minimum. The printed specifications, however, should always be available for reference to refresh the official's memory or to be displayed to support his decisions, and they are an essential item of his kit.

Specification requirements for a particular class of equipment are not all to be found in the separate code for that class. The requirements of the General Code apply, in general, to all classes of equipment, and these must always be considered in combination with the requirements of the appropriate separate code to arrive at the total of the requirements applicable to a piece of commercial equipment.

4.4. General Considerations. – The simpler the commercial device, the fewer are the specification requirements affecting it, and the more easily and quickly can adequate inspection be made. As mechanical complexity increases, however, inspection becomes increasingly important and more time consuming, because the opportunities for the existence of faulty conditions are multiplied. It is on the relatively complex device, too, that the official must be on the alert to discover any modification that may have been made by an operator that might adversely affect the proper functioning of the device.

It is essential for the officials to familiarize themselves with the design and operating characteristics of the devices that he inspects and tests. Such knowledge can be obtained from the catalogs and advertising literature of device manufacturers, from trained service persons and plant engineers, from observation of the operations performed by service persons when reconditioning equipment in the field, and from a study of the devices themselves.

Inspection should include any auxiliary equipment and general conditions external to the device that may affect its performance characteristics. In order to prolong the life of the equipment and forestall rejection, inspection should also include observation of the general maintenance of the device and of the proper functioning of all required elements. The official should look for worn or weakened mechanical parts, leaks in volumetric equipment, or elements in need of cleaning.

4.5. Misuse of Equipment. – Inspection, coupled with judicious inquiry, will sometimes disclose that equipment is being improperly used, either through ignorance of the proper method of

operation or because some other method is preferred by the operator. Equipment should be operated only in the manner that is obviously indicated by its construction or that is indicated by instructions on the equipment, and operation in any other manner should be prohibited.

4.6. Recommendations. – A comprehensive knowledge of each installation will enable the official to make constructive recommendations to the equipment owner regarding proper maintenance of his weighing and measuring devices and the suitability of his equipment for the purposes for which it is being used or for which it is proposed that it be used. Such recommendations are always in order and may be very helpful to an owner. The official will, of course, carefully avoid partiality toward or against equipment of specific makes and will confine his recommendations to points upon which he is qualified, by knowledge and experience, to make suggestions of practical merit.

4.7. Accurate and Correct Equipment. – Finally, the Official is reminded that commercial equipment may be accurate without being correct. A piece of equipment is accurate when its performance or value (that is, its indications, its deliveries, its recorded representations, or its capacity or actual value, etc., as determined by tests made with suitable standards) conforms to the standard within the applicable tolerances and other performance requirements. Equipment that fails to conform is inaccurate. A piece of equipment is correct when, in addition to being accurate, it meets all applicable specification requirements. Equipment that fails to meet any of the requirements for correct equipment is incorrect. Only equipment that is correct should be sealed and approved for commercial use.<sup>3</sup>

## 5. Correction of Commercial Equipment

5.1. Adjustable Elements. – Many types of weighing and measuring instruments are not susceptible to adjustment for accuracy by means of adjustable elements. Linear measures, liquid measures, graduates, measure-containers, milk and lubricating-oil bottles, farm milk tanks, dry measures, and some of the more simple types of scales are in this category. Other types (for example, taximeters and odometers and some metering devices) may be adjusted in the field, but only by changing certain parts such as gears in gear trains.

Some types, of which fabric-measuring devices and cordage-measuring devices are examples, are not intended to be adjusted in the field and require reconditioning in shop or factory if inaccurate. Liquid-measuring devices and most scales are equipped with adjustable elements, and some vehicle-tank compartments have adjustable indicators. Field adjustments may readily be made on such equipment. In the discussion that follows, the principles pointed out and the recommendations made apply to adjustments on any commercial equipment, by whatever means accomplished.

5.2. When Corrections Should Be Made – One of the primary duties of a Official is to determine whether equipment is suitable for commercial use. If a device conforms to all legal requirements, the official “marks” or “seals” it to indicate approval. If it does not conform to all official requirements, the official is required to take action to ensure that the device is corrected within a reasonable period of time. Devices with performance errors that could result in serious economic

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<sup>3</sup> See Section 1.10. General Code and Appendix D. Definitions.

injury to either party in a transaction should be prohibited from use immediately and not allowed to be returned to service until necessary corrections have been made. The official should consider the most appropriate action, based on all available information and economic factors.

Some officials contend that it is justifiable for the official to make minor corrections and adjustments if there is no service agency nearby or if the owner or operator depends on this single device and would be “out of business” if the use of the device were prohibited until repairs could be made. Before adjustments are made at the request of the owner or the owner’s representative, the official should be confident that the problem is not due to faulty installation or a defective part, and that the adjustment will correct the problem. The official should never undertake major repairs, or even minor corrections, if services of commercial agencies are readily available. The official should always be mindful of conflicts of interest before attempting to perform any services other than normal device examination and testing duties.

5.3. Gauging. – In the majority of cases, when the Official tests commercial equipment, he is verifying the accuracy of a value or the accuracy of the performance as previously established either by himself or by someone else. There are times, however, when the test of the official is the initial test on the basis of which the calibration of the device is first determined, or its performance first established. The most common example of such gauging is in connection with vehicle tanks the compartments of which are used as measures. Frequently the official makes the first determination on the capacities of the compartments of a vehicle tank, and his test results are used to determine the proper settings of the compartment indicators for the exact compartment capacities desired. Adjustments of the position of an indicator under these circumstances are clearly not the kind of adjustments discussed in the preceding paragraph.

## 6. Rejection of Commercial Equipment

6.1. Rejection and Condemnation. – The Uniform Weights and Measures Law contains a provision stating that the director shall reject and order to be corrected such physical weights and measures or devices found to be incorrect. Weights and measures and devices that have been rejected may be seized if not corrected within a reasonable time or if used or disposed of in a manner not specifically authorized. The director shall remove from service and may seize weights and measures found to be incorrect that are not capable of being made correct.

These broad powers should be used by the official with discretion. The director should always keep in mind the property rights of an equipment owner and cooperate in working out arrangements whereby an owner can realize at least something from equipment that has been rejected. In cases of doubt, the official should initially reject rather than condemn outright. Destruction and confiscation of equipment are harsh procedures. Power to seize and destroy is necessary for adequate control of extreme situations, but seizure and destruction should be resorted to only when clearly justified.

On the other hand, rejection is clearly inappropriate for many items of measuring equipment. This is true for most linear measures, many liquid and dry measures, graduates, measure-containers, milk bottles, lubricating-oil bottles, and some scales. When such equipment is “incorrect,” it is either impractical or impossible to adjust or repair it, and the official has no alternative to outright

condemnation. When only a few such items are involved, immediate destruction or confiscation is probably the best procedure. If a considerable number of items are involved (as, for example, a stock of measures in the hands of a dealer or a large shipment of bottles), return of these to the manufacturer for credit or replacement should ordinarily be permitted provided that the official is assured that they will not get into commercial use. In rare instances, confiscation and destruction are justified as a method of control when less harsh methods have failed.

In the case of incorrect mechanisms such as fabric-measuring devices, taximeters, liquid-measuring devices, and most scales, repair of the equipment is usually possible, so rejection is the customary procedure. Seizure may occasionally be justified, but in the large majority of instances this should be unnecessary. Even in the case of worn-out equipment, some salvage is usually possible, and this should be permitted under proper controls.

(Amended 1995)

## 7. Tagging of Equipment

7.1. Rejected and Condemned. – It will ordinarily be practicable to tag or mark as rejected each item of equipment found to be incorrect and considered susceptible of proper reconditioning. However, it can be considered justifiable not to mark as rejected incorrect devices capable of meeting acceptable performance requirements if they are to be allowed to remain in service for a reasonable time until minor problems are corrected since marks of rejection may tend to be misleading about a device's ability to produce accurate measurements during the correction period. The tagging of equipment as condemned, or with a similar label to indicate that it is permanently out of service, is not recommended if there is any other way in which the equipment can definitely be put out of service. Equipment that cannot successfully be repaired should be dismantled, removed from the premises, or confiscated by the official rather than merely being tagged as "condemned."

(Amended 1995)

7.2. Nonsealed and Noncommercial. – Rejection is not appropriate if measuring equipment cannot be tested by the official at the time of his regular visit—for example, when there is no gasoline in the supply tank of a gasoline-dispensing device. Some officials affix to such equipment a nonsealed tag stating that the device has not been tested and sealed and that it must not be used commercially until it has been officially tested and approved. This is recommended whenever considerable time will elapse before the device can be tested.

Where the official finds in the same establishment, equipment that is in commercial use and also equipment suitable for commercial use that is not presently in service, but which may be put into service at some future time, he may treat the latter equipment in any of the following ways:

- (a) Test and approve the same as commercial equipment in use.
- (b) Refrain from testing it and remove it from the premises to preclude its use for commercial purposes.
- (c) Mark the equipment nonsealed.

Where the official finds commercial equipment and noncommercial equipment installed or used in close proximity, he may treat the noncommercial equipment in any of the following ways:

- (a) Test and approve the same as commercial equipment.
- (b) Physically separate the two groups of equipment so that misuse of the noncommercial equipment will be prevented.
- (c) Tag it to show that it has not been officially tested and is not to be used commercially.

## 8. Records of Equipment

8.1. Records, General. - The official will be well advised to keep careful records of equipment that is rejected, so that he may follow up to ensure that the necessary repairs have been made. As soon as practicable following completion of repairs, the equipment should be retested. Complete records should also be kept of equipment that has been tagged as nonsealed or noncommercial. Such records may be invaluable should it subsequently become necessary to take disciplinary steps because of improper use of such equipment.

## 9. Sealing of Equipment

9.1. Types of Seals and Their Locations. - Most weights and measures jurisdictions require that all equipment officially approved for commercial use (with certain exceptions to be pointed out later) be suitably marked or sealed to show approval. This is done primarily for the benefit of the public to show that such equipment has been officially examined and approved. The seal of approval should be as conspicuous as circumstances permit and should be of such a character and so applied that it will be reasonably permanent. Uniformity of position of the seal on similar types of equipment is also desirable as a further aid to the public.

The official will need more than one form of seal to meet the requirements of different kinds of equipment. Good quality, weather-resistant, water-adhesive, or pressure-sensitive seals or decalcomania seals are recommended for fabric-measuring devices, liquid-measuring devices, taximeters, and most scales, because of their permanence and good appearance. Steel stamps are most suitable for liquid and dry measures, for some types of linear measures, and for weights. An etched seal, applied with suitable etching ink, is excellent for steel tapes, and greatly preferable to a seal applied with a steel stamp. The only practicable seal for a graduate is one marked with a diamond or carbide pencil, or one etched with glass-marking ink. For a vehicle tank, the official may wish to devise a relatively large seal, perhaps of metal, with provision for stamping data relative to compartment capacities, the whole to be welded or otherwise permanently attached to the shell of the tank. In general, the lead-and-wire seal is not suitable as an approval seal.

9.2. Exceptions. - Commercial equipment such as measure-containers, milk bottles, and lubricating-oil bottles are not tested individually because of the time element involved. Because manufacturing processes for these items are closely controlled, an essentially uniform product is produced by each manufacturer. The official normally tests samples of these items prior to their sale within his jurisdiction and subsequently makes spot checks by testing samples selected at random from new stocks.

Another exception to the general rule for sealing approved equipment is found in certain very small weights whose size precludes satisfactory stamping with a steel die.

## 10. Rounding Off Numerical Values

10.1. Definition. – To round off or round a numerical value is to change the value of recorded digits to some other value considered more desirable for the purpose at hand by dropping or changing certain figures. For example, if a computed, observed, or accumulated value is 4738, this can be rounded off to the nearest thousand, hundred, or ten, as desired. Such rounded-off values would be, respectively, 5000, 4700, and 4740. Similarly, a value such as 47.382 can be rounded off to two decimal places, to one decimal place, or to the units place. The rounded-off figures in this example would be, respectively, 47.38, 47.4, and 47.

10.2. General Rules. – The general rules for rounding off may be stated briefly as follows:

- (a) When the figure next beyond the last figure or place to be retained is less than 5, the figure in the last place retained is to be kept unchanged. When rounding off 4738 to the nearest hundred, it is noted that the figure 3 (next beyond the last figure to be retained) is less than 5. Thus, the rounded-off value would be 4700. Likewise, 47.382 rounded to two decimal places becomes 47.38.
- (b) When the figure next beyond the last figure or place to be retained is greater than 5, the figure in the last place retained is to be increased by 1. When rounding off 4738 to the nearest thousand, it is noted that the figure 7 (next beyond the last figure to be retained) is greater than 5. Thus, the rounded-off value would be 5000. Likewise, 47.382 rounded to one decimal place becomes 47.4.
- (c) When the figure next beyond the last figure to be retained is 5 followed by any figures other than zero(s), treat as in (b) above; that is, the figure in the last place retained is to be increased by 1. When rounding off 4501 to the nearest thousand, 1 is added to the thousands figure and the result becomes 5000.
- (d) When the figure next beyond the last figure to be retained is 5 and there are no figures, or only zeros, beyond this 5, the figure in the last place to be retained is to be left unchanged if it is even (0, 2, 4, 6, or 8) and is to be increased by 1 if it is odd (1, 3, 5, 7, or 9). This is the odd and even rule, and may be stated as follows: “If odd, then add.” Thus, rounding off to the first decimal place, 47.25 would become 47.2 and 47.15 would become 47.2. Also, rounded to the nearest thousand, 4500 would become 4000 and 1500 would become 2000.

It is important to remember that, when there are two or more figures to the right of the place where the last significant figure of the final result is to be, the entire series of such figures must be rounded off in one step and not in two or more successive rounding steps. [Expressed differently, when two or more such figures are involved, these are not to be rounded off individually, but are to be rounded off as a group.] Thus, when rounding off 47.3499 to the first decimal place, the result becomes 47.3. In arriving at this result, the figures “499” are treated as a group. Since the 4 next beyond the last figure to be retained is less than 5, the “499” is dropped (see subparagraph (a))

above). It would be incorrect to round off these figures successively to the left so that 47.3499 would become 47.350 and then 47.35 and then 47.4.

10.3. Rules for Reading of Indications. – An important aspect of rounding off values is the application of these rules to the reading of indications of an indicator-and-graduated-scale combination (where the majority of the indications may be expected to lie somewhere between two graduations) if it is desired to read or record values only to the nearest graduation. Consider a vertical graduated scale and an indicator. Obviously, if the indicator is between two graduations but is closer to one graduation than it is to the other adjacent graduation, the value of the closer graduation is the one to be read or recorded.

In the case where, as nearly as can be determined, the indicator is midway between two graduations, the odd-and-even rule is invoked, and the value to be read or recorded is that of the graduation whose value is even. For example, if the indicator lies exactly midway between two graduations having values of 471 and 472, respectively, the indication should be read or recorded as 472, this being an even value. If midway between graduations having values of 474 and 475, the even value 474 should be read or recorded. Similarly, if the two graduations involved had values of 470 and 475, the even value of 470 should be read or recorded.

A special case not covered by the foregoing paragraph is that of a graduated scale in which successive graduations are numbered by twos, all graduations thus having even values; for example, 470, 472, 474, etc. When, in this case, an indication lies midway between two graduations, the recommended procedure is to depart from the practice of reading or recording only to the value of the nearest graduation and to read or record the intermediate odd value. For example, an indication midway between 470 and 472 should be read as 471.

10.4. Rules for Common Fractions. – When applying the rounding-off rules to common fractions, the principles are to be applied to the numerators of the fractions that have, if necessary, been reduced to a common denominator. The principle of “5s” is changed to the one-half principle; that is, add if more than one-half, drop if less than one-half, and apply the odd-and even rule if exactly one-half.

For example, a series of values might be  $1^{1/32}$ ,  $1^{2/32}$ ,  $1^{3/32}$ ,  $1^{4/32}$ ,  $1^{5/32}$ ,  $1^{6/32}$ ,  $1^{7/32}$ ,  $1^{8/32}$ ,  $1^{9/32}$ . Assume that these values are to be rounded off to the nearest eighth ( $^{4/32}$ ). Then,

$1^{1/32}$  becomes 1. ( $^{1/32}$  is less than half of  $^{4/32}$  and accordingly is dropped.)

$1^{2/32}$  becomes 1. ( $^{2/32}$  is exactly one-half of  $^{4/32}$ ; it is dropped because it is rounded (down) to the “even” eighth, which in this instance is  $^0/8$ .)

$1^{3/32}$  becomes  $1^{4/32}$  or  $1^{1/8}$ . ( $^{3/32}$  is more than half of  $^{4/32}$ , and accordingly is rounded “up” to  $^{4/32}$  or  $^{1/8}$ .)

$1^{4/32}$  remains unchanged, being an exact eighth ( $1^{1/8}$ ).

$1^{5/32}$  becomes  $1^{4/32}$  or  $1^{1/8}$ . ( $^{5/32}$  is  $^{1/32}$  more than an exact  $^{1/8}$ ;  $^{1/32}$  is less than half of  $^{4/32}$  and accordingly is dropped.)



$1\frac{6}{32}$  becomes  $1\frac{2}{8}$  or  $1\frac{1}{4}$ . ( $\frac{6}{32}$  is  $\frac{2}{32}$  more than an exact  $\frac{1}{8}$ ;  $\frac{2}{32}$  is exactly one-half of  $\frac{4}{32}$ , and the final fraction is rounded (up) to the “even” eighth, which in this instance is  $\frac{2}{8}$ .)

$1\frac{7}{32}$  becomes  $1\frac{2}{8}$  or  $1\frac{1}{4}$ . ( $\frac{7}{32}$  is  $\frac{3}{32}$  more than an exact  $\frac{1}{8}$ ;  $\frac{3}{32}$  is more than one-half of  $\frac{4}{32}$  and accordingly the final fraction is rounded (up) to  $\frac{2}{8}$  or  $\frac{1}{4}$ .)

$1\frac{8}{32}$  remains unchanged, being an exact eighth ( $1\frac{2}{8}$  or  $1\frac{1}{4}$ .)

$1\frac{9}{32}$  becomes  $1\frac{2}{8}$  or  $1\frac{1}{4}$ . ( $\frac{9}{32}$  is  $\frac{1}{32}$  more than an exact  $\frac{1}{8}$ ;  $\frac{1}{32}$  is less than half of  $\frac{4}{32}$  and accordingly is dropped.)

**[KEY ELEMENTS OF HB-44 GENERAL CODE]**

- Applies to all devices except when superseded by a specific code requirement
- Applicability of HB-44, applicable to commercial and law enforcement devices
- General Marking and Sealing requirements
- Defines Retroactive and Non-Retroactive tolerances
- Defines Acceptance and Maintenance tolerances.
- General User Requirements

**The General Code is not a stand-alone code. It is to be used in conjunction with the specific device codes just as they are to be used with the General Code. The specific code always takes precedence over the General Code when there is a conflict.]**

**G-A. Application**

**G-A.1. Commercial and Law-Enforcement Equipment.** - These Specifications, tolerances, and other technical requirements apply as follows:

The specifications, tolerances, and other technical requirements of HB-44 apply to:

- (a) commercial weighing and measuring equipment; that is, to weights and measures and weighing and measuring devices commercially used or employed in establishing the size, quantity, extent, area, composition (limited to meat and poultry), constituent values (limited to grain), or measurement of quantities, things, produce, or articles for distribution or consumption, purchased, offered, or submitted for sale, hire, or award, or in computing any basic charge or payment for services rendered on the basis of weight or measure.

**[Simply stated, HB-44 is applicable to devices use to buy, sell, or determine any charges based on weight or measure.]**

- (b) To any accessory attached to or used in connection with a commercial weighing or measuring device when such accessory is so designed that its operation affects the accuracy of the device.

**[The authority of weights and measures is limited to only devices that weigh or measure. However, when another device (associated and ancillary equipment) is connected to it, that device then falls under the authority of the Weights and Measures Agency. An example of this is a printer connected to the VTM.]**

**The purpose of an inspection and test is not only to ensure that the device is accurate, but also that the transaction is correct and the opportunity for fraud is eliminated to the highest degree possible. This requires inspecting and testing all components of the system and verifying if the device is being used properly.]**

- (c) To weighing and measuring equipment in official use for the enforcement of law or for the collection of statistical information by government agencies.

**G-A.2. Code Application.** – This General Code shall apply to all classes of devices as covered in the specific codes. The specific code requirements supersede General Code requirements in all cases of conflict.

**[The General Code applies to all devices, but the Specific Code section is to be applied when there is a difference and conflict.]**

**G-A.3. Special and Unclassified Equipment.** – Insofar as they are clearly appropriate, the requirements and provisions of the General Code and of specific codes apply to equipment failing, by reason of special design or otherwise, to fall clearly within one of the particular equipment classes for which separate codes have been established. With respect to such equipment, code requirements and provisions shall be applied with due regard to the design, intended purpose, and conditions of use of the equipment.

**[HB-44 does not have Specific Codes for all devices. Devices not specified in HB-44 may be commercial and subject to inspection and test. The General Code and to the degree applicable, the relevant Specific Code(s) may be applied.]**

**G-A.4. Metric Equipment.** – Employment of the weights and measures of the metric system is lawful throughout the United States. These specifications, tolerances, and other requirements shall not be understood or construed as in any way prohibiting the manufacture, sale, or use of equipment designed to give results in terms of metric units. The specific provisions of these requirements and the principles upon which the requirements are based shall be applied to metric equipment insofar as appropriate and practicable. The tolerances on metric equipment, when not specified herein, shall be equivalent to those specified for similar equipment constructed or graduated in the U.S. customary system.

**[The use of metric equipment is permissible in the United States. HB-44 contains the necessary information to inspect metric devices.]**

**G-A.5. Retroactive Requirements.** – “Retroactive” requirements are enforceable with respect to all equipment. Retroactive requirements are printed herein in upright roman type.

**[It is important to note the status of an item to avoid improperly applying a nonretroactive requirement.]**

**G-A.6. Nonretroactive Requirements.** – “Nonretroactive” requirements are enforceable on or after the effective date for devices:

- (a) manufactured within a state after the effective date;
- (b) both new and used, brought into a state after the effective date;

- (c) used in noncommercial applications which are placed into commercial use after the effective date; and
- (d) undergoing type evaluation, including devices that have been modified to the extent that a new NTEP Certificate of Conformance (CC) is required.

Nonretroactive requirements are not enforceable with respect to devices that are in commercial service in the state as of the effective date or to new equipment in the stock of a manufacturer or a dealer in the state as of the effective date.

[Nonretroactive requirements are printed in italic type.]

**[The nonretroactive requirement is not applied if the device was manufactured in the state before the requirement was added to HB-44.]**

**The nonretroactive requirement is not applied to a device if it was manufactured and placed into commercial service before the nonretroactive date *UNLESS* it is brought into a different state and placed into commercial service after the nonretroactive date. In this case, the device must meet all HB-44 requirements as if it were a new device.**

**The requirements of HB-44 do not apply to noncommercial devices, except when noncommercial devices are placed into commercial service.**

**In this instance, all requirements of HB-44 including nonretroactive requirements, regardless of date of manufacture for the device are applicable. For all intents and purposes, it is a “new” device.**

**Nonretroactive requirements are enforceable for devices undergoing type evaluation, including devices that have been modified to the extent that a new NTEP Certificate of Conformance (CC) is required unless:**

**The devices are in commercial service in the state as of the effective date or to new equipment in the stock of a manufacturer or a dealer in the state as of the effective date.]**

**G-A.7. Effective Enforcement Dates of Code Requirements.** – Unless otherwise specified, each new or amended code requirement shall not be subject to enforcement prior to January 1 of the year following the adoption by the National Conference on Weights and Measures and publication by the National Institute of Standards and Technology.

**[Key elements:**

- **New or amended requirements are usually adopted by the NCWM in July but they are not enforceable until January 1 of the following year. Example: Adopted July 20, 2021, but not enforceable until January 1, 2022.**
- **There have been times when the NCWM, because of the significant impact of a requirement, has made it effective immediately upon adoption.**

- **It is important to note that HB-44 does not carry the force of law until it is adopted into law by a government agency. Thus, it is imperative to understand which edition of HB-44 your state has adopted as this will impact what requirements are legally enforceable.**
- **HB-44 defines “built-for-purpose device as – Any main device or element which was manufactured with the intent that it be used as, or part of, a weighing or measuring device or system.”**
- **Not-Built-For-Purpose refers to software that can be used in a variety of applications.]**

## **G-S. Specifications**

**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 identifier that positively identifies the pattern or design of the device;
- (1) The model identifier shall be prefaced by the word “Model,” “Type,” or “Pattern.” These terms may be followed by the word “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.” Prefix lettering may be initial capitals, all capitals, or all lower case.

[Nonretroactive as of January 1, 2003]

- (c) a nonrepetitive serial number, except for equipment with no moving or electronic component parts and software;

[Nonretroactive as of January 1, 1968]

The serial number shall be prefaced by words, an abbreviation, or a symbol, that clearly identifies the number as the required serial number.

[Nonretroactive as of January 1, 1986]

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]

(d) the current software version or revision identifier for not-built-for-purpose, software-based devices manufactured as of January 1, 2004, and all software-based devices (or equipment) manufactured as of January 1, 2022;

The version or revision identifier shall be:

- i. prefaced by words, an abbreviation, or a symbol, that clearly identifies the number as the required version or revision.

[Nonretroactive as of January 1, 2007]

NOTE: If the equipment is capable of displaying the version or revision identifier, but is unable to meet the formatting requirements, through the NTEP type evaluation process, other options may be deemed acceptable and described in the CC.

- ii. continuously displayed or be accessible via the display. Instructions for displaying the version or revision identifier shall be described in the CC. As an alternative, permanently marking the version or revision identifier shall be acceptable providing the device does not always have an integral interface to communicate the version or revision identifier.

[Nonretroactive as of January 1, 2022]

(2) Abbreviations for the word “Version” shall, as a minimum, begin with the letter “V” and may be followed by the word “Number.” Abbreviations for the word “Revision” shall, as a minimum, begin with the letter “R” and may be followed by the word “Number.” The abbreviation for the word “Number” shall, as a minimum, begin with the letter “N” (e.g., No or No.). Prefix lettering may be initial capitals, all capitals, or all lowercase.

[Nonretroactive as of January 1, 2007]

(Added 2006)

(e) a National Type Evaluation Program (NTEP) Certificate of Conformance (CC) number or a corresponding CC Addendum Number for devices that have a CC.

(1) The CC Number or a corresponding CC Addendum Number shall be prefaced by the terms “NTEP CC,” “CC,” or “Approval.” These terms may be followed by the word “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.

**[A device, subject to the nonretroactive dates must be permanently marked with:**

- the name, initials, or trademark of the manufacturer or distributor,
- the model,
- nonrepetitive serial number,
- the current software version or revision identifier for not-built-for-purpose, software-based devices manufactured as of January 1, 2004, and all software-based devices (or equipment) manufactured as of January 1, 2022,
- NTEP CC number]

***G-S.1.1. Location of Marking Information for Not-Built-For-Purpose, Software-Based Devices.*** – For not-built-for-purpose, software-based devices either:

- (a) The required information in G-S.1 Identification. (a), (b), (d), and (e) shall be permanently marked or continuously displayed on the device; or
- (b) The Certificate of Conformance (CC) Number shall be:
  - (1) permanently marked on the device;
  - (2) continuously displayed; or
  - (3) accessible through an easily recognized menu and, if necessary, a submenu. Examples of menu and submenu identification include, but are not limited to, “Help,” “System Identification,” “G-S.1. Identification,” or “Weights and Measures Identification.”

**NOTE:** For (b), clear instructions for accessing the information required in G-S.1. (a), (b), and (d) shall be listed on the CC, including information necessary to identify that the software in the device is the same type that was evaluated.

[Nonretroactive as of January 1, 2004]

**[There are three options for not-built-for-purpose, software devices to comply with the marking information requirement.**

- **The information can be permanently marked on the device**
- **Continuously displayed**
- **Be accessible from an easily recognized menu. Refer to the NTEP CC for clear instructions for accessing the information not continuously displayed.]**

**G-S.1.2. Devices and Main Elements Remanufactured as of January 1, 2002.** – All devices and main elements remanufactured as of January 1, 2002, 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; and

(b) the remanufacturer's or distributor's model designation, if different than the original model designation.

**NOTE:** Definitions for “manufactured device,” “repaired device,” and “repaired element” are included (along with definitions for “remanufactured device” and “remanufactured element”) in Appendix D, Definitions.

**[A remanufactured device must be marked with the name, initials, or trademark of the last remanufacturer or distributor, and the remanufacturer's or distributor's model designation, if different than the original model designation.]**

**A remanufactured device is device that is disassembled, checked for wear, parts replaced or fixed, reassembled and made to operate like a new device of the same type.]**

**G-S.2. Facilitation of Fraud.** – All equipment and all mechanisms, software, and devices attached to or used in conjunction therewith shall be so designed, constructed, assembled, and installed for use such that they do not facilitate the perpetration of fraud.

**[It is a duty of Officials to ensure that the device is correct (conforms with applicable specifications and tolerances) and the transaction is accurate.]**

**The entire weighing or measuring system must be inspected with an eye toward detecting fraud or design flaws that may intentionally or unintentionally introduce errors into the measurement that will result in the buyer or seller receiving less than the quantity for which they have paid or should be paid.]**

**G-S.3. Permanence.** – All equipment shall be of such materials, design, and construction as to make it probable that, under normal service conditions:

- (a) accuracy will be maintained;
- (b) operating parts will continue to function as intended; and
- (c) adjustments will remain reasonably permanent.

Undue stresses, deflections, or distortions of parts shall not occur to the extent that accuracy or permanence is detrimentally affected.

**G-S.4. Interchange or Reversal of Parts.** – Parts of a device that may readily be interchanged or reversed in the course of field assembly or of normal usage shall be:

- (a) so constructed that their interchange or reversal will not affect the performance of the device; or
- (b) so marked as to show their proper positions.

**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.

[The VTM Code goes beyond this General Code requirement and requires all VTMs, except those used solely for the sale of aviation fuel into aircraft and for aircraft-related operations to be equipped with a primary display and a recording element. This is required by UR.2.2. Ticket Printer; Customer Ticket.]

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

**G-S.5.2.1. Analog Indication and Representation.** – Graduations and a suitable indicator shall be provided in connection with indications designed to advance continuously.

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

- (a) All digital values of like value in a system agree with one another.
- (b) A digital value coincides with its associated analog value to the nearest minimum graduation.
- (c) A digital value “rounds off” to the nearest minimum unit that can be indicated or recorded.
- (d) A digital zero indication includes the display of a zero for all places that are displayed to the right of the decimal point and at least one place to the left. When no decimal values are displayed, a zero shall be displayed for each place of the displayed scale division.

[Nonretroactive as of January 1, 1986]

[The digital value of a digital display must agree with its printed value.

The analog display must agree with its associated analog value to the nearest minimum value.

Digital values round off to the nearest minimum unit that can be indicated or recorded, i.e., when between whole values, to the nearest whole value above or below.]

**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.5.3. 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.

**[All graduations, indications and recorded representations must be uniform.]**

**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.

**[The values of devices can indicate and record in more than one value, e.g., gallons or liters must be clearly identified.]**

**G-S.5.4. Repeatability of Indications.** – A device shall be capable of repeating, within prescribed tolerances, its indications and recorded representations. This requirement shall be met irrespective of repeated manipulation of any element of the device in a manner approximating normal usage (including displacement of the indicating elements to the full extent allowed by the construction of the device and repeated operation of a locking or relieving mechanism) and of the repeated performance of steps or operations that are embraced in the testing procedure.

**[Devices must be capable of repeating their indications within the prescribed tolerances.]**

**G-S.5.5. Money Values, Mathematical Agreement.** – Any recorded money value and any digital money-value indication on a computing-type weighing or measuring device used in retail trade shall be in mathematical agreement with its associated quantity representation or indication to the nearest 1 cent of money value. This does not apply to auxiliary digital indications intended for the operator's use only, when these indications are obtained from existing analog customer indications that meet this requirement.

**G-S.5.6. Recorded Representations.** – Insofar as they are appropriate, the requirements for indicating and recording elements shall also apply to recorded representations. All recorded values shall be printed digitally.

In applications where recorded representations are required, the customer may be given the option of not receiving the recorded representation. For systems equipped with the capability of issuing an electronic receipt, ticket, or other recorded representation, the customer may be given the option to receive any required information electronically (e.g., via cell phone, computer, etc.) in lieu of or in addition to a hard copy.

**[This General Code requirement specifies that a receipt may be emailed or texted to the customer, however the specific VTM code states in UR. 2.2. “ A copy of the ticket issued by device shall be left with the customer at the time of delivery or as otherwise specified by the customer. However, this does not preclude providing an electronic receipt or ticket to the customer provided the VTM is equipped with a ticket printer and the customer has the option of receiving a hard copy of the ticket, but opts, instead for an electronic version.]**

**G-S.5.6.1. Indicated and Recorded Representation of Units.** – Appropriate abbreviations.

- (a) For equipment manufactured on or after January 1, 2008, the appropriate defining symbols are shown in NIST Special Publication SP 811 “Guide for the Use of International System of Units (SI)” and Handbook 44 Appendix C – General Tables of Units of Measurement.

**Note:** SP 811 can be viewed or downloaded at <http://physics.nist.gov/cuu/pdf/sp811.pdf> or by going to <http://www.nist.gov/pml/wmd/index.cfm> and selecting Weights and Measures Publications and the link to Special Publications (SP 811), “**Guide for the Use of the International System of Units (SI).**”

- (b) The appropriate defining symbols on equipment manufactured prior to January 1, 2008, with limited character sets are shown in Table 1. Representation of SI Units on Equipment Manufactured Prior to January 1, 2008, with Limited Character Sets.

(Added 1977) (Amended 2007)

Table 1. Representation of SI Units on Equipment Manufactured Prior to January 1, 2008, with Limited Character Sets				
Name of Unit	International Symbol (common use symbol)	Representation		
		Form I	Form II	
		(double case)	(single case lower)	(single case upper)
Base SI Units				
Meter	M	M	M	M
Kilogram	Kg	Kg	Kg	KG
Derived SI Units				
Newton	N	N	n	N
Pascal	Pa	Pa	pa	PA
Watt	W	W	w	W
Volt	V	V	v	V
degree Celsius	°C	°C	°c	°C
Other Units				
Liter	l or L	L	l	L
Gram	G	G	g	G
metric ton	T	T	tne	TNE
Bar	Bar	Bar	bar	BAR

(Table Amended 2007)

**G-S.5.7. Magnified Graduations and Indications.** – All requirements for graduations and indications apply to a series of graduations and an indicator magnified by an optical system or as magnified and projected on a screen.

**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]

**[All controls or features of a device must be clearly and definitively identified. Approved pictograms and symbols are acceptable.]**

**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.

**[All markings and instructions must be legible and easily readable.]**

**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.

Amended 1989 and 1993)

**[All electronic adjustable components that can affect the metrological integrity (accuracy and/or performance) of the device must be sealable. This can be done with a physical seal or electronic data change audit trail.**

**Means to seal include:**

- **A physical seal that must be broken to access configuration or calibration features**
- **An event logger that tracks and counts the number of configuration and calibration changes; or an event logger that logs specific information about configuration and calibration changes.**
- **Refer to the specific code and the NTEP CC for additional information regarding sealing requirements; specifically, the “Sealing” section of the NTEP CC.**

**NTEP CC DATABASE SEARCH <https://www.ncwm.com/ntep-certificates>]**

***G-S.8.1. Multiple Weighing or Measuring Elements that Share a Common Provision for Sealing.*** – A change to any metrological parameter (calibration or configuration) of any weighing or measuring element shall be individually identified.

*[Nonretroactive as of January 1, 2010]*

**Note:** For devices that utilize an electronic form of sealing, in addition to the requirements in G-S.8.1., any appropriate audit trail requirements in an applicable specific device code also apply.

Examples of identification of a change to the metrological parameters of a weighing or measuring element include, but are not limited to:

a broken, missing, or replaced physical seal on an individual weighing, measuring, or indicating element or active junction box;

a change in a calibration factor or configuration setting for each weighing or measuring element;

a display of the date of calibration or configuration event for each weighing or measuring element; or

counters indicating the number of calibration and/or configuration events for each weighing or measuring element.

**[Multiple Weighing or Measuring Elements that share a common provision for sealing must be separately identified when using an electronic means of sealing, e.g., “meter 1 and meter 2”]**

**G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Device.** - For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device\*, such as a secure digital (SD) card, USB flash drive, etc., security shall be provided for those parameters using either:

an event logger in the device; or

a physical seal that must be broken in order to remove the digital storage device from the device (or system). If security is provided using an event logger, the event logger shall 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 on demand through the device or through another on-site device. In addition to providing a printed copy of the information, the information may be made available electronically. The event logger shall have a capacity to retain records equal to 10 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.)

\* Applies only to removable digital storage devices that must remain in the device or system for it to be operational.

**[Devices that have a removable data storage device for configuration and/or calibration changes, must be sealed with either an electronic seal or a physical seal to prevent removing the data storage device after calibration, if it intended to remain in the device.]**

**G-S.9. Metrologically Significant Software Updates.** – A software update that changes the metrologically significant software shall be considered a sealable event.

**[Metrologically Significant Software updates (updates that affect the performance, not just the appearance or other non-performance features) must be sealable and identified in an event logger or audit trail.]**

**The Official should review the NTEP CC for approved features before conducting the inspection. The Official should notify NTEP if non-approved features are found. Report irregularities to [info@ncwm.com](mailto:info@ncwm.com)<sup>4</sup>**

## **G-N. Notes**

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<sup>4</sup>[Conformity Assessment | National Conference on Weights & Mea \(ncwm.com\)](http://ConformityAssessment.NationalConferenceonWeights&Mea.ncwm.com)

**G-N.1. Conflict of Laws and Regulations.** – If any particular provisions of these specifications, tolerances, and other requirements are found to conflict with existing state laws, or with existing regulations or local ordinances relating to health, safety, or fire prevention, the enforcement of such provisions shall be suspended until conflicting requirements can be harmonized. Such suspension shall not affect the validity or enforcement of the remaining provisions of these specifications, tolerances, and other requirements.

**[The conflict, when one exists between the requirements contained in HB-44 and other government laws and regulations, must be resolved before proceeding.]**

**It is important that the field inspector be well-versed in their state or local laws and Agency policies because Weights and Measures Agencies sometimes do not adopt the most current version of NIST HB-44, modify what is adopted into their law or have policies that deviate from NIST HB-44.**

**For example, at least one state at the time of this writing has modified UR.2.2 Ticket Printer, Customer Ticket to make it non-retroactive.]**

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

**[Nonassociated equipment, e.g., a handheld radio, may be used to test RFI if the equipment and test replicate normal and usual use at the location. This is easily addressed by having the operator use their equipment and observe the performance of the scale.]**

**Nonassociated equipment is not just limited to handheld radios. Be aware of other electronic equipment that might affect performance of the device and if the equipment is not in operation, it may be appropriate to ask management to turn on the equipment.]**

## **G-T. Tolerances**

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

- (a) to be put into commercial use for the first time;
- (b) that has been placed in commercial service within the preceding 30 days and is being officially tested for the first time;
- (c) that has been returned to commercial service following official rejection for failure to conform to performance requirements and is being officially tested for the first time within 30 days after corrective service;
- (d) that is being officially tested for the first time within 30 days after major reconditioning or overhaul; and
- (e) undergoing type evaluation.

[Devices undergoing type evaluation refers to when an NTEP evaluator is conducting an NTEP evaluation. They will apply acceptance tolerance throughout the entire evaluation regardless of (a) through (d).]

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

[Maintenance tolerances are applied when not applying acceptance tolerances.]

**G-T.3. Application.** – Tolerances “in excess” and tolerances “in deficiency” shall apply to errors in excess and to errors in deficiency, respectively. Tolerances “on overregistration” and tolerances “on underregistration” shall apply to errors in the direction of overregistration and of underregistration, respectively. (Also see Appendix D, Definitions.)

[Tolerances apply regardless of the direction of error; overregistraion or underregistraion. Acceptance tolerance is generally half of Maintenance Tolerance.]

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

[When the value is between two tolerance points, always apply the tolerance for the lower value.]

## **G-UR. User Requirements**

[User Requirements are the responsibility of the device owner or operator and enforced by the Official. Remember, an improperly used device, no matter how accurate it is, will not yield accurate results.]

### **G-UR.1. Selection Requirements.**

**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.

[The initial step in an inspection is determining suitability of a device for the specific application. The NTEP CC’s application section should be reviewed to understand the device’s approved uses.]



For example, a NTEP CC might state “Application: These meters are approved for use in stationery and vehicle tank applications to measure refined petroleum products as specified below.

- Refined petroleum products in the specific gravity range of .68 to 1.1. Viscosities of these liquids are in the range of 2 to 150,000 SSU (.5 to 30,000 centistrokes).”

From this information, the Official can ascertain not only is the meter suitable for a vehicle tank meter application, but the products for which it is suitable.]

**G-UR.1.2. Environment.** – Equipment shall be suitable for the environment in which it is used including, but not limited to, the effects of wind, weather, and RFI.

## **G-UR.2. Installation Requirements.**

**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 installed so 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.

**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. (Also see G-UR.3.3. Position of Equipment.)

**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 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 Official.

[The device must be installed and located to allow inspection and testing, applying security seals, ease of bringing test equipment without unnecessary, abnormal, or unsafe means to accomplish it.

**It is the responsibility of the device owner or operator to supply the means and labor to inspect, test and seal the device.**

**In the case of inspecting VTM this may require the owner or operator to have sufficient product for the test and an operator to run the unit during the tests.]**

### **G-UR.3. Use Requirements.**

**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.

**[Abnormal or unintended use of equipment is unacceptable. It is important to observe employees using the device to ensure it is being used properly.**

**This is a disadvantage of testing VTMs at a central location, but due to the nature of their use, i.e., delivering products to homes, businesses etc., it is difficult to observe use. The Official may want to discuss how the unit is operated with the operator during the test to determine if the unit is being operated properly.]**

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

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

**[While technically this requirement is applicable to VTM, it is recognized that the customer often is not present during the sale. It is one of the reasons UR.2.2 Ticket Printer, Customer Ticket was added to HB-44 – requiring a ticket printer and a customer ticket to given to the customer or left provides a layer of protection.]**

**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.

#### **G-UR.4. Maintenance Requirements.**

**G-UR.4.1. Maintenance of Equipment.** – All equipment in service and all mechanisms and devices 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 shall not be considered “maintained in a proper operating condition” if: predominantly, equipment of all types or applications are found to be in error in a direction favorable to the device user; or predominantly, equipment of the same type or application is found to be in error in a direction favorable to the device user.

**[Both inspecting and testing a device, as well as inquiring about routine maintenance is necessary to ensure adherence to this requirement.**

**Devices must be maintained in proper operating condition and adjusted as close to zero as possible. There must not be a bias in a direction that is favorable to the device owner.**

**The Official should make note of the direction of error when testing multiple VTMs at a central location and take appropriate action if the direction of error favors the device owner.]**

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

**G-UR.4.3. Use of Adjustments.** – Weighing elements and measuring elements that are adjustable shall be adjusted only to correct those conditions that such elements are designed to control and shall not be adjusted to compensate for defective or abnormal installation or accessories or for badly worn or otherwise defective parts of the assembly. Any faulty installation conditions shall be corrected, and any defective parts shall be renewed or suitably repaired, before adjustments are undertaken. Whenever equipment is adjusted, the adjustments shall be so made as to bring performance errors as close as practicable to zero value.

**[The device must be maintained in proper operating condition and any abnormal performance can only be corrected using the features intended to correct, adjust, and calibrate the device.**

**Only original equipment manufacturer parts or NTEP equivalent parts may be used when the device is traceable to an NTEP CC. Failure to comply may invalidate the NTEP CC. NTEP CC DATABASE SEARCH <https://www.ncwm.com/ntep-certificates> ]**

**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 Official.

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

**G-UR.4.6. Testing Devices at a Central Location.**

(a) When devices in commercial service require special test facilities, or must be removed from service for testing, or are routinely transported for the purpose of use (e.g., vehicle-mounted devices and devices used in multiple locations), the official with statutory authority may require that the devices be brought to a central location for testing. The dealer or owner of these devices shall provide transportation of the devices to and from the test location.

(b) When the request for removal and delivery to a central test location involves devices used in submetering (e.g., electric, hydrocarbon vapor, or water meters), the owner or operator shall not interrupt the utility service to the customer or tenant except for the removal and replacement of the device. Provisions shall be made by the owner or operator to minimize inconvenience to the customer or tenant. All replacement or temporary meters shall be tested and sealed by a Official or bear a current, valid approval seal prior to use.

**[For example, it is common practice to test all of a business' VTMs at their location. This is beneficial to the Official as it is efficient and to the business so they can schedule the time to limit disruption of service to customers.]**

**Another advantage of testing a fleet of trucks at a central location is the ability to determine if there is a bias in the direction of error favorable to the device owner.**

**As previously mentioned, it does limit the ability to observe the VTM as it is used.]**

## HB-44 VTM CODE

### S. Specifications

#### S.1. Design of Indicating and Recording Elements and of Recorded Representations.

#### Section 3.31. Vehicle-Tank Meters

##### A. Application

**A.1. General.** – This code applies to meters mounted on vehicle tanks including those used for the measurement and delivery of petroleum products or agri-chemical liquids such as fertilizers, feeds, pesticides, defoliants, and bulk deliveries of water.

(Amended 1985 and 1995)

**A.2. Exceptions.** – This code does not apply to the following devices:

- (a) Devices used for dispensing liquefied petroleum gases, or other liquids that do not remain in a liquid state at atmospheric pressures and temperatures. (Also see Section 3.32. Code for Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices.)
- (b) Devices used solely for dispensing a product in connection with operations in which the amount dispensed does not affect customer charges.
- (c) Vehicle tanks used as measures. (Also see Section 4.40. Code for Vehicle Tanks Used as Measures.)
- (d) Mass flow meters. (Also see Section 3.37. Code for Mass Flow Meters.)  
(Added 1994)
- (e) Devices used to measure cryogenic liquids. (Also see Section 3.34. Code for Cryogenic Liquid-Measuring Devices.)
- (f) Devices used to measure carbon dioxide liquids. (Also see Section 3.38. Code for Carbon Dioxide Liquid-Measuring Devices.)

**A.3. Additional Code Requirements.** – In addition to the requirements of this code, Vehicle-Tank Meters shall meet the requirements of 1.10. General Code requirements.

## S. Specifications

### S.1. Design of Indicating and Recording Elements and of Recorded Representations.

#### S.1.1. Primary Elements.

**S.1.1.1. General.** – A meter shall be equipped with a primary indicating element and may also be equipped with a primary recording element.

**Note:** Except for systems used solely for the sale of aviation fuel into aircraft and for aircraft-related operations, vehicle-tank meters shall be equipped with a primary recording element as required by paragraph UR.2.2. Ticket Printer; Customer Ticket.

(Amended 1993)

#### S.1.1.2. Units.

- (a) A meter shall indicate, and record if the meter is equipped to record, its deliveries in terms of liters or gallons. Fractional parts of the liter or gallon shall be in terms of either decimal or binary subdivisions.
- (b) When it is an industry practice to purchase and sell milk by weight based upon 1.03 kg/L (8.6 lb/gal), the primary indicating element may indicate in kilograms or pounds and decimal kilograms or pounds. The weight value division shall be a decimal multiple or submultiple of 1, 2, or 5. (Also see Section S.5.5. Conversion Factor.)

**S.1.1.3. Value of Smallest Unit.** – The value of the smallest unit of indicated delivery, and recorded delivery if the meter is equipped to record, shall not exceed the equivalent of:

- (a) 0.5 L (0.1 gal) or 0.5 kg (1 lb) on milk-metering systems;
- (b) 0.5 L (0.1 gal) on meters with a rated maximum flow rate of 750 L/min (200 gal/min) or less;
- (c) 5 L (1 gal) on meters with a rated maximum flow of 375 L/min (100 gal/min) or more used for jet fuel aviation refueling systems; or

(Added 2006)

- (d) 5 L (1 gal) on other meters.

(Amended 1989, 1994 and 2006)

**S.1.1.4. Advancement of Indicating and Recording Elements.** – Primary indicating and recording elements shall be susceptible to advancement only by the mechanical

operation of the meter. However, a meter may be cleared by advancing its elements to zero, but only if:

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

**S.1.1.5. Return to Zero.** – Primary indicating elements shall be readily returnable to a definite zero indication. Means shall be provided to prevent the return of primary indicating elements, and of primary recording elements if these are returnable to zero, beyond their correct zero position. Primary indicating elements shall not be resettable to zero during a delivery.

(Amended 2016)

### **S.1.2. Graduations.**

**S.1.2.1. Length.** – Graduations shall be so varied in length that they may be conveniently read.

**S.1.2.2. Width.** – In any series of graduations, the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations, and the width of main graduations shall be not more than 50 % greater than the width of subordinate graduations. Graduations shall in no case be less than 0.2 mm (0.008 in) wide.

**S.1.2.3. Clear Interval Between Graduations.** – The clear interval shall be not less than 2.5 mm (0.10 in). If the graduations are not parallel, the measurement shall be made:

- (a) along the line of relative movement between the graduations at the end of the indicator; or
- (b) if the indicator is continuous, at the point of widest separation of the graduations.

(Amended 1986)

### **S.1.3. Indicators.**

**S.1.3.1. Symmetry.** – The index of an indicator shall be symmetrical with respect to the graduations at least throughout that portion of its length associated with the graduations.

**S.1.3.2. Length.** – The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case the distance between the end of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 1.0 mm (0.04 in).

**S.1.3.3. Width.** – The width of the index of an indicator in relation to the series of graduations with which it is used shall be not greater than:

*(a) the width of the narrowest graduation;\* and*  
*[\*Nonretroactive as of January 1, 2002]*

(Amended 2001)

(b) the width of the minimum clear interval between graduations.

When the index of an indicator extends along the entire length of a graduation, that portion of the index of the indicator that may be brought into coincidence with the graduation shall be of the same width throughout the length of the index that coincides with the graduation.

**S.1.3.4. Clearance.** – The clearance between the index of an indicator and the graduations shall in no case be more than 1.5 mm (0.06 in).

**S.1.3.5. Parallax.** – Parallax effects shall be reduced to the practicable minimum.

**S.1.3.6. Travel of Indicator.** – If the most sensitive element of the primary indicating element utilizes an indicator and graduations, the relative movement of these parts corresponding to the smallest indicated value shall not be less than 5 mm (0.20 in).

#### **S.1.4. Computing-Type Device.**

**S.1.4.1. Display of Unit Price.** – In a device of the computing type, means shall be provided for displaying, in a manner clear to the operator and an observer, the unit price at which the device is set to compute. The unit price is not required to be displayed continuously.

(Amended 1983 and 2005)

**S.1.4.2. Printed Ticket.** – If a computing-type device issues a printed ticket which displays the total computed price, the ticket shall also have printed clearly thereon the total quantity of the delivery, the appropriate fraction of the quantity, and the price per unit of quantity.

(Amended 1989)

**S.1.4.3. Money-Value Computations.** – Money-value computations shall be of the full-computing type in which the money-value at a single unit price, or at each of a series of unit prices, shall be computed for every delivery within either the range of measurement of the device or the range of the computing elements, whichever is less. Value graduations shall be supplied and shall be accurately positioned. The value of each graduated interval shall be one cent. On electronic devices with digital indications, the



total price may be computed on the basis of the quantity indicated when the value of the smallest division indicated is equal to or less than 0.2 L (0.1 gal) or 0.2 kg (1 lb).

(Amended 1979 and 1989)

**S.1.4.4. Money-Values, Mathematical Agreement.** – Any digital money-value indication and any recorded money-value on a computing-type device shall be in mathematical agreement with its associated quantity indication or representation to within one cent of money-value.

## S.2. Design of Measuring Elements.

**S.2.1. Air/Vapor Elimination.** – A measuring system shall be equipped with an effective air/vapor eliminator or other automatic means to prevent the passage of air/vapor through the meter. Vent lines from the air/vapor eliminator shall be made of appropriate non-collapsible material.

(Amended 1993 and 2017)

**S.2.2. Provision for Sealing.** – For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security



*Register with security seal*

shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices. For parameters adjusted using other means, the following applies.

Adequate provision shall be made for an approved means of security (e.g., data change audit trail) or for physically applying a security seal in such a manner that requires the security seal to be broken before a change or an adjustment or interchange can be made of:

- (a) any measuring or indicating element;
- (b) any adjustable element for controlling delivery rate when such rate tends to affect the accuracy of deliveries; and
- (c) any metrological parameter that will affect the metrological integrity of the device or system.

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

*Audit trails shall use the format set forth in Table S.2.2. Categories of Device and Methods Sealing.\**

*[\*Nonretroactive as of January 1, 1995]*

(Amended 2006 and 2019)

<b>Table S.2.2.</b> <b>Categories of Device and Methods of Sealing</b>	
<b>Categories of Device</b>	<b>Methods of Sealing</b>
<b>Category 1:</b> No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
<b>Category 2:</b> Remote configuration capability, but access is controlled by physical hardware.  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.	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.
<b>Category 3:</b> Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).  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.	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 on demand through the device or through another on-site device. The information may also be available electronically. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1000 records are required. <b>(Note:</b> Does not require 1000 changes to be stored for each parameter.)

[Nonretroactive as of January 1, 1995]

(Table Added 2006) (Amended 2016)

**S.2.3. Directional Flow Valves.** – Valves intended to prevent reversal of flow shall be automatic in operation. However, on equipment used exclusively for fueling aircraft, such valves may be manual in operation.

**S.2.4. Zero-Set-Back Interlock, Vehicle-Tank Meters, Electronic.** – Except for vehicle-mounted metering systems used solely for the delivery of aviation fuel, a device shall be so constructed that after individual or multiple deliveries at one location have been completed, an automatic interlock system shall engage to prevent a subsequent delivery until the indicating and, if equipped, recording elements have been returned to their zero position. For individual deliveries, if there is no product flow for three minutes the transaction must be completed before additional product flow is allowed. The three-minute timeout shall be a sealable feature of an indicator.

*[Nonretroactive as of January 1, 2006]*

(Added 2005)

## **S.2.5. Automatic Temperature Compensation for Refined Petroleum Products.**

**S.2.5.1. Automatic Temperature Compensation for Refined Petroleum Products.** – A device may be equipped with an automatic means for adjusting the indication and registration of the measured volume of product to the volume at 15 °C for liters or the volume at 60 °F for gallons and decimal subdivisions or fractional equivalents thereof where not prohibited by state law. [\[Be sure to review your agency's law as some states may have specific requirements for temperature compensation.\]](#)

**S.2.5.2. Provision for Deactivating.** – On a device equipped with an automatic temperature-compensating mechanism that will indicate or record only in terms of liters compensated to 15°C or gallons compensated to 60 °F, provision shall be made for deactivating the automatic temperature-compensating mechanism so the meter can indicate and record, if it is equipped to record, in terms of the uncompensated volume.

**S.2.5.3. Gross and Net Indications.** – A device equipped with automatic temperature compensation shall indicate or record, if equipped to record, both the gross (uncompensated) and net (compensated) volume for testing purposes. It is not necessary that both net and gross volume be displayed simultaneously.

**S.2.5.4. Provision for Sealing Automatic Temperature-Compensating Systems.** – 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 an automatic temperature-compensating system cannot be disconnected and no adjustment may be made to the system.

**S.2.5.5. Temperature Determination with Automatic Temperature Compensation.** – For test purposes, means shall be provided (e.g., thermometer well) to determine the temperature of the liquid either:

(a) in the liquid chamber of the meter; or

(b) immediately adjacent to the meter in the meter inlet or discharge line.

(Added 2007)

**S.2.6. Thermometer Well, Temperature Determination.** – For test purposes, means shall be provided (e.g., thermometer well) to determine the temperature of the liquid either in the:

- (a) liquid chamber of the meter; or
  - (b) meter inlet or discharge line immediately adjacent to the meter.
- [Nonretroactive as of January 1, 2012]  
(Added 2011)

**S.3. Design of Discharge Lines and Discharge Line Valves.**  
(Not applicable to milk-metering systems.)

**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 the discharge line thereof. However, two or more delivery outlets may be installed if means are provided to ensure that:

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

This paragraph does not apply to the following:

- (1) Equipment used exclusively for fueling aircraft.
- (2) Multiple-product, single-discharge hose metering systems that are equipped with systems designed to flush the discharge hose, provided the flushing system complies with the provisions of paragraph S.3.1.1. Means for Clearing the Discharge Hose.

(Amended 2018)

**S.3.1.1. Means for Clearing the Discharge Hose.** – Metering systems may be equipped with systems specifically designed to facilitate clearing of the discharge hose prior to delivery to avoid product contamination. In such systems, a valve to temporarily divert product from the measuring chamber of the meter to a storage tank shall be installed only if all the following are met:

- (a) the discharge hose remains of the wet hose type;
- (b) the valve and associated piping are approved by the weights and measures authority having jurisdiction over the system prior to commercial use;
- (c) the valve is permanently marked with its purpose (e.g., flush valve);
- (d) the valve is installed in a conspicuous manner and as far from the hose reel as practical;

(e) the system clearly and automatically indicates the direction of product flow during operation of the flush system;

(f) clear means, such as an indicator light or audible alarm, is used to identify when the valve is in use; and

(g) no hoses or piping are connected to the inlet when it is not in use.

(Added 2018)

**S.3.2. Pump-Discharge Unit.** – On a pump-discharge unit, the discharge hose shall be of the wet-hose type with a shutoff valve at its outlet end. However, a pump-discharge unit may be equipped also with a dry-hose without a shutoff valve at its outlet end, but only if:

(a) the dry-hose is as short as practicable; and

(b) there is incorporated in the discharge piping, immediately adjacent to the meter, effective means to ensure that liquid can flow through only one of the discharge hoses at any one time and that the meter and the wet-hose remain full of liquid at all times.

**S.3.3. Gravity-Discharge Unit.** – On a gravity-discharge unit, the discharge hose or equivalent pipe shall be of the dry-hose type with no shutoff valve at its outlet end. The dry-hose shall be of such stiffness and only of such length as to facilitate its drainage. The inlet end of the hose or of an equivalent outlet pipe shall be of such height as to provide for proper drainage of the hose or pipe. There shall be incorporated an automatic vacuum breaker or equivalent means to prevent siphoning and to ensure the rapid and complete drainage.

**S.3.4. Discharge Hose.** – A discharge hose shall be adequately reinforced.

**S.3.5. Discharge Valve.** – A discharge valve may be installed in the discharge line only if the device is of the wet-hose type, in which case such valve shall be at the discharge end of the line. 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.3.6. Antidrain Valve.** – In a wet-hose, pressure-type device, an effective antidrain valve shall be incorporated in the discharge valve or immediately adjacent thereto. The antidrain valve shall function so as to prevent the drainage of the discharge hose. However, a device used exclusively for fueling and defueling aircraft may be of the pressure type without an antidrain valve.

#### S.4. Design of Intake Lines (for Milk-Metering Systems).

**S.4.1. Diversion of Liquid to be Measured.** – No means shall be provided by which any liquid can be diverted from the supply tank to the receiving tank without being measured by the device.

**S.4.2. Intake Hose.** – The intake hose shall be:

- (a) of the dry-hose type;
- (b) adequately reinforced;
- (c) not more than 6 m (20 ft) in length, unless it can be demonstrated that a longer hose is essential to permit pickups from a supply tank; and
- (d) connected to the pump at horizontal or above, to permit complete drainage of the hose.

#### S.5. Marking Requirements.

**S.5.1. Limitation of Use.** – If a meter is intended to measure accurately only liquids having particular properties, or to measure accurately only under specific installation or operating conditions, or to measure accurately only when used in conjunction with specific accessory equipment, these limitations shall be clearly and permanently stated on the meter.

**S.5.2. Discharge Rates.** – A meter shall be marked to show its designed maximum and minimum discharge rates. However, the minimum discharge rate shall not exceed 20 % of the maximum discharge rate.

**Note:** Also see example in Section 3.30. Liquid-Measuring Devices Code, paragraph S.4.4.1. Discharge Rates.

(Added 2003)

**S.5.3. Measuring Components, Milk-Metering System.** – All components that affect the measurement of milk that are disassembled for cleaning purposes shall be clearly and permanently identified with a common serial number.

**S.5.4. Flood Volume, Milk-Metering System.** – When applicable, the volume of product necessary to flood the system when dry shall be clearly, conspicuously, and permanently marked on the air eliminator.

**S.5.5. Conversion Factor.** – When the conversion factor of 1.03 kg/L (8.6 lb/gal) is used to convert the volume of milk to weight, the conversion factor shall be clearly marked on the primary indicating element and recorded on the delivery ticket.

(Added 1989)



**S.5.6. Temperature Compensation for Refined Petroleum Products.** – If a device is equipped with an automatic temperature compensator, the primary indicating elements, recording elements, and recorded representations shall be clearly and conspicuously marked to show the volume delivered has been adjusted to the volume at 15 °C for liters or the volume at 60 °F for gallons and decimal subdivisions or fractional equivalents thereof.

(Added 2007)

## N. Notes

### N.1. Test Liquid.

- (a) A measuring system shall be tested with the liquid to be commercially measured or with a liquid of the same general physical characteristics. Following a satisfactory examination, the weights and measures official should attach a seal or tag indicating the product used during the test. **[This is required because product characteristics such as specific gravity, and lubricity may affect meter performance.]**

(Amended 1975)

- (b) A milk-measuring system shall be tested with the type of milk to be measured when the accuracy of the system is affected by the characteristics of milk (e.g., positive displacement meters).

(Added 1989)

(Amended 1975 and 1989)

**N.2. Evaporation and Volume Change.** – Care shall be exercised to reduce to a minimum, evaporation losses and volume changes resulting from changes in temperature of the test liquid.

**N.3. Test Drafts.** – Test drafts should be equal to at least the amount delivered by the device in 1 minute at its maximum discharge rate and shall in no case be less than 180 L (50 gal) or 225 kg (500 lb).

(Amended 1989)

### N.4. Testing Procedures.

**N.4.1. Normal Tests.** – The “normal” test of a measuring system shall be made at the maximum discharge rate that may be anticipated under the conditions of the installation. Any additional tests conducted at flow rates down to and including one-half of the sum of the maximum discharge flow rate and the rated minimum discharge flow rate shall be considered normal tests.

(Amended 1992)

**N.4.1.1. Milk Measuring System.** – The “normal” test shall include a determination of the effectiveness of the air elimination system.

**N.4.1.2. Automatic Temperature-Compensating Systems for Refined Petroleum Products.** – On devices equipped with automatic temperature-compensating systems, normal tests shall be conducted:

- (a) by comparing the compensated volume indicated or recorded to the actual delivered volume corrected to 15 °C for liters or 60 °F for gallons and decimal subdivisions or fractional equivalents thereof; and
- (b) with the temperature-compensating system deactivated, comparing the uncompensated volume indicated or recorded to the actual delivered volume.

The first test shall be performed with the automatic temperature-compensating system operating in the “as-found” condition. On devices that indicate or record both the compensated and uncompensated volume for each delivery, the tests in (a) and (b) may be performed as a single test.

(Added 2007)

**N.4.2. Special Tests (Except Milk-Measuring Systems).** – “Special” tests shall be made to develop the operating characteristics of a measuring system and any special elements and accessories attached to or associated with the device. Any test except as set forth in N.4.1. Normal Tests and N.4.5. Product Depletion Test shall be considered a special test. Special tests of a measuring system shall be made at a minimum discharge rate of 20 % of the marked maximum discharge rate or at the minimum discharge rate marked on the device, whichever is less.

(Amended 1978 and 2005)

**N.4.3. Antidrain Valve Test.** – The effectiveness of the antidrain valve shall be tested after the pump pressure in the measuring system has been released and a valve between the supply tank and the discharge valve is closed.

**N.4.4. System Capacity.** – The test of a milk-measuring system shall include the verification of the volume of product necessary to flood the system as marked on the air eliminator.

**N.4.5. Product Depletion Test.** – Except for vehicle-mounted metering systems used solely for the delivery of aviation fuel, the effectiveness of the vapor eliminator or vapor elimination means shall be tested by dispensing product at the normal flow rate until the product supply is depleted and continuing until the lack of fluid causes the meter indication to stop completely for at least 10 seconds. If the meter indication fails to stop completely for at least 10 seconds, continue to operate the system for 3 minutes. Finish the test by switching to another compartment with sufficient product to complete the test on a multi-compartment vehicle or by adding sufficient product to complete the test to a single compartment vehicle. When adding product to a single compartment vehicle, allow appropriate time for any

entrapped vapor to disperse before continuing the test. Test drafts shall be of the same size and run at approximately the same flow rate.

(Added 2005)

**N.4.6. Verification of Linearization Factors.** – All enabled linearization factors shall be verified. The verification of enabled linearization factors shall be done through physical testing or a combination of physical testing and empirical analysis at the discretion of the official with statutory authority.

(Added 2016)

**N.4.7. Repeatability Tests.** – Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors such as temperature, pressure, and flow rate are reduced to the extent that they will not affect the results obtained. When conducting the tests, the flow rates shall be within the minimum and maximum discharge rates as marked by the manufacturer. For devices equipped with an automatic temperature compensator, the results shall be based on the uncompensated (gross) volume (e.g., with the temperature compensator deactivated).

(Amended 2019)

**N.5. Temperature Correction for Refined Petroleum Products.** – Corrections shall be made for any changes in volume resulting from the differences in liquid temperatures between the time of passage through the meter and the time of volumetric determination in the prover. When adjustments are necessary, appropriate petroleum measurement tables should be used.

(Added 2007)

## **T. Tolerances**

### **T.1. Application.**

**T.1.1. To Underregistration and to Overregistration.** – The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration.

**T.2. Tolerance Values.** – Tolerances shall be as shown in Table 1. Accuracy Classes and Tolerances for Vehicle-Tank Meters Other Than Vehicle-Mounted Milk Meters and Table 2. Tolerances for Vehicle-Mounted Milk Meters.

(Amended 1995)

**Table 1.**  
**Accuracy Classes and Tolerances for Vehicle-Tank Meters Other Than Vehicle-Mounted Milk Meters**

Accuracy Class	Application		Acceptance Tolerance	Maintenance Tolerance	Special Test Tolerance
0.3	<ul style="list-style-type: none"> <li>- Petroleum products delivered from large capacity (flow rates over 115 L/min or 30 gpm)** devices, including motor-fuel devices</li> <li>- Heated products (other than asphalt) at temperatures greater than 50 °C (122 °F)</li> <li>- Asphalt at temperatures equal to or below 50 °C (122 °F)</li> <li>- All other liquids not shown in the table where the typical delivery is greater than 200 L (50 gal)</li> </ul>		0.15 %	0.3 %	0.45 %
0.3A	- Asphalt at temperatures greater than 50 °C (122 °F)		0.3 %	0.3 %	0.5 %
0.5*	<ul style="list-style-type: none"> <li>- Petroleum products delivered from small capacity (at 4 L/min (1 gpm) through 115 L/min or 30 gpm)** motor-fuel devices</li> <li>- Agri-chemical liquids</li> <li>- All other applications not shown in the table where the typical delivery is ≤ 200 L (50 gal)</li> </ul>		0.3 %	0.5 %	0.5 %
1.1	<ul style="list-style-type: none"> <li>- Petroleum products and other normal liquids from devices with flow rates** less than 4 L/min (1 gpm) and</li> <li>- Devices designed to deliver less than 4 L (1 gal)</li> </ul>		0.75 %	1.0 %	1.25 %
1.5	- Water	Overregistration	1.5 %	1.5 %	1.5 %
		Underregistration	1.5 %	1.5 %	5.0 %

\* For 5 gal and 10 gal test drafts, the tolerances specified for Accuracy Class 0.5 in the table above do not apply. For these test drafts, the maintenance tolerances on normal and special tests for 5 gal and 10 gal test drafts are 6 in<sup>3</sup> and 11 in<sup>3</sup>, respectively. Acceptance tolerances on normal and special tests are 3 in<sup>3</sup> and 5.5 in<sup>3</sup>.

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

(Added 2002) (Amended 2013)

<b>Table 1.</b> <b>Accuracy Classes and Tolerances for Vehicle-Tank Meters Other Than Vehicle-Mounted Milk Meters</b>				
Accuracy Class	Application	Acceptance Tolerance	Maintenance Tolerance	Special Test Tolerance

<b>Table 2.</b> <b>Tolerances for Vehicle-Mounted Milk Meters</b>		
Indication (gallons)	Maintenance Tolerance (gallons)	Acceptance Tolerance (gallons)
100	0.5	0.3
200	0.7	0.4
300	0.9	0.5
400	1.1	0.6
500	1.3	0.7
Over 500	Add 0.002 gallon per indicated gallon over 500	Add 0.001 gallon per indicated gallon over 500

(Added 1989)

**T.2.1. Automatic Temperature-Compensating Systems.** – The difference between the meter errors (expressed as a percentage) determined with and without the automatic temperature-compensating system activated shall not exceed:

- (a) 0.2 % for mechanical automatic temperature-compensating systems; and
- (b) 0.1 % for electronic automatic temperature-compensating systems.

The delivered quantities for each test shall be approximately the same size. The results of each test shall be within the applicable acceptance or maintenance tolerance.

(Added 2007) (Amended 2010)

**T.3. Repeatability.** – When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 % of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. (Also see N.4.7. Repeatability Tests.)

(Added 1992) (Amended 2001, 2002, and 2019)

**T.4. Product Depletion Test.** – The difference between the test result for any normal test and the product depletion test shall not exceed 0.5 % of the volume delivered in one minute at the maximum flow rate marked on the meter for meters rated higher than 380 Lpm (100 gpm) or 0.6 % of the volume delivered in one minute at the maximum flow rate marked on the meter for meters rated 380 Lpm (100 gpm) or lower. Test drafts shall be of the same size and run at approximately the same flow rate.

**Note:** The result of the product depletion test may fall outside of the applicable test tolerance as specified in Table 1. Accuracy Classes and Tolerances for Vehicle-Tank Meters.  
(Amended 2013)

## UR. User Requirements

### UR.1. Installation Requirements.

**UR.1.1. Discharge Rate.** – A meter shall be so installed that the actual maximum discharge rate will not exceed the rated maximum discharge rate. If necessary, means for flow regulation shall be incorporated in the installation, in which case this shall be fully effective and automatic in operation.

**UR.1.2. Unit Price.** – There shall be displayed on the face of a device of the computing type the unit price at which the device is set to compute.

**UR.1.3. Intake Hose.** – The intake hose in a milk-metering system shall be installed to permit complete drainage and ensure that all available product is measured following each pickup.

**UR.1.4. Liquid Measured.** – A vehicle-tank meter shall continue to be used to measure the same liquid or one with the same general physical properties as that used for calibration and weights and measures approval unless the meter is recalibrated with a different product and tested by a registered service agency or a weights and measures official and approved by the weights and measures jurisdiction having statutory authority over the device.

(Added 2003)

### UR.2. Use Requirements.

**UR.2.1. Return of Indicating and Recording Elements to Zero.** – The primary indicating elements (visual), and the primary recording elements, when these are returnable to zero, shall be returned to zero immediately before each delivery is begun and after the pump has been activated and the product to be measured has been supplied to the measuring system.

(Amended 1981)

**UR.2.2. Ticket Printer, Customer Ticket.** – Vehicle-Mounted metering systems shall be equipped with a ticket printer which shall be used for all sales where product is delivered through the meter. A copy of the ticket issued by the device shall be left with the customer at the time of delivery or as otherwise specified by the customer.

(Added 1993) (Amended 1994)

**UR.2.2.1. Exceptions for the Sale of Aviation Fuel.** – The provisions of UR.2.2. Ticket Printer, Customer Ticket shall not apply to vehicle-mounted metering systems used solely for the delivery of aviation fuel into aircraft and for aircraft-related operations.

(Added 1999)

**UR.2.3. Ticket in Printing Device.** – A ticket shall not be inserted into a device equipped with a ticket printer until immediately before a delivery is begun, and in no case shall a ticket be in the device when the vehicle is in motion while on a public street, highway, or thoroughfare.

**UR.2.4. Credit for Flood Volume.** – The volume of product necessary to flood the system as marked on the air eliminator shall be individually recorded on the pickup ticket of each seller affected.

**UR.2.5. Automatic Temperature Compensation for Refined Petroleum Products.**

**UR.2.5.1. When to be Used.** – In a state that does not prohibit, by law or regulation, the sale of temperature-compensated product, a device equipped with an activated automatic-temperature compensator shall be connected, operable, and in use at all times. An electronic or mechanical automatic temperature-compensating device or system may not be removed or deactivated, nor may a compensated device be replaced with an uncompensated device or system, without the written approval of the responsible weights and measures jurisdiction.

**Note:** This requirement does not specify the method of sale for products measured through a meter.  
(Amended 2009)

**UR.2.5.2. Period of Use.** – When fuel is bought or sold on an automatic temperature compensation basis, it shall be bought or sold using this basis over at least a consecutive 12-month period unless otherwise agreed to by both the buyer and seller in writing.  
(Added 2009)

**UR.2.5.3. Invoices.** – An invoice based on a reading of a device that is equipped with an automatic temperature compensator shall show that the volume delivered has been adjusted to the volume at 15 °C for liters or the volume at 60 °F for gallons and decimal subdivisions or fractional equivalents thereof.  
(Added 2007)

**UR.2.6. Clearing the Discharge Hose.**

**UR.2.6.1. Records.** – Whenever, prior to delivery, a different product is pumped through the discharge hose to avoid contamination, a record including the date, time, original product, new product, and gallons pumped shall be maintained. These records shall be kept for a period of 12 months and available for inspection by the weights and measures authority having jurisdiction over the system.  
(Added 2018)

### UR.3. Maintenance Requirements.

**UR.3.1.Use of Adjustments.** – Whenever a device is adjusted, all enabled linearization factors shall be verified to determine that the errors are in tolerance and any adjustments which are made shall be made so as to bring performance errors as close as practicable to zero value. The verification of enabled linearization factors shall be done through physical testing or a combination of physical testing and empirical analysis

(Added 2016)



## 2023 VTM Examination Procedure Outline

2023 NCWM EXAMINATION PROCEDURE		
COMBINED POWER OPERATED AND GRAVITY DISCHARGE VEHICLE TANK METERS		
<p>It is recommended that this outline be followed as the minimum criteria for examining all power-operated or gravity discharge vehicle-tank meters – analog or digital. Requirements specific only to a power operated or gravity discharge vehicle-tank meter are noted.</p> <p>Nonretroactive requirements are followed by the applicable date in parentheses. Do not use this outline for testing vehicle-tank metering systems used to measure milk, LPG, cryogenics, or carbon dioxide. This EPO does not apply to gravity-discharge vehicle tank meters or vehicle-mounted mass flow meters. Nonretroactive requirements are followed by the applicable date in parentheses.</p>		
SAFETY NOTES		
<p>Safety policies and regulations vary among jurisdictions. It is essential that Officials or service persons be aware of all safety regulations and policies in place at the inspection site and to practice their employer's safety policies. The safety reminders included in this EPO contain general guidelines useful in alerting Officials and service persons to the importance of taking adequate precautions to avoid personal injury. <b>These safety notes are not intended to supersede specific agency or site location requirements.</b></p> <p>As a minimum, the following safety precautions should be noted and followed during the inspection.</p> <p>The product's Manufacturers Safety Data Sheet should be reviewed to understand the nature of the product and what personal protective equipment (PPE) is required to provide adequate protection.</p> <p>The Official should have the proper (PPE) which includes:</p> <p>Clothing, Safety Shoes, Gloves, Eye Protection, Hearing Protection, Hard Hat, and any other site required PPE due to site specific conditions.</p> <p>Other required safety equipment includes, Fire Extinguisher, First Aid Kit, Safety Cones, or Warning Signs</p> <p>Note at some locations, the use of electronic equipment such as cellular telephones may be prohibited.</p> <p>The Official should inspect the area and equipment for Wet/Slick Conditions, Chemicals, Hazardous Materials, Petroleum Products, and Obstructions etc. before beginning the inspection.</p>		
INSPECTION		
HB-44 Section Heading	HB-44 Code Reference	Additional Comment
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.2.2., UR.2.4.	

Position of equipment	G-UR.3.3.	This code reference is included, but generally VTM are used to deliver product to a customer location, thus, position of equipment is not always applicable.
Accessibility	G-UR.2.3.	
Assistance	G-UR.4.4., G-UR.4.6.	
Use and Maintenance	G-UR.3.1., G-UR.4.1., G-UR.4.2., UR.2.3.	
Use of Automatic Temperature Compensator (ATC)	UR.2.5., UR.2.5.1, UR.2.5.2., UR.2.5.3	
<b>DESIGN OF INDICATING AND RECORDING ELEMENTS</b>		
Primary Elements, General	S.1.1., S.1.1.1.	
Units	S.1.1.2. (a), S.1.1.3. (b) and (c)	
Readability	G-S.5., G-S.6. (1/1/77), G-S.7., S.1.2., S.1.3.	
Values of Intervals	G-S.5.3., G-S.5.3.1.	
Recorded representations General Required for VTM Exceptions for aviation fuel	G-S.5.6., S.1.4.2., UR.2.2., UR.2.3. UR.2.2.1	<p>UR-2.2. states “Vehicle-Mounted metering systems shall be equipped with a ticket printer ...” A copy of the ticket issued by the device shall be left with the customer...or as otherwise specified by the customer.”</p> <p>This does not preclude providing the customer with an electronic receipt or ticket as specified in G-S.5.6. provided the VTM is equipped with a ticket printer capable of printing a ticket and the customer elects to receive an electronic ticket in lieu of the hard copy ticket.</p>
Computing-type devices Display of unit price Money-value computations	S.1.4.1., UR.1.2. S.1.4.3.	

ATC – volume adjusted temperature	S.5.6.	
Return to zero	UR.2.1.	
Provisions for sealing - General	S.2.2., Table S.2.2.	
Provisions for sealing ATC systems	S.2.5.4.	
<b>MARKING</b>		
General Location, Not-Built-For Purpose, Software-Based Devices Devices or Main elements Remanufactured as of January 1, 2002, Limitation on Use,	G-S.1., G-S.1.1. (1/1/04), G-S.1.2. (1/1/02), G-UR.2.1.1.,	
Limitations of Use	S.5.1.	
Discharge Rates	S.5.2.	
Temperature Compensation for Refined Petroleum Products	S.5.6.	
<b>PRETEST DETERMINATIONS</b>		
<b>For Gravity Discharge VTM Only:</b> Test Equipment Set-up. Gravity discharge VTMs are designed to make deliveries to underground storage tanks; products are delivered to a tank that is entirely below the level of the truck tank. As such, when a product is delivered from these systems the discharge end of the hose is approximately roadway level and the discharge hose is said to have a negative head to allow gravity to push product through the system. To approximate commercial operating conditions in the testing operations of these devices, the prover height must simulate road level height so that the end of the delivery line from the VTM corresponds to its position when inserted in the fill pipe of an underground storage tank at a filling station		
Test Liquid	N.1.1.	Verify that the liquid available for testing is appropriate. The liquid is appropriate if it is the same product normally dispensed or has the same or similar property characteristics and has been approved for that device.
<b>For Gravity Discharge VTM Only:</b> Determine that a compartment or compartments have a sufficient amount of product to conduct “high head” and “low head” tests (also referred to as full compartment and near empty compartments tests since the head pressure acting on the meter decreases as the compartment is drained).		
Test Drafts – Ensure prover is of adequate size	N.3.	Test drafts should be equal to at least the amount delivered by the device in 1 minute at its maximum discharge rate and shall in no case be less than 50 gallons.
<b>For Gravity Discharge VTM Only:</b> Ensure that the prover inlet is lower than the meter outlet.		

Tolerances – Acceptance and Maintenance Tolerances, Applications,	G-T.1.1, G-T.2, G-T.3	Determine the appropriate tolerances to be applied.
Intermediate Values	G-T.4.	
Repeatability	T.3.	
Product Depletion Test	T.4.	Note: The result of the product depletion test may fall outside of the applicable test tolerance as specified in Table 1. Accuracy Classes and Tolerances for Vehicle-Tank Meters.
Note Totalizer Reading  Record totalize indication before and after each draft to determine proper operation		
Security Means – check for the presence of a security seal/means on the device.	G-UR.4.5. G-S.8., Table S.2.2. (1/95)	Document missing seals on the official report.
If prover is dry, wet prover. Follow proper draining procedures and allow a 30-second drain period each time the prover is emptied		Use a stopwatch to determine 30-second drain period.
Level the prover empty and recheck the level when the prover is full of liquid.		
Be aware of evaporation and volume change and exercise care so the product temperature is the same in the prover as it is in the meter.	N.2.	
Temperature corrections are to be made for the accuracy tests to account for any difference between the temperature of the liquid passing through the meter and the liquid in the prover.	N.5.	
After each test draft:  Print a ticket	G-S.5.2.2., G-S.5.6.	

<p>If computing type, check price computation on indication and on recorded representations</p> <p>Check for agreement between indicators</p>	<p>G-S.5.6., S.1.42., S.1.4.3., S.1.4.4.</p> <p>G-S.5.2.2.</p>	
<p>If the result of any test is at or near the tolerance limit, repeat that test. If necessary, conduct a repeatability test as outlined under “Tests - All Meters” below.</p>		
<b>TESTS NON-TEMPERATURE-COMPENSATED METERS</b>		
<p>Normal test – full flow, basic tolerance</p>	N.4.1., T.2.	
<p><b>For Gravity Discharge VTM Only:</b></p> <p>Normal test - - full flow (high head/full compartment), basic tolerance.</p> <p>Normal test - - full flow (medium head/one-half full compartment), basic tolerance.</p> <p>Normal test - - full flow (low head/one and one-half times prover capacity in the compartment), basic tolerance.</p>	N.4.1., T.2.	
<p><b>For Power Operated VTM Only:</b></p> <p>Special test – Slow flow, special tolerance</p>	N.4.2., T.2.	<p>Any test except as set forth in N.4.1. Normal Tests and N.4.5. Product Depletion Test shall be considered a Special Test.</p>
Proceed to the “Tests – All Meters” Section		
<b>TESTS TEMPERATURE-COMPENSATED METERS</b>		
<p>Normal test with compensator activated – full flow, normal tolerance</p>	N.4.1., N.4.1.2.	<p>On devices that indicate or record both the compensated and uncompensated volume for delivery, both N.4.1.2. (a) and (b) may be performed as a single test.</p> <p>Be sure to have the operator maintain the flow rate below</p>
<p>Deactivate temperature compensator and repeat normal test. Compare the compensated volume indicated or recorded to the actual delivered volume corrected to 60°</p>	N.4.2.,N.4.1.2.,T.2.1.	

		the maximum flow rate and emphasize that the meter cannot be operated above its rated maximum flow rate.
Proceed to the "Tests – All Meters" Section		
<p><b>For Power Operated VTM Only:</b> Product Depletion Test</p> <p>Conduct product depletion test by:</p> <ol style="list-style-type: none"> <li>Start test at normal flow from a compartment containing less test fluid than one-half the capacity of the prover and with pump in operation and pressure to the discharge nozzle.</li> <li>Permit test to continue until lack of fluid supply causes the meter register to stop completely for 10 seconds.</li> <li>If the meter indication fails to stop completely for at least 10 seconds, continue to operate the system for 3 minutes.</li> <li>With the pump in operation, shut manifold valve or disconnect whip-hose connection from the now empty compartment.</li> <li>Finish the test by switching to another compartment with sufficient product to complete the test on a multi-compartment vehicle or by adding sufficient product to complete the test to a single compartment vehicle. When adding</li> </ol>	S.2.1., N.4.5., T.4.	S.2.1. refers to the device being equipped with an effective air/vapor eliminator which is verified by the product depletion test.

product to a single compartment vehicle, allow appropriate time for any entrapped vapor to disperse before continuing the test.		
<b>Repeatability Test:</b>  If necessary, conduct a repeatability test. Test must include at least three consecutive test drafts. Test drafts must be conducted under approximately the same conditions.	N.4.7., T.3.	For devices equipped with an automatic temperature compensator, the results shall be based on the uncompensated, gross, volume. This is done by deactivating the temperature compensator.
RFI/EMI Test	G-N.2., G-UR.1.2., G-UR.3.2., G-UR.4.2.	This test is only for electronic equipment.
Check automatic stop mechanism	G-UR.4.1.	The device should stop the flow within one-half the minimum interval indicated.
<b>For Power Operated VTM Only:</b> Check the effectiveness of the ant drain valve with pump pressure offline.	S.3.6., N.4.3.	
<b>POST-TEST TASKS</b>		
Security Seal	G-UR.4.5.	Apply a security seal if the device was found without one or replace the security seal if dated seals are used by your agency.
Audit Trail Information – if the system is equipped with an audit trail, note the event counter settings on the official report for future reference.  If equipped with an event logger, print, or download a copy of the event log and maintain it with the official report for future reference.	G-S.8., Table S.2.2., (1/95)	
Record the number of gallons of dispensed product on the official report.		
Review results to determine compliance or non-compliance with all applicable	G-UR.4.1. G-UR.4.3.	

requirements, including, maintenance of equipment and use of adjustments.		
Record the compliance action and disposition of the device on the official report and explain the results, and if applicable, the necessary corrective action to the device owner/user.		



## VTM Checklist

**Purpose:** *This checklist is intended as a quick guide to conducting an inspection and test of a vehicle-tank meter, a means to ensure that all relevant and applicable tests were conducted and to make notes regarding violations and other pertinent information.*

VTM Checklist				
Inspection or Test	Description of Test (when applicable). For example, flow rates, etc.	Action, Inspection or Test Conducted Yes          No		Violations, Additional Notes and Comments. <b><i>Always verify and validate violations with NIST-HB-44 and your jurisdiction's laws</i></b>
General Introduction with manager to explain the purpose of the visit, what you will do, determine, in the case of multiple VTMs, if there is a preference to where you start and to answer any questions about the purpose of the visit and your authority to conduct the inspection				
Visual inspection of the inspection site, vehicle, meter for any leaks and other potential safety hazards.  Ensure you have the proper personal protection equipment and are using it.  Do not conduct the test if a leak is found. The leak should be repaired before conducting tests.				
Inspect the prover to ensure it certified, properly sealed and it is empty and clean. If the				

<p>prover has been used prior to the current inspection, ensure that any residual product is compatible with the product to be used for testing.</p> <p>It is advisable to notify the business representative of the product tested in the prior test to ensure there is no risk of cross-contamination.</p> <p>Follow agency procedures, but it may be advisable to note this information on the official report.</p>				
<p>Suitability – if applicable, review the NTEP CC for information regarding application, features, sealing and other relevant information.</p> <p>It is advisable not to proceed with a test if the VTM is not suitable for its application to avoid having to explain why the VTM is accurate but cannot be used. The exception is if you are investigating a complaint. In that case, accuracy may be relevant.</p>				
<p>Products – as part of the NTEP CC review, determine the products for which the meter is suitable and compare to products sold and on hand for testing.</p>				

Check for security seals. Determine if the system is equipped with an event counter or logger and that an employee is available to provide the information.				
Check and record required marking information.				
<p>The meter must be marked with its maximum and minimum discharge rates. Based on this information, determine if your prover is of sufficient volume to conduct the tests.</p> <p>Additionally, explain the test procedures with the operator and emphasize the importance of maintaining the flow rate near the maximum flow rate but not to exceed it during the test and during normal operation.</p>				
<p>Determine the applicable tolerances to be applied.</p> <p>Refer to HB-44 section on tolerances: unmarked, marked, maintenance, acceptance tolerances.</p>				
Verify operational features to understand their functions but rely on the operator to operate the VTM.				
Verify the options for providing the customer a ticket.				
Determine if the system is equipped with automatic				

temperature compensation (ATC).  Ensure that someone is on site who is knowledgeable and available to deactivate the ATC.				
Record totalizer reading.				
Level prover empty and verify when full.				
Wet prover if dry.				
Be prepared to correct temperature corrections for accuracy tests to account for any difference between the temperature of the liquid passing through the meter and the liquid in the meter.				
<b>Tests</b>				
Explain to the operator the purpose of your test and the “what” and the “why” of the tests you will conduct.  Explain their role in the tests and the importance of maintaining proper flow rates during the normal and slow flow tests.				
<b>For Non-Temperature-Compensated Power Operated Meters</b>				
Conduct a normal test – full flow and apply basic tolerance.  Ensure that the operator maintains the flow rate at the proper flow rate.				
Conduct a special test – slow flow and apply special tolerance.				

Ensure that the operator maintains the flow rate at the proper flow rate.				
<b>For Non-Temperature-Compensated Gravity Discharge Meters</b>				
Conduct a normal test – full flow (high head/full compartment) and apply basic tolerance.				
Conduct a normal test full flow (medium head/one-half full compartment) and apply basic tolerance.				
Conduct a normal test full flow (low head/one and one-half times prover capacity in the compartment) and apply basic tolerance.				
<b>For Temperature-Compensated Meters</b>				
Conduct a normal test with compensator activated – full flow and apply basic tolerance.				
Ensure that the operator maintains the flow rate at the proper flow rate.				
Deactivate compensator and repeat normal test.				
Ensure that the operator maintains the flow rate at the proper flow rate.				
Compare the compensated volume indicated or recorded to the actual delivered volume corrected to 60 °F.				

Conduct a special test – slow flow and apply special tolerance.  Ensure that the operator maintains the flow rate at the proper flow rate.				
<b>For Power Operated Meters</b>				
Conduct product depletion test.				
If necessary, conduct a repeatability test.				
For electronic equipment, conduct RFI/EMI test.				
Check automatic stop mechanism.				
Check anti-drain valve.				
<b>Post Test</b>				
Obtain audit trail information.				
Record number of gallons dispensed during the test.				
Review results of test and discuss them along with any compliance action required to be completed by the device owner/user.  When discussing violations, cite the specific code violation and the “why” behind the violation. For example, “the nozzle failed the antidrain test. Your system uses a wet hose and when product leaks from it, it begins metering as the hose fills up. This results in the customer not receiving all product for which they paid.”				

## APPENDIX A

### KEY POINTS OF AN INSPECTION

Weights and Measures Officials conduct inspections of weighing and measuring devices. Test of the VTM for accuracy is only one component of the overall inspection. A weighing and measuring device may be accurate, but not correct (complying with both tolerances, specifications, and user requirements). The key function of the Weights and Measures Official should be to ensure that the entire transaction while using a weighing and measuring device is accurate in addition to the device being correct.

- Observation – When possible, take a moment to observe the operation of the VTM before beginning the test. When this is not possible, discuss the operation of the VTM with the driver or operator to ensure they understand the applicable laws and regulations pertaining to the sale of the products using a VTM.
- Introduction to manager – This is a critical component of the inspection. Remember, you represent your agency. Establish yourself as a professional and courteous public servant.
- Explain the purpose of your visit and establish an atmosphere of trust and open dialogue. Encourage the manager to ask questions and be ready to explain the why and what of your visit.
- Be prepared to explain the why behind any violations found. Avoid only citing code violations without explaining what they are, why they are important and what corrective action is to be taken.
- Remember, your job is law enforcement, but it is also education. Many device owners are not knowledgeable about using and maintaining devices. Use the inspection as an opportunity to share your knowledge and help bring about better measurements.
- Inquire if the business has their device(s) routinely inspected by a service company. Explain the reason for properly maintaining a device if they are not already maintaining them.
- Highlight errors that while within tolerance, are near the tolerance limits. Extrapolating the amount of product “given away” in a year when the errors are plus errors is a useful tool to stress the importance of maintaining a VTM not only in tolerance but also as close to zero as possible.
- Be considerate of the business’s operation. Recognize that your inspection, while important and authorized by law, is a disruption to their business. Work, to the degree possible, to minimize the disruption.
- Pre-test functions
  - Always observe the test area for safety hazards.

- Look for leaks and do not conduct the test until they are corrected. Not only are leaks a safety hazard, but they may also prevent an accurate assessment of meter performance.
- Prepare your report and determine tests, flow rates, tolerances, etc. to be conducted and applied.
- Determine suitability of the device.
- Test
  - Begin the tests.
  - Do not operate the device. Allow the operator to do it.
  - Repeat and document tests that are questionable.
  - Complete the applicable tests, determine whether the device is in compliance and any necessary compliance actions required of the device owner/operator.
  - Discuss the inspection results with the manager. Ask if they have any questions and thank them for their cooperation.
  - Leave a copy of the inspection report.

Remember to always be professional, courteous, and knowledgeable. Take the time to explain your role and purpose of the inspection. Try to convey the attitude that you are there to confirm that the business is compliant as opposed to trying to find violations. Essentially, you're conducting a quality control check for the business. You're also ensuring a level playing field for the business by ensuring fair and honest measurement by all businesses.

A representative of a large grocery store chain once testified in support of a new fee to support the state weights and measures agency. He stated, "I normally do not testify in front of legislators supporting new fees. But I know my company operates honestly and I support the weights and measures agency because I want to be sure my competitors do so too."

**How you present yourself and the information you convey will help businesses to recognize the value you provide not only to the consumer but to business.**



## Appendix B

### Quantity Versus Quality of Inspections – Taking Shortcuts

By

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Provided by NIST OFFICE OF WEIGHTS AND MEASURES

<https://www.nist.gov/news-events/news/2022/09/quantity-versus-quality-inspections-taking-shortcuts>

## Appendix C

### **Model Standard Operating Procedure - Testing Vehicle- Tank Meters**

*Courtesy of Colorado LP-Gas/Weights & Measures  
Petroleum Program*

#### **Introduction**

This training manual is intended to serve as the basis for training and inspecting vehicle-tank meters. It is recognized that each jurisdiction may have different statutes, regulations, and equipment and the training manual may not address all local issues associated with the inspection of vehicle-tank meters.

For this reason, it is encouraged that along with using this manual that jurisdictions develop their own standard operating procedures to address the uniqueness of their vehicle-tank meter program.

The following is a model standard operating procedure that other jurisdictions can use to design their own standard operating procedure.

### **SOP - Testing Vehicle-Tank Meters**

#### **Equipment/Supplies Needed**

- SOP for Testing Vehicle Tank Meters
- NIST Handbook 44
- NIST Examination Procedure Outline (EPO) 23 or 24 For Vehicle Tank Meters
- The NCWM VTM Field Manual contains all of the above information related to testing and inspection of VTM's
- Clipboard
- Ballpoint pen
- Meter Calibration Reports
- Prover of appropriate size
- Return hose with nozzle
- Various hand tools, e.g. screwdriver (Phillips & Flathead/Slotted), pliers, side cutters, socket set, seal press, etc.
- Appropriate seals
- Inspection stickers
- Calculator

#### **Tolerances**

1. Tolerances 100-gallon prover.
  - A. Maintenance 69 cu in
  - B. Acceptance 35 cu in
  - C. Special-Slow Flow Test 104 cu in
  - D. Special-Product Depletion Test, difference between normal result and PD result:
    1. UP to 100 GPM Meter - 0.6% of max flow rate
    2. 100 GPM Meter and higher - 0.5% of max flow rate
  - E. Repeatability 28 cu in
4. Apply maintenance tolerance to meters over 30 days old.

5. Apply acceptance tolerance to meters less than 30 days old, or if repaired within 30 days, or if adjusted.
6. Slow flow tests and product depletion tests are special tests.

#### **Pretest determinations**

1. Determine that each meter dispenses the proper product.
2. Determine if prover size is adequate.
  - A. Prover should be at least as large as the amount of product delivered by meter in one minute, and in no case shall it be less than 50 gallons.

#### **Set up for Trailer-Mounted Prover**

1. Disconnect prover trailer from vehicle.
2. Level prover.
  - A. Lower trailer tongue first.
  - B. Level side to side.
  - C. Raise tongue in order to level front to back.
3. Connect the return hose and nozzle to the prover pump.
4. Place the hose and nozzle in the truck compartment that contains the product to be tested. (Verify that the compartment can hold the amount of product to be returned. Best practice is to return product to the compartment that is being delivered out of so a continuous loop is achieved.)
5. Place the truck delivery nozzle in the prover neck.
6. Connect electrical cord from prover pump to electrical outlet.
7. Connect ground cable from prover to fuel truck.

#### **Wet Down Run**

8. Record the totalizer reading from the tested meter.
9. Engage the truck pump.
10. Insert a ticket into the meter.
11. Zero the meter.
12. Set auto stop if so equipped.
13. Fill the prover to capacity using the truck nozzle.
14. While the prover is filling, check the meter flow rate and record.
15. Stop the delivery when the meter is at the desired number of gallons. (100 gallons, or otherwise depending on the prover size)
16. Disengage the truck pump.
17. Stamp the ticket to inspect the ticket printer.

18. Check the auto stop. (Required to work if installed, should stop within ½ tenth of goal.
19. Pump prover off. (**ENSURE THAT RETURN HOSE NOZZLE IS IN THE PROPER COMPARTMENT!**) **IMPORTANT!** First engage the prover pump, then open the prover drain valve. (This ensures that there is no back flow into the prover from head pressure on the hose resulting in prover overflow.)
20. While the prover is pumping off, fill out header information on the Meter Calibration Report.
21. Observe a 30 second drain time when the prover is empty.
22. When the drain is complete, first shut the prover drain valve then disengage the pump. (This ensures that there is no back flow into the prover from head pressure on the hose.)

#### **As Found Normal Test**

23. Engage the truck pump.
24. Zero the meter.
25. Fill the prover to capacity at normal flow rate.
26. Stop the delivery when the meter is at the desired number of gallons. (See step 15.)
27. Disengage the truck pump.
28. Record the meter error on the Meter Calibration Report.
29. Pump the prover off. (**IMPORTANT! See step 19 procedure and warning.**)
30. If the meter is outside of tolerance conduct a repeatability test, (follow steps 23-29). If the meter fails the repeatability test, reject for repairs, or take enforcement action as required.
31. If the meter is within tolerance go to the Slow Flow Test.

#### **Slow Flow Test**

32. Follow steps 23-29 except at slow flow rate.
33. Regulate flow using the truck nozzle. Flow rate should be the minimum stamped on meter or 20% of maximum stamped on meter. (Try to be slightly above the minimum stamped.)
34. If the meter is outside of tolerance conduct a repeatability test, (see step 32). If the meter fails the repeatability test, reject for repairs, or take enforcement action as required.
35. If the meter is within tolerance go to the Product Depletion Test.

#### **Product Depletion Test**

36. Switch the truck manifold hose to a compartment containing less than ½ the capacity of the prover being used.
37. Engage the truck pump.
38. Deliver product to the prover at normal flow rate.
39. Continue the run until lack of product causes the meter to stop absolutely for at least 10 seconds. (If the meter fails to stop, continue to operate for 3 minutes then reject the meter.)

40. With the truck pump running, shut the manifold valve on the truck and or disconnect the hose from the empty compartment.
41. Connect the manifold hose on the truck to the valve from the compartment with enough product to complete the run, then open the manifold valve.
42. Complete the run at normal flow rate.
43. Record meter error on the Meter Calibration Report.
44. Pump the prover off. (See step 19)
45. If the meter is outside of tolerance conduct a repeatability test, (see step 36-44). If the meter fails the repeatability test, reject for repairs, or take enforcement action as required.
46. If the meter is within tolerance go to the Antidrain Valve Test.

#### **Antidrain Valve Test**

47. With the truck pump disengaged and the supply valve closed, raise the truck hose above the nozzle level.
48. Open the nozzle above a container (test measure, steel bucket, etc.). Flow should stop after 30 seconds. If flow continues after 30 seconds, the antidrain valve is not working. Reject for repairs.

#### **Complete inspection**

49. Apply all security seals.
50. Record the totalizer readings from the tested meter.
51. Complete the Meter Calibration Report.
52. Explain and have the owner/operator sign the Meter Calibration Report.
53. Affix an approval sticker to the meter.
54. Drain the return hose into a bucket or back to a truck compartment.
55. Remove the return hose and nozzle from the truck compartment.
56. Remove the truck delivery hose and nozzle from the prover. (If inspecting other meters on site, return to step 3.)
57. Return drained product to truck compartment.
58. Disconnect the return hose and nozzle from the prover pump.
59. Disconnect the electrical cord from the outlet.
60. Stow all equipment in the proper place in the toolbox on the prover trailer.
61. Lower the rear jacks and fold them up.
62. Connect the prover trailer to the vehicle.
63. Do a walk around inspection of the vehicle and trailer to make sure the trailer is properly connected to the vehicle, all equipment is properly stowed, all jacks are up, lights are working,

and tires are properly inflated. Also check for anything that might have been put in the path of the vehicle prior to leaving.

## Appendix D

### Introduction to Weights and Measures Regulation in the United States

#### Introduction

This section provides a broad overview of the United States weights and measures system, which is unique and can, at times, be a bit complicated and confusing.

#### United States Weights and Measures Organizations

There are numerous United States organizations that engage in weights and measures, each of which have different, but sometimes overlapping responsibilities. The key organizations responsible for weights and measures regulation or standard development are:

- The National Institute of Technology
- The National Conference on Weights and Measures
- The National Type Evaluation Program
- State and Local Weights and Measures Agencies
- The Food and Drug Administration
- The Federal Trade Commission
- The American Petroleum Institute
- ASTM International

#### National Institute of Standard and Technology (NIST)

NIST maintains the national standards to which all standards used for the calibration and maintenance of weighing and measuring devices are traceable. NIST is a non-regulatory federal agency with several key functions pertaining to weights and measures that are conducted by the Office of Weights and Measures (OWM).

According to their website, since “1836, OWM has been an integral part of the development of a national uniform system of weights and measures laws, regulations, and standards in the U.S., and is currently designated within the NIST Organic Act. These uniform standards are subsequently adopted, implemented, and regulated by the U.S. States and other local jurisdictions to ultimately achieve equity in the marketplace for consumers and businesses alike.”

The key takeaway here, is that as previously mentioned, NIST has significant responsibility for ensuring a uniform national system of weights and measures in the United States. However, as previously mentioned, they do not have regulatory authority. That regulatory authority rests with other federal agencies, state, and local governments.

NIST OWM works directly with state and local weights and measures regulatory agencies, through the National Conference on Weights and Measures, by providing technical assistance at the National Conference on Weights and Measures Interim and Annual meetings, ongoing discussions and assistance outside of those meetings, technical assistance directly to the state and local weights and measures agencies, publications, articles and training.

The National Institute of Standard and Technology’s Office of Weights and Measures is an integral part of the uniform national weights and measures assistance. While they are not a regulatory agency, they work with other

federal regulatory agencies, state and local weights and measures regulatory agencies to ensure uniformity and provide expert technical assistance.

## National Conference on Weights and Measures (NCWM)

The NCWM has been long and important history in weights and measures.

In short, the NCWM was created by the National Bureau of Standards (now NIST) as an instrumentality of the federal government to bring together the state weights and measures directors to develop uniform standards, test methods and laws.

The reason this was done is worth noting as it highlights the importance of weights and measures agencies and the inspectors who perform their duties. The NCWM website explains why the NCWM was created. Its purpose is even more important today as more products and services are sold based on weight and/or measure using devices that could not even be imagined in the 1900's.

The U.S. Constitution reserves to the states the right to regulate commerce and the weights and measures system within their borders. Throughout the 19th century, each state developed and enforced its standards. This lack of uniformity crippled economic growth, interstate commerce, and honest trade. In 1905, the National Bureau of Standards called for a meeting of the states to discuss the lack of uniform standards and in many instances, a lack of regulatory oversight. The participants decided to meet again the next year marking the birth of the National Conference on Weights and Measures (NCWM). NCWM's first model standards were published in 1915 to serve as tolerances and specifications for weighing and measuring devices.<sup>5</sup>

The NCWM is now a non-profit organization with a full-time staff of its own. However, it is very much dependent on volunteers from both the public and private sectors. These volunteers share their time and expertise to develop the standards that are used to regulate commerce throughout the United States.

Each January at the Interim meeting and July at the Annual meeting, weights and measures officials, technical advisors from NIST OWM, industry members, representatives from trade organizations, private individuals and retired government weights and measure officials come together to develop or amend weights and measures standards that are published and adopted into law by government agencies. The primary publications developed by the NCWM are NIST Handbook 130, NIST Handbook 44 and NIST Handbook 44. It is important to note that these handbooks while published by NIST at the time of this writing, are developed through the NCWM.<sup>6</sup>

## NCWM Committees

- **Laws and Regulations (L&R)**

The Laws and Regulations (L&R) Committee is charged with developing uniform model laws and regulations for adoption by the states. These laws and regulations address basic weights and measures laws and specific laws and regulations for weighmasters, commodity regulations, price scanners, unit pricing, engine fuel and automotive lubricants and more.

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<sup>5</sup> <https://www.ncwm.com/history>

<sup>6</sup> There have been discussions about the NCWM publishing handbooks in the future.



The model laws and regulations are published in Handbook 130, Uniform Laws and Regulations but have no force of enforcement until adopted into law or regulation by a government regulatory agency.

The L&R Committee also addresses test procedures and standards for verifying the net quantity contained in packages offered or exposed for sale. These procedures and standards are published in Handbook 133, Checking the Net Quantity of Packaged Goods.

- **Specifications and Tolerances (S&T)**

The Specifications and Tolerances (S&T) Committee is charged with developing the standards used to regulate the design, testing, tolerances, and user requirements for commercial weighing and measuring devices. These specifications and tolerances impact scales, meters, measure containers, grain analyzers, taxi meters, timing devices, length measuring devices. The list continues to grow as technology changes and new devices are developed for commercial applications. The standards are published in Handbook 44 Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices but have no force of enforcement until adopted into law or regulation by a government regulatory agency.

- **Professional Development**

The Professional Development Committee (PDC) is dedicated to ongoing education and certification of professionals in the weights and measures field, whether public or private. It also serves as a clearing house for safety awareness.

- **Associate Member**

The Associate Membership group serves the important role of bringing industry expertise and perspective to the standards development process. Associate members serve on the L&R and S&T committees. Their participation and expertise are essential in developing strong, sound, and **reasonable** standards. Just as the lack of regulation in commerce creates chaos and damages the economy, over-regulation can also stymie the economy and create unnecessary costs for industry and the consumer.

The participation of industry in the development of weights and measures standards, laws and regulations serve to promote “right-sized” standards, laws, and regulations. Of course, there are critics might suggest that industry participation is like having the “fox guard the henhouse.”

This concern, however, is mitigated by limiting voting on items that will be published in NIST Handbooks 130, 133 and 44 to state and local weights and measures officials.

## National Type Evaluation Program

The National Type Evaluation Program (NTEP) is a program administered by the NCWM that provides certification that a device will be manufactured in accordance with the standards published in NIST Handbook 44.

It must be emphasized that there is no guarantee that a weighing or measuring device that is traceable to an NTEP certificate of conformance (CC) will comply with NIST Handbook 44 when placed into service.

The NTEP CC, while an important tool, only indicates that the manufacturer of the device has demonstrated they can produce a device that complies with the specification and tolerances of NIST Handbook 44 – continued manufacturing and installation can alter the design and performance of a weighing and measuring device.

In-field inspection by weights and measures Officials is paramount to ensuring that a weighing and measuring device is accurate and suitable for its application. *NTEP does not replace in-field inspections.*

The NTEP CC is a complement to in-field inspections and is a valuable tool for the field inspector. It should be reviewed whenever inspecting and testing a weighing and measuring device for the first time because there are requirements for weighing and measuring devices that cannot be field inspected, for example temperature range and permanence. NTEP will have tested the device to ensure that the manufacturer has demonstrated they can build a compliant device.

The NTEP CC consists of several parts that will provide information to assist the weights and measures inspector in determining if the weighing and measuring device is suitable for the application.

The “For” section details what the weighing and measuring device is and models covered. Models not listed are not covered by the NTEP CC.

The “For” section also will contain additional information such as, for scales, nmax, emin: Capacity Platform Size, CLC and Accuracy Class.

For Liquid Measuring Devices, the information contained may be flow rate

The weighing and measuring device being inspected must fall within these parameters to be traceable to the NTEP CC.

The NTEP CC also provides the application for which the weighing and measuring device is approved. While this is applicable to all weighing and measuring devices it is especially important with liquid measuring devices.

Some NTEP CCs will specify a range of liquids for which the measuring device is suitable. It must be used only for liquids that meet all of the specified parameters.

Other NTEP CCs may specify the liquids, e.g., gasoline and diesel fuel. The measuring device may be in service to sell a product very similar to gasoline or diesel fuel, but the NTEP CC is limited, in that case, only to those two products. Thus, the measuring device is not suitable to measure any other products, no matter how similar it is to the approved liquids.

NTEP has a program a quality control program to ensure that once a manufacturer has received an NTEP CC that they continue to manufacture their weighing or measuring device to the same standards as the one they submitted to obtain certification.

This is an important program, but the field inspector plays an equally important role in ensuring the integrity of NTEP CCs.

By examining a weighing and measuring device in the field, and comparing it to its NTEP CC, the field inspector is also conducting a quality control inspection of the weighing and measuring device. Any deviations from the NTEP CC, such as additional features, models, capacities sizes, etc. should be reported to NTEP. This will help ensure the integrity of the NTEP.

## State and Local Weights and Measures Agencies

State and Local weights and measures agencies are regulatory agencies responsible for enforcing state and local laws regarding the sale of commodities and the devices used to sell them. These laws are based on NIST Handbook 130 and NIST Handbook 44. NIST Handbook 44 is often adopted in its entirety although states might lag in adopting the most current edition.

NIST Handbook 130 may be adopted by the states, but often states adopt their own laws based on those contained in NIST 130.

Sometimes, other state and local agencies may have laws or regulations impacting the sale of commodities. For example, a state department of Revenue may specify temperature correction for the sale of petroleum products for the purpose of determining a tax.

Due to the emergence of the Cannabis industry, states have created new agencies responsible for the regulation of the sale of Cannabis. Their duties and responsibilities may overlap those of the state weights and measures agency.

The NCWM, through its members and technical advisors, seeks to minimize and eliminate conflicts between other federal or state agencies.

## Other Federal Agencies

The key federal agencies having weights and measures regulatory authority are, the United States Department of Agriculture's Packers and Stockyards Division (PSD), Federal Trade Commission (FTC) and the Food and Drug Administration (FDA).

The PSD describes their mission as follows: "PSD's mission in the area of accurate weights consists of two elements that affect the integrity of livestock and poultry transactions: (1) the accuracy of the scales used for weighing livestock, meat, and poultry, and (2) the proper and honest operation of scales to ensure that the weight on which a transaction is based is accurate. The major emphases in the enforcement of this program are the monitoring of scale tests and the detection of improper and fraudulent use of subject scales."

The FTC derives its authority from the Fair Packaging and Labeling Act (Act). Their website contains information about their authority. The Act 'enacted in 1967, directs the Federal Trade Commission and the Food and Drug Administration to issue regulations requiring that all "consumer commodities" be labeled to disclose net contents, identity of commodity, and name and place of business of the product's manufacturer, packer, or distributor. The Act authorizes additional regulations where necessary to prevent consumer deception (or to facilitate value comparisons) with respect to descriptions of ingredients, slack fill of packages, use of "cents-off" or lower price labeling, or characterization of package sizes."

The FDA has a website devoted to food labeling requirements for foods under the Federal Food, Drug, and Cosmetic Act and its amendments. Under this Act, food labeling is required for most prepared foods, such as breads, cereals, canned and frozen foods, snacks, desserts, drinks, etc. Both the NCWM and NIST OWM work with FDA to ensure uniformity and that any conflicts in regulations are eliminated.

## Other Standard Development Organizations

There are numerous private organizations that assist in the development of weighing and measuring standards. This is just a brief description of two organizations whose standards the Weights and Measures Official may see cited in their laws or regulations.

As example, here is an actual state weights and measures regulation that references the American Petroleum Institute: “Invoice disclosure requirements for wholesalers and distributors of gasoline and diesel fuel. (a) Each distributor or wholesaler of gasoline and diesel fuel shall provide the following information to the purchaser at the time of delivery: (1) The minimum octane of the product as determined by the (R+M)/2 method; (2) for diesel fuel, the grade, minimum flash point, and American petroleum institute gravity of the product.”

And one for ASTM International: “Standards for tests; test methods and equipment. (a) Whenever possible, in making any test pursuant to this act, the secretary shall use methods and equipment similar to those methods and equipment adopted by the American society for testing materials.”

## The American Petroleum Institute

The American Petroleum Institute (API) is both an advocacy organization that represents the natural gas and oil industry and a standard development organization. API has developed and maintains standards, some of which have been incorporated into state and federal regulations.

## ASTM International

ASTM International, formerly known as the American Society for Testing and Materials (ASTM), is an organization that develops voluntary consensus standards. ASTM has developed and maintains standards, some of which have been incorporated into state and federal regulations.



