FIELD TRAINING MANUAL

Liquid Petroleum Gas Meter

NATIONAL COUNCIL ON WEIGHTS AND MEASURES

NCWM Field Training Manual

Liquid Petroleum Gas Meter

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ABOUT THE NATIONAL COUNCIL ON WEIGHTS AND MEASURES

Setting the United States Standards for Weights and Measures

The National Council on Weights and Measures (NCWM)[1] 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

[1] The National Council on Weights and Measures was formerly The National Conference on Weights and Measures until a name change, to better reflect its mission, was made in 2024.

PREAMBLE

The NCWM Liquid Petroleum Gas Meter Training Manual is based on the 2023 Edition of the National Institute of Standards and Technology Handbooks 44 (HB-44) Handbook.

This Training Manual does not replace HB-44. It serves as a training tool and reference for officials when inspecting or testing commercial devices. It provides key elements of HB-44 and explanations that enable uniform interpretation.

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

Not all jurisdictions adopt the latest edition of HB-44 or adopt it in its entirety. Refer to the edition of HB-44 adopted by your jurisdiction's statutes and regulations when considering enforcement action.

INTRODUCTION TO HB-44

The Introduction section of HB-44 contains important information about how to use HB-44, It is recommended to read it before conducting inspections.

A. Source.

The specifications, tolerances and other technical requirements in this Training Manual comprise all of applicable requirements adopted by the NCWM. Contact NCWM at:

9011 South 83rd Street | Lincoln, Nebraska 68516
P. (402) 434-4880 | **F.** (402) 434-4878 | **E. info@ncwm.com**

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 jurisdiction 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**. For information on the regional weights and measures associations, visit **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 Council 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 an 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 LPG METER TRAINING MANUAL

The purpose of this NCWM Training Manual is to provide the technical requirements of HB-44 to properly test and inspect vehicle, livestock and railway scales. The Training Manual 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 is accomplished through inspecting the entire measuring system. This also includes verifying the use and operation of the device for those requirements of a fair transaction. Testing the device will confirm it meets the performance requirements of the device to ensure a fair transaction. Enforcement and education are the two primary tools used by the Weights and Measures Agency and inspector in carrying out their duties.

Documentation- Document thoroughly everything that is relevant and important to support and defend your inspection and test results if the inspection is ever contested. ***If you didn't document it, it didn't happen."***

Documentation is important for legal reasons, but also because it creates a history for the device, business, and other officials.

FUNDAMENTAL CONSIDERATIONS HANDBOOK 44

Appendix A of NIST HB-44 contains the fundamental considerations associated with the 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. NCWM codes. – Weights and measures jurisdictions are urged to promulgate and adhere to the NCWM 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 NCWM 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 NCWM 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 Council 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 Council 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 Council requirements by language somewhat as follows:

The specifications, tolerances, and other technical requirements for weighing and measuring devices as recommended by the National Council 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 equipment; equipment returned to service following official rejection for failure to conform to performance requirements; or equipment undergoing NTEP evaluation 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.[2]

3. Testing Apparatus

3.1. Adequacy. – 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.
(Amended 2023)

3.1.1. Essential Elements of Traceability. – To ensure that field test standards and test methods provide for measurements that are traceable to the International System of Units (SI), through NIST or other National Metrology Institutes, they must satisfy the "Essential Elements of Traceability." As explained in NIST IR6969 GMP-13 Good Measurement Practice for Ensuring Metrological Traceability, these elements include the following.

- Realization of SI Units
- Unbroken Chain of Comparisons
- Documented Calibration Program
- Documented Measurement Uncertainty
- Documented Measurement Procedure
- Accredited Technical Competence

[2] See General Code, Section 1.10.; User Requirement G-UR.4.3. Use of Adjustments.

- Measurement Assurance

3.1.2. Specifications for Standards. – Standards shall meet the specifications of the National Institute of Standards and Technology Handbook 105-Series standards or other appropriate designated documentary standards (e.g., ASTM, ASME, etc.). 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.

3.1.3. Authority for Approving Field Test Standards and/or Equipment. – 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. Specific types of field test standards are not required to be identified in a NIST Handbook 44 code in order to be considered suitable. Provided the standards meet the "Essential Elements of Traceability" (described in Section 3.1.1. above) that help ensure the standards are suitable and capable of supporting measurements traceable to the International System of Units (SI) through NIST or other National Metrology Institutes, they need only be approved by the Director.

(Added 2023)

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 field standard or a transfer 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.

Whenever possible and practical, field standards should be used to test commercial weighing and measuring devices. However, where it is impractical or unduly cumbersome to use field standards, transfer standards may be used. There are two categories of transfer standards. The critical criteria that distinguish between these standards are: (1) the accuracy and uncertainty of the standard; (2) the stability as a standard over a designated period of time (as determined by the Director); and (3) demonstrated validity or performance of the standard over the range of environmental and operational conditions in which the standard can be reasonably anticipated to be used.

A "field standard" is one that meets the one-third requirement mentioned earlier in this section. Additionally, the field standard maintains its validity or stability as a standard over an designated period of time (defined based on data of the standard's stability by an authorized metrology lab or as specified by the Director) and can be demonstrated to maintain its value as a standard over the range of environmental conditions and the range of operating conditions in which the standard can be reasonably anticipated to be used to test commercial weighing and measuring devices.

Transfer standards do not meet one or more of these critical criteria. One category of transfer standards, which is referred to here as a "Type 1 transfer standard," is a transfer standard that meets the one-third accuracy requirement for a limited time of use, under a limited range of environmental conditions and/or a limited range of operating conditions. The accuracy of a Type 1 transfer standard may have to be verified through testing each time it is used to verify that the desired accuracy and performance can be achieved when the Type 1 transfer standard is used under the limited environmental and operating conditions. When a Type 1 transfer standard is used, the basic tolerances specified for the commercial weighing and measuring devices are applied as specified in the applicable codes.

The second category of transfer standard, which is referred to here as a "Type 2 transfer standard," is one that does not meet the one-third requirement. The Type 2 transfer standard must be stable and valid under the environmental or operating conditions in which it can be reasonably anticipated to be used. The performance characteristics must be confirmed with sufficient data to properly characterize the uncertainty associated with the Type 2 transfer standard. When a Type 2 transfer standard is used, the tolerances applicable to the commercial weighing and measuring device must be increased to recognize the large uncertainty associated with the Type 2 transfer standard. When commercial weighing and measuring devices are tested using a Type 2 transfer standard, the tolerance applied to the commercial weighing and measuring devices meter under test shall be determined as specified in Section 1.10. General Code, G-T.5. Tolerances on Tests When Type 2 Transfer Standards Are Used.

(Added 2023)

3.3. Accuracy of Field 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. 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 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.

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.

(Amended 2023)

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 weights and measures 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 so 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.[3]

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

[3] See Section 1.10. General Code and Appendix D. Definitions.

measures, graduates, measure-containers, milk and lubricating-oil bottles, farm milk tanks, dry measures, and some of the simpler 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 weights and measures 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 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.
(Amended 1995)

5.3. Gauging. – In the majority of cases, when the weights and measures 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.)

$1^{6}/32$ becomes $1^{2}/8$ or 1¼. ($^{6}/32$ is $^{2}/32$ more than an exact $^{1}/8$; $^{2}/32$ is exactly one-half of $^{4}/32$, and the final fraction is rounded (up) to the "even" eighth, which in this instance is $^{2}/8$.)

$1^{7}/32$ becomes $1^{2}/8$ or 1¼. ($^{7}/32$ is $^{3}/32$ more than an exact $^{1}/8$; $^{3}/32$ is more than one-half of $^{4}/32$ and accordingly the final fraction is rounded (up) to $^{2}/8$ or ¼.)

$1^{8}/32$ remains unchanged, being an exact eighth ($1^{2}/8$ or 1¼.)

$1^{9}/32$ becomes $1^{2}/8$ or 1¼. ($^{9}/32$ is $^{1}/32$ more than an exact $^{1}/8$; $^{1}/32$ is less than half of $^{4}/32$ and accordingly is dropped.)

General Code Section 1.10

Note: The bolded blue text in brackets [ ] appearing within the NIST Handbook 44 (HB-44) code referenced in this Training Manual is not part of HB-44 but additional information to assist the user in understanding and applying the applicable requirements of HB-44.

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:

1. To commercial weighing and measuring equipment; that is:

   (a) To weights and measures and weighing and measuring devices used or employed:

   (1) 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;

   (2) when assessing a fee for the use of the equipment to determine a weight or measure;

   (3) in determining the basis of an award using count, weight, or measure; or

   (4) in computing any basic charge or payment for services rendered on the basis of weight or measure.
   (Amended 2008 and 2022)

[Simply stated, HB-44 is applicable to devices used 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 jurisdiction is limited to devices that weigh or measure. However, when another device (associated and ancillary equipment) is connected to the primary metering equipment, that device then falls under the jurisdiction of the Weights and Measures Agency. For example, a totalizer or printer attached to the meter is subject to inspection.

The purpose of an inspection and test is to ensure that the device is accurate and correct, however, it is not the only purpose. Additionally, it is imperative to ensure that during the normal metering operation 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.]

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

(These requirements should be used as a guide by the weights and measures official when, upon request, courtesy examinations of noncommercial equipment are made.)
(Amended 2022)

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/or 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. For example, a facility has a meter but has not placed it into commercial service. It had been sitting idle and not used to sell a product.

However, later, they determine they have a need for it and place it 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 regulatory purposes, it is considered 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 Council 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, 2022, but not enforceable until January 1, 2023.**
- **There have been times when the NCWM, because of the significant impact of the 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 jurisdiction has adopted as this will impact on 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]

(1) 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]

(2) *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;

(1) *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 as of January 1, 1968,**
- **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 as of January 1, 2003]**

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, or**
- **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, tolerances and user requirements) 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.

[Primary indicating and recording elements are those that are used as the basis for a commercial transaction. The inspector should verify they are appropriate in design, adequate in amount, and easy to read under normal operating conditions.]

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]

[All graduations must be uniform in size and character and subordinate or lesser values must be differentiated, generally, by being smaller.]

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.

[This requirement is verified during the NTEP Evaluation and there isn't a specific field test for it. However, during an inspection it is determined the required information is worn, or illegible then it does not meet this requirement and is a violation.]

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.

[On devices that can indicate and record in more than one unit of measure, (e.g., liters and gallons) 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. Any meter must be able to repeat the display of a measure repeatedly.]

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 representations. All recorded values shall be presented digitally. In applications where recorded representations are required by a specific code, the customer may be given the option of not receiving the recorded representation. Recorded representations referenced in specific codes shall be made available to the customer in hard copy form, unless otherwise specified by the customer. 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.

[Indicated and recorded representations are to be digital, e.g., 1, not one. These records can be provided in various electronic forms including email or text.]

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.**

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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:

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

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

(3) 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.

(4) 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:

(1) an event logger in the device; or

(2) 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 is 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 appearance on other non-performance features) must be sealable and identified in an event logger or audit trail.]

G-N. Notes

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.]

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 device.

Nonassociated equipment is not just limited to handheld radios. Be aware of other electronic equipment that might affect the 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.

["undergoing type evaluation" refers to when an NTEP evaluator is conducting an NTEP evaluation. The evaluator will apply acceptance tolerance throughout the entire evaluation regardless of (a) through (d). Acceptance tolerance is generally half of maintenance tolerance.]

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; overregistration or underregistration.]

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 to properly use and maintain the device. User Requirements are enforced by the Official. Remember, an improperly used device, no matter how accurate it is, will not yield accurate results.

It is recommended to take a few minutes and watch the device operators and operation before beginning your test. This will provide an opportunity to determine if any improper measuring practices are taking place.]

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 the suitability of a device for the specific application it is intended to be used. The NTEP CCs should be reviewed to understand the device's approved uses, limitations, features, products and options. Some NTEP CCs list only the specific products that may be measured, and others list a range of products based on, for example, specific gravity or may include the term, "or other similar products." When specific products are listed, only those products, and no others are approved for the device.]

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 weights and measures official to the device by customary means and in the amount and size deemed necessary by such official for the proper conduct of the test.

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

[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 any special means and labor to inspect, test and seal the device.]

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, when possible, to observe employees using the device to ensure it is being used 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.

[Compliance with the requirement, due to many variables, is determined on a case-by-case basis. The key point is that the customer, if present, can observe all aspects of the measuring process to protect against fraud.]

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:

(a) predominantly, equipment of all types or applications are found to be in error in a direction favorable to the device user; or

(b) 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 verifying that routine maintenance is conducted 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. A business may also unknowingly introduce a bias that favors the customer. The device owner should be made aware of the situation.]

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 weights and measures 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 weights and measures official or bear a current, valid approval seal prior to use.

MODIFIED LPG METER HB-44 CODE

A.1. General. – This code applies to devices used for the measurement of liquefied petroleum gas and anhydrous ammonia in the liquid state, whether such devices are installed in a permanent location or mounted on a vehicle. For retail motor-fuel devices, see Appendix D, definition of "liquefied petroleum gas retail motor-fuel device."
(Amended 2022)

A.2. Devices Used to Measure Other Liquid Products not Covered in Specific Codes. – Insofar as they are clearly appropriate, the requirements and provisions of the code may be applied to devices used for the measurement of other liquids that do not remain in a liquid state at atmospheric pressures and temperatures.

A.3. Exceptions. – This code does not apply to mass flow meters. (Also see Section 3.37. Code for Mass Flow Meters.)
(Added 1994)

A.4. Additional Code Requirements. – In addition to the requirements of this code, LPG and Anhydrous Ammonia Liquid-Measuring Devices shall meet the requirements of Section 1.10. General Code.

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 device shall be equipped with a primary indicating element and may also be equipped with a primary recording element.

Note: Vehicle-mounted metering systems shall be equipped with a primary recording element as required by paragraph UR.2.6. Recorded Representations.
(Amended 2023)

S.1.1.2. Units. – A device shall indicate, and record if the device is equipped to record, its deliveries in terms of liters, gallons, quarts, pints, or binary-submultiple or decimal subdivisions of the liter or gallon.
(Amended 1987)

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

(a) 0.5 L (1 pt) on retail devices; or

(b) 5 L (1 gal) on wholesale devices.

(Amended 1987)

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 device. However, a device 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. 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 1 cent of money-value; except that a stationary retail computing-type device must compute and indicate to the nearest 1 cent of money-value. (Also see Section 1.10. General Code, G-S.5.5. Money-Values, Mathematical Agreement.) (Amended 1984 and 1988)

S.1.1.6. Recorded Representations. – Any recorded representation created by a device of the computing type which includes the total computed price, shall also include thereon the total volume of the delivery in terms of liters or gallons, and the appropriate decimal fraction of the liter or gallon, and the corresponding price per liter or gallon.
(Added 1979) (Amended 1987 and 2023)

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:

(a) the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations;

(b) the width of main graduations shall be not more than 50 % greater than the width of subordinate graduations; and

(c) graduations shall in no case be less than 0.2 mm (0.008 in) in width.

S.1.2.3. Clear Interval between Graduations. – The clear interval shall be not less than 1.0 mm (0.04 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.

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 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.1.4. For Retail Devices Only.

S.1.4.1. Indication of Delivery. – A retail device shall automatically show on its face the initial zero condition and the quantity delivered up to the nominal capacity of the device. However, the following requirements shall apply:

(a) For electronic devices manufactured prior to January 1, 2006, the first 0.03 L (or 0.009 gal) of a delivery and its associated total sales price need not be indicated.

(b) For electronic devices manufactured on or after January 1, 2006, the measurement, indication of delivered quantity, and the indication of total sales price shall be inhibited until the fueling position reaches conditions necessary to ensure that the delivery starts at zero.
[Nonretroactive as of January 1, 2006]
(Amended 2016)

S.1.4.2. Return to Zero.

(a) Primary indicating elements shall be readily returnable to a definite zero indication.

(b) Primary recording elements on a stationary retail device shall be readily returnable to a definite zero indication if the device is equipped to record.

(c) 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.

(d) Primary indicating elements shall not be resettable to zero during a delivery.
(Amended 1990 and 2016)

S.1.5. For Stationary Retail Devices Only.

S.1.5.1. Display of Unit Price and Product Identity. – A device of the computing type shall display on each face the unit price at which the device is set to compute or to deliver, and there shall be conspicuously displayed on each side of the device the identity of the product that is being dispensed.

Except for dispensers used exclusively for fleet sales and other price contract sales, all of the unit prices at which that product is offered for sales shall meet the following conditions:

(a) For a system that applies a discount prior to the delivery, all unit prices shall be displayed or shall be capable of being displayed on the dispenser through a deliberate action of the purchaser prior to the delivery of the product. It is not necessary that all of the unit prices be simultaneously displayed prior to the delivery of the product.
[Nonretroactive as of January 1, 2016]

(b) For a system that offers post-delivery discounts on fuel sales, display of pre-delivery unit price information is exempt from (a) above, provided the system complies with S.1.5.5. Recorded Representations for Transactions Where a Post-Delivery Discount(s) is Provided.

Note: When a product is offered at more than one unit price, display of the unit price information may be through the deliberate action of the customer: 1) using controls on the device; 2) through the customer's use of personal or vehicle-mounted electronic equipment communicating with the system; or 3) verbal instructions by the customer.
(Amended 2016)

S.1.5.2. Money-Value Computations. – A computing device shall compute the total sales price at any single-purchase unit price (excluding fleet sales and other price contract sales) for which the product is offered for sale at any delivery possible within either the measurement range of the device or the range of the computing elements, whichever is less. The analog money-value indication shall not differ from the mathematically computed money-value (quantity × unit price = sales price), for any delivered quantity, by an amount greater than the values shown in Table 1. Money-Value Divisions and Maximum Allowable Variations for Money-Value Computations on Mechanical Analog Computers.

(Amended 1995)

Table 1. Money-Value Divisions and Maximum Allowable Variations for Money-Value Computations on Mechanical Analog Computers

Unit Price Money- Value Division Maximum Allowable Variation

From To and Including Design Test Field Test

0 $0.25/liter or $1.00/gallon 1¢ ± 1¢ ± 1¢

$0.25/liter or

$1.00/gallon $0.75/liter or $3.00/gallon 1¢ or 2¢ ± 1¢ ± 2¢

$0.75/liter or

$3.00/gallon $2.50/liter or $10.00/gallon 1¢ or 2¢ ± 1¢ ± 2¢ 5¢ ± 2½¢ ± 5¢

S.1.5.2.1. Money-Value Divisions, Analog. – The value of the graduated intervals representing money-values on a computing-type device with analog indications shall be as follows:

(a) Not more than 1 cent at all unit prices up to and including $0.25 per liter or $1.00 per gallon.

(b) Not more than 2 cents at unit prices greater than $0.25 per liter or $1.00 per gallon up to and including $0.75 per liter or $3.00 per gallon.

(c) Not more than 5 cents at all unit prices greater than $0.75 per liter or $3.00 per gallon.

(Amended 1984)

S.1.5.2.2. Money-Value Divisions, Digital. – A computing-type device with digital indications shall comply with the requirements of paragraph G.-S.5.5. Money-Values, Mathematical Agreement, and the total price computation shall be based on quantities not exceeding 0.01 gal intervals for devices indicating in U.S. customary units and 0.05 L for devices indicating in metric units.

S.1.5.2.3. Money-Value Divisions, Auxiliary Indications. – In a system equipped with auxiliary indications, all indicated money-value divisions shall be identical.
[Nonretroactive as of January 1, 1985.]

S.1.5.3. Agreement Between Indications.

(a) When a quantity value indicated or recorded by an auxiliary element is a derived or computed value based on data received from a device, the value may differ from the quantity value displayed on the dispenser, provided that the following conditions are met:

(1) All total values for an individual sale that are indicated or recorded by the system agree, and

(2) Within each element, the values indicated or recorded meet the formula (quantity × unit price = total sale price) to the closest cent.

(b) When a system applies a post-delivery discount(s) to a fuel's unit price through an auxiliary element, the total volume of the delivery shall be in agreement between all elements in the system. [Nonretroactive as of January 1, 2016]
(Added 2016)

S.1.5.4. Recorded Representations. – Except for fleet sales and other price contract sales and for transactions where a post-delivery discount is provided, a receipt providing the following information shall be available through a built-in or separate recording element for all transactions conducted with point-of-sale systems or devices activated by debit cards, credit cards, and/or cash:

(a) the total volume of the delivery;

(b) the unit price;

(c) the total computed price; and

(d) the product identity by name, symbol, abbreviation, or code number.
(Added 2014) (Amended 2016)

S.1.5.5. Recorded Representations for Transactions Where a Post-Delivery Discount(s) is Provided. – Except for fleet sales and other price contract sales, a recorded representation providing the following information shall be available through a built-in or separate recording element that is part of the system for transactions involving a post-delivery discount:

(a) the product identity by name, symbol, abbreviation, or code number;

(b) transaction information as shown on the dispenser at the end of the delivery and prior to any post-delivery discount(s), including the:

(1) total volume of the delivery;

(2) unit price; and

(3) total computed price of the fuel sale.

(c) an itemization of the post-delivery discounts to the unit price; and

(d) the final total price of the fuel sale after all post-delivery discounts are applied.
(Added 2016) (Amended 2023)

S.1.5.6. Transaction Information, Power Loss. – In the event of a power loss, the information needed to complete any transaction in progress at the time of the power loss (such as the quantity and unit price, or

sales price) shall be determinable for at least 15 minutes at the device or another on-site device accessible to the customer.
[Nonretroactive as of January 1, 2017]
(Added 2016)

S.1.5.7. Totalizers for Retail Motor-Fuel Dispensers. – Retail motor-fuel dispensers shall be equipped with a nonresettable totalizer for the quantity delivered through the metering device.
[Nonretroactive as of January 1, 2017]
(Added 2016)

S.1.6. For Wholesale Devices Only.

S.1.6.1. Travel of Indicator. – A wholesale device shall be readily operable to deliver accurately any quantity from 180 L (50 gal) to the capacity of the device. If the most sensitive element of the indicating system uses an indicator and graduations, the relative movement of these parts corresponding to a delivery of 4 L (1 gal) shall be not less than 5 mm (0.20 in).
(Amended 1987)

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 2016 and 2018)

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 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 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 of Sealing.*
[*Nonretroactive as of January 1, 1995]
(Amended 2006 and 2019)

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

Categories of Device Methods of Sealing

Category 1: No remote configuration capability. Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.

Category 2: 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.
Category 3: 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. (Note: 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. – A measuring system shall be equipped with a valve or other effective means, automatic in operation and installed in or adjacent to the measuring element, to prevent reversal of flow of the product being measured.
(Amended 1982)

S.2.4. Maintenance of Liquid State. – A device shall be so designed and installed that the product being measured will remain in a liquid state during the passage through the meter.

S.2.5. Zero-Set-Back Interlock.

S.2.5.1. Zero-Set-Back Interlock, Electronic Stationary Meters (Other than Stationary Retail Motor-Fuel Dispensers) and Electronic Vehicle-Mounted Meters. - A device shall be constructed so that after an individual delivery or multiple deliveries at one location have been completed, an automatic interlock system shall engage to prevent a subsequent delivery until the indicating element and, if equipped, recording element have been returned to their zero positions.
[Nonretroactive as January 1, 2021]
(Added 2019) (Amended 2021)

S.2.5.2. Zero-Set-Back Interlock for Stationary Retail Motor-Fuel Devices. – A device shall be constructed so that:

(a) after a delivery cycle has been completed by moving the starting lever to any position that shuts off the device, an automatic interlock prevents a subsequent delivery until the indicating elements and recording elements, if the device is equipped and activated to record, have been returned to their zero positions;

(b) the discharge nozzle cannot be returned to its designed hanging position (that is, any position where the tip of the nozzle is placed in its designed receptacle and the lock can be inserted) until the starting lever is in its designed shut-off position and the zero-set-back interlock has been engaged; and

(c) in a system with more than one dispenser supplied by a single pump, an effective automatic control valve in each dispenser prevents product from being delivered until the indicating elements on that dispenser are in a correct zero position.

[Nonretroactive as of January 1, 2017]
(Added 2016)

S.2.6. Automatic Timeout.

S.2.6.1. Electronic Stationary (Other than Stationary Retail Motor-Fuel Dispensers). – 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 on an indicator.

[Nonretroactive as of January 1, 2021]
(Added 2021) (Amended 2023)

S.2.6.2. Automatic Timeout Pay-at-Pump Retail Motor-Fuel Devices. – Once a device has been authorized, it must deauthorize within three minutes if not activated. Reauthorization of the device must be performed before any product can be dispensed. If the time limit to deauthorize the device is programmable, it shall not accept an entry greater than three minutes.
[Nonretroactive as of January 1, 2022]
(Added 2021)

S.2.6.3. Electronic Vehicle-Mounted Meters. – For individual deliveries, if there is no product flow for five minutes the transaction must be completed before additional product flow is allowed. The five-minute timeout shall be a sealable feature on the indicator.
(Added 2023)

S.2.7. Thermometer Well. – For test purposes, means shall be provided to determine the temperature of the liquid either:

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

(b) in the meter inlet or discharge line and immediately adjacent to the meter.
(Amended 1987)

S.2.8. Automatic Temperature Compensation. – A device may be equipped with an adjustable automatic means for adjusting the indication and registration of the measured volume of product to the volume at 15 °C (60 °F**). [Refer to NIST Handbook 130,Uniform Regulation for the Method of Sale of Commodities, 2.21 Liquified Petroleum Gas. Which states that all metered sales by the gallon, except those using meters with a maximum rated capacity of 20 gal/min or less shall be accomplished by use of a meter and device that automatically compensates for temperature.**

Review your state's laws and regulations to ensure that this section of NIST Handbook 130 has been adopted and that there are no laws or regulations requiring the sale of LPG by "gross gallons/liters."

NOTE: There is an item before the 2025 NCWM to make temperature compensation apply to all meters regardless of flow rate as of 2030. This has not been passed as of this writing.]

S.2.8.1. Provision for Deactivating. – On a device equipped with an automatic temperature-compensating mechanism that will indicate or record only in terms of liters or gallons adjusted to 15 °C (60 °F), provision shall be made to facilitate the deactivation of the automatic temperature-compensating

mechanism so that the meter may indicate, and record if it is equipped to record, in terms of the uncompensated volume.
(Amended 1972)

S.2.8.2. Provision for Sealing. – Provision shall be made for applying security seals in such a manner that an automatic temperature-compensating system cannot be disconnected and that no adjustment may be made to the system.

S.3. Design of Discharge Lines and Discharge Line Valves.

S.3.1. Diversion of Measured Liquid. – No means shall be provided by which any measured liquid can be diverted from the measuring chamber of the meter or the discharge line therefrom. However, two or more delivery outlets may be permanently installed if means are provided to insure 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.

In addition, a manually controlled outlet that may be opened for the purpose of emptying a portion of the system to allow for repair and maintenance operations shall be permitted. Effective means shall be provided to prevent the passage of liquid through any such outlet during normal operation of the device and to indicate clearly and unmistakably when the valve controls are so set as to permit passage of liquid through such outlet.
(Amended 1975)

S.3.2. Delivery Hose. – The delivery hose of a retail device shall be of the wet-hose type with a shutoff valve at its outlet end.

S.4. Marking Requirements.

S.4.1. Limitation of Use. – If a device is intended to measure accurately only products 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 device.

S.4.2. Discharge Rates. – A device shall be marked to show its designed maximum and minimum discharge rates. The marked minimum discharge rate shall not exceed:

(a) 20 L (5 gal) per minute for stationary retail devices; or

(b) 20 % of the marked maximum discharge rate for other retail devices and for wholesale devices.

(Amended 1987)

Note: Also see example in Section 3.30. Liquid-Measuring Devices Code, paragraph S.4.4.1. Discharge Rates.
(Added 2003)

S.4.3. Location of Marking Information; Retail Motor-Fuel Dispensers. – The marking information required in General Code, paragraph G-S.1. Identification shall appear as follows:

(a) within 60 cm (24 in) to 150 cm (60 in) from the base of the dispenser;

(b) either internally and/or externally provided the information is permanent and easily read; and

(c) on a portion of the device that cannot be readily removed or interchanged (i.e., not on a service access panel).

The use of a dispenser key or tool to access internal marking information is permitted for retail motor-fuel dispensers.
[Nonretroactive as of January 1, 2003]

(Added 2006)

S.4.4. Temperature Compensation. – If a device is equipped with an automatic temperature compensator, the primary indicating elements, recording elements, and recorded representation shall be clearly and conspicuously marked to show that the volume delivered has been adjusted to the volume at 15 °C (60 °F).

N. Notes

N.1. Test Liquid. – A device shall be tested with the liquid to be commercially measured or with a liquid of the same general physical characteristics.

N.2. Vaporization and Volume Change. – Care shall be exercised to reduce to a minimum vaporization and volume changes. **[Read the liquid level in the prover immediately upon filling prover.]**

N.3. Test Drafts.

N.3.1. Minimum Test. – Test drafts shall be equal to at least the amount delivered by the device in one minute at its normal discharge rate.
(Amended 2023)

N.3.2. Field Standard Meter Test. – The minimum quantity for any test draft shall be equal to or greater than the amount delivered in one minute at the flow rate being tested.
(Added 2023)
(Amended 1982 and 2023)

N.4. Testing Procedures.

N.4.1. Normal Tests. – The "normal" test of a device shall be made at the maximum discharge flow rate developed under the conditions of the installation. Any additional tests conducted at flow rates down to and including one-half the sum of the maximum discharge flow rate and the rated minimum discharge flow rate shall be considered normal tests.
(Amended 1998)

N.4.1.1. Automatic Temperature Compensation. – On devices equipped with automatic temperature-compensating systems, normal tests shall be conducted as follows:

(a) by comparing the compensated volume indicated or recorded to the actual delivered volume adjusted to 15 °C (60 °F); 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.
(Amended 1987)

N.4.2. Special Tests. – "Special" tests shall be made to develop the operating characteristics of a device 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 shall be considered a special test.

N.4.2.1. For Motor-Fuel Devices. – A motor-fuel device shall be so tested at a minimum discharge rate of:

(a) 20 L (5 gal) per minute; or

(b) the minimum discharge rate marked on the device, whichever is less.

N.4.2.2. For Other Retail Devices. – A retail device other than a motor-fuel device shall be tested at a minimum discharge rate of the:

(a) minimum discharge rate that can be developed under the conditions of installation; or

(b) minimum discharge rate marked on the device, whichever is greater.
(Amended 1973)

N.4.2.3. For Wholesale Devices. – "Special" tests on a wholesale device shall include a test at, or slightly above, the minimum discharge rate marked on the device. In no case shall the test be performed at a flow rate less than the minimum discharge rate marked on the device.
(Amended 1987 and 2017)

N.4.3. Money-Value Computation Tests.

N.4.3.1. Laboratory Design Evaluation Tests. – In the conduct of laboratory design evaluation tests, compliance with paragraph S.1.5.2. Money-Value Computations shall be determined by using the cone gear as a reference for the total quantity delivered. The indicated delivered quantity shall agree with the cone gear representation with the index of the indicator within the width of the graduation. The maximum allowable variation of the indicated sales price shall be as shown in Table 1. Money-Value Divisions and Maximum Allowable Variations for Money-Value Computations on Mechanical Analog Computers.

N.4.3.2. Field Tests. – In the conduct of field tests to determine compliance with paragraph S.1.5.2. Money-Value Computations the maximum allowable variation in the indicated sales price shall be as shown in Table 1. Money-Value Divisions and Maximum Allowable Variations for Money-Value Computations on Mechanical Analog Computers.
(Added 1984)

N.4.4. 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 discharge rates shall be within the minimum and maximum discharge rates as marked by the manufacturer. For devices equipped with an automatic temperature compensator, results shall be based on the uncompensated (gross) volume (e.g., with the temperature compensator deactivated).
(Amended 2019)

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

T.1.1. To Underregistration and to Overregistration. – The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration, whether or not a device is equipped with an automatic temperature compensator.

T.2. Tolerance Values. – The maintenance and acceptance tolerances for normal and special tests shall be as shown in Table T.2. Accuracy Classes and Tolerances for LPG and Anhydrous Ammonia Liquid-Measuring Devices.
(Amended 2003)

Table T.2.2 Accuracy Classes and Tolerances for LPG and Anhydrous Ammonia Liquid Measuring Devices				
Accuracy Class	**Application**	**Acceptance Tolerance**	**Maintenance Tolerance**	**Special Test Tolerance**
1.0	**Anhydrous ammonia, LPG (Including vehicle-mounted meters)**	0.6%	1.0%	1.0%

[Tolerances are based on the meter's indicated gallon and not the size of the prover.]

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 applicable tolerance. (Also see N.4.4. Repeatability Tests)
(Added 1992) (Amended 1997, 2001, and 2019)

T.4. 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) 1.0 % for mechanical automatic temperature-compensating systems; and

(b) 0.5 % 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 1991) (Amended 1992, 1996, and 1997)

UR. User Requirements

UR.1. Installation Requirements.

UR.1.1. Discharge Rate. – A device 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. Length of Discharge Hose. – The length of the discharge hose on a stationary motor-fuel device shall not exceed 5.5 m (18 ft), measured from the outside of the housing of the device to the inlet end of the discharge nozzle, unless it can be demonstrated that a longer hose is essential to permit deliveries to be made to receiving vehicles or vessels. Unnecessarily remote location of a device shall not be accepted as justification for an abnormally long hose.
(Amended 1991)

UR.2. Use Requirements.

UR.2.1. Return of Indication 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 before each delivery.

UR.2.2. Condition of Fill of Discharge Hose. – The discharge hose shall be completely filled with liquid before the "zero" condition is established prior to the start of a commercial delivery, whether this condition is established by resetting the primary indicating elements to zero indication or by recording the indications of the primary indicating elements. (Also see UR.2.1. Return of Indication and Recording Elements to Zero.)

UR.2.3. Vapor-Return Line. – During any metered delivery of liquefied petroleum gas from a supplier's tank to a receiving container, a vapor-return line from the receiving container to the supplier's tank is prohibited except:

(a) in the case of any receiving container to which normal deliveries cannot be made without the use of such vapor-return line; or

(b) in the case of any top spray-fill receiving container when the ambient temperature is at or above 32 °C (90 °F).
(Amended 2016)

UR.2.4. Temperature Compensation.

UR.2.4.1. Use of Automatic Temperature Compensators. – If a device is equipped with an automatic temperature compensator, this shall be connected, operable, and in use at all times. Such automatic temperature compensator may not be removed, nor may a compensated device be replaced with an uncompensated device, without the written approval of the weights and measures authority having jurisdiction over the device.

UR.2.4.2. Temperature Compensated Sale. – All sales of liquefied petroleum gas in a liquid state, when the quantity is determined by an approved measuring system equipped with a temperature-compensating mechanism, or by weight and converted to liters or gallons, or by a calibrated container, shall be in terms of liters or the U.S. gallon of 231 in3 at 15 °C (60 °F).
(Added 1984)

UR.2.4.3. Invoices. – Any invoice based on a reading of a device that is equipped with an automatic temperature compensator or based on a weight converted to gallons, or based on the volume of a calibrated container, shall have shown thereon that the volume delivered has been adjusted to the volume at 15 °C (60 °F).
(Amended 1984)

UR.2.4.4. Automated Temperature-Compensating Systems. – Means for determining the temperature of measured liquid in an automatic temperature-compensating system shall be so designed and located that, in any "usual and customary" use of the system, the resulting indications and/or recorded representations are within applicable tolerances.

(Added 1987)

UR.2.5. 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.2.6. Recorded Representations. – Vehicle-mounted metering systems shall be equipped with a means to record all sales where product is delivered through the meter and shall comply with G-S.5.6. Recorded

Representations. A copy of the recorded representation issued by the device shall be provided to the customer at the time of delivery or as otherwise specified by the customer.
(Added 1992) (Amended 2023)

UR.2.7. For Stationary Retail Computing-Type Systems Only, Installed After January 1, 2017.

UR.2.7.1. Unit Price and Product Identity.

(a) The following information shall be conspicuously displayed or posted on the face of a retail dispenser used in a direct sale:

(1) except for unit prices resulting from any post-delivery discount and dispensers used exclusively for fleet sales, other price contract sales, and truck refueling (e.g., truck stop dispensers used only to refuel trucks), all of the unit prices at which the product is offered for sale; and

(2) in the case of a computing-type device or money-operated type device, the unit price at which the dispenser is set to compute.

Provided that the dispenser complies with S.1.5.1. Display of Unit Price and Product Identity, it is not necessary that all the unit prices be simultaneously displayed or posted.

(b) The following information shall be conspicuously displayed or posted on each side of a retail dispenser used in a direct sale:

(1) The identity of the product in descriptive commercial terms; and

(2) The identity of the grade, brand, blend, or mixture that a multi-product dispenser is set to deliver.
(Added 2016)

UR.2.7.2. Computing Device. – Any computing device used in an application where a product or grade is offered for sale at one or more unit prices shall be used only for sales for which the device computes and displays the sales price for the selected transaction. The following exceptions apply:

(a) Fleet sales and other price contract sales are exempt from this requirement.

(b) A truck stop dispenser used exclusively for refueling trucks is exempt from this requirement provided that:

(1) all purchases of fuel are accompanied by a recorded representation of the transaction containing the applicable price per unit of measure, the total quantity delivered, and the total price of the sale; and

(2) unless a dispenser complies with S.1.5.1. Display of Unit Price, the price posted on the dispenser and the price at which the dispenser is set to compute shall be the highest price for any transaction which may be conducted.

(c) A dispenser used in an application where a price per unit discount is offered following the delivery is exempt from this requirement, provided the following conditions are satisfied:

(1) the unit price posted on the dispenser and the unit price at which the dispenser is set to compute shall be the highest unit price for any transaction;

(2) all purchases of fuel are accompanied by a receipt recorded by the system for the transaction containing:

a. the product identity by name, symbol, abbreviation, or code number;

b. transaction information as shown on the dispenser at the end of the delivery and prior to any post-delivery discount including the:

1. total volume of the delivery;

2. unit price; and

3. total computed price of the fuel sale prior to post-delivery discounts being applied.

c. an itemization of the post-delivery discounts to the unit price; and

d. the final total price of the fuel sale after all post-delivery discounts are applied.
(Added 2016) (Amended 2023)

2024 LPG Examination Procedure Outline

2024 NCWM EXAMINATION PROCEDURE

LIQUID PETROLEUM GAS METERS

It is recommended that this outline be followed as the minimum criteria for examining Liquid Petroleum Gas meters.

Nonretroactive requirements are followed by the applicable date in parentheses.

When a main requirement is noted, e.g., G-S.1, all the subsections also apply.

SAFETY NOTES

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.

These safety notes are not intended to supersede specific agency or site location requirements. Nor are they all-inclusive and comprehensive.

Liquid Petroleum Gas is extremely dangerous , highly flammable and will ignite readily if released.

It poses the risk of freezing human tissue as well as inflicting first, second- and third-degree burns.

The product manufacturer's Safety Data Sheet (SDS) must be reviewed to understand the nature of the product and what personal protective equipment (PPE) is required to provide adequate protection.

The review of the SDS must be conducted by a competent and knowledgeable person. Training then must be provided to the inspector(s) by this person or other competent and knowledgeable trainer before inspectors conduct inspections of Liquid Petroleum Gas meters.

As a minimum, the following safety precautions should be noted and followed during the inspection.

Note at some locations, the use of electronic equipment such as cellular telephones may be prohibited.

It is recommended that inspectors have the system operator / owner perform a test of the Emergency Shut Down system (ESD) by opening the internal valve or emergency shut-of valve (ESV), followed by activation of the cable, pneumatic, or electrical shut-down mechanism prior to setting up the test process. Upon activation the liquid valve within close proximity to the tank should close. If the system includes a combination ESV / electrical shut off, the valve should close and all system power should be de-energized. The latter is only required on vehicle refueling systems open for public dispensing of their own fuel. If the ESD test does not result in a full closure of the internal or emergency shut off valve, all further testing should be cancelled.

As for open flames, smoking, extension lights electrical tools that are capable of igniting propane are not permitted within 25' of a point of transfer while filling, in accordance with NFPA 58 7.2.3.2

In accordance with NFPA 58 6.26.2.2 Class I Div I is required within 5' of the point of transfer and Class 1 Div 2 is required from 5-15'. There is no requirement for explosion proof outlets out to 25'.

Under no circumstances will the test be conducted in an enclosed area.

An electrical outlet must be available for 115/120 AC volt in close proximity to the testing area. The outlet must be explosion proof if it is located within 5 feet of the point of transfer and Class 1 Division 2 is required from 5 to 15 feet. Portable generators are not acceptable. Check electric supply by operating prover switch.

Consult with your agency, but generally tests should not be conducted if the temperature of the product in the prover is below 30°F or above 90°F.

INSPECTION		
HB-44 Section Heading	**HB-44 Code Reference**	**Additional Comment**
GENERAL CONSIDERATIONS		
The testing of LPG meters mounted on vehicles is different than many other weights and measures devices as they are mobile, and the product is extremely dangerous. Generally, the inspector must call and schedule an appointment to test the meters. During this call the need for a safe level location for the test (enclosed locations must be avoided), the necessary product quantity, the number of meters to be tested, the duration of the inspection and the availability of experienced operators to assist in the conduct of the tests must be discussed. The inspector is to inquire about specific personal protection equipment needed and ensure that the personal protection equipment they have is suitable to ensure safety. The test must be cancelled until either the device owner or the agency can provide the inspector with suitable personal protection equipment. Additionally, it is recommended that the device owner be advised that they must conduct an offboard remote shut off system test at the time of inspection. The offboard remote will shut off the pump, close the internal valve stopping any product release, and shut off the vehicle's engine. Failure to operate including each of the three required results should cause a cancellation of the test.		
Selection	G-S.3., G-UR.1.1., G-UR.1.2. G-UR.1.3.	
Installation, Use and Maintenance	G-S.2., G-UR.2, G-UR.3., G-UR.4., UR.2.	
Testing devices at a central location.	G-UR4.6.(a).	
Assistance and Accessibility	G-UR.4.4.G-UR.2.3	
Automatic Temperature Compensator (ATC)	UR.2.4.	
Discharge line and valves Directional flow valve Maintenance of liquid state Diversion of measured liquid Delivery hose Fill of discharge Vapor -return line	S.2.3., S.2.4., S.3.1, S.3.2., UR.1.2., UR.2.2., UR.2.3.	

MARKING		
Marking General Visibility of markings after installation Temperature compensated volume	G-S.1., G-S.6. (1/1/77), G-S.7.,G-UR-2.1.1.,S.4.1., S.4.2., S.4.3., S.4.4.	
DESIGN OF INDICATING AND RECORDING ELEMENTS		
Primary Elements	S.1.	
Graduations	S.1.2.	
Indicators	G-S.5., S.1.3,	
Readability	G-S.5., G-S.6. (1/1/77), G-S.7.	
Recorded representations	G-S.5.6., S.1.4.2.	
Computing-type devices Display of unit price Money-value computations	 S.1.4.1., UR.1.2. S.1.4.3.	
Return to zero	UR.2.1.	
Provisions for sealing - General	G-S.8. (1/1/90), G-UR.4.5, S.2.2.	
Provisions for sealing ATC systems	S.2.8.2.	
PRETEST DETERMINATIONS AND STEPS		
Initial setup and considerations: Have the vehicle undergoing the test, positioned at the test site in a manner that will enable: a. the inspector to see the meter indications while observing prover's sight gauges. b. the ground cable to be properly connected. For safety reasons, grounding connections are not to be attached to a painted metal surface. c. Ensure that the prover's liquid return line and vapor equalization line will reach storage tank connections.		
Security Means	S.2.2. (1/95), Table S.2.2.	Check for the presence of a proper security seal/means on the device. Document missing seals on the official report.
Test Liquid	N.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.
Vaporization and Volume Change	N.2.	Care shall be exercised to reduce to a minimum, vaporization and volume changes.
Test Drafts	N.3.	Test drafts should be equal to at least the amount delivered by the device in one minute at its normal discharge rate.
Tolerances Applicable requirements Tolerance values Repeatability Automatic temperature-compensating systems	G-T., T.1.,T.2., Table 2, T.3., T.4.	
Wet the prover by filling to nominal capacity. Drain for 30 seconds using a stopwatch.		Provers are calibrated in accordance with NIST HB 105-4. It is critical to properly wet the prover to ensure accuracy of volume. Using a stopwatch for the drain time is key to accurate and repeatable drain times.
Vaporization and Volume Change	N.2.	Exercise care to reduce to a minimum vaporization and volume change by taking readings immediately following each test draft so that the volume indication in the prover does not change due to changes in ambient temperature (which will change pressure readings as well). In addition, closing the vapor return valve on the prover immediately following each test draft and prior to taking the prover readings will help "fix" the value of the volume reading by preventing boiling of the liquid, which could have the effect of converting some of the liquid to vapor causing a change in the volume reading.
Temperature Correction	N.5.	Adjustments must be made for any change in volume resulting from the differences in liquid temperatures between the time of passage through the meter and time of volumetric determination in the prover. Read the temperature and pressure of the product in the prover immediately following each test draft and make appropriate corrections to the test results to account for changes in volume between the meter and prover due to temperature.

		Adjustments are to be made using the appropriate measurement tables.
Ticket Printer; Customer Ticket	G-S.5.2.2., G-S.5.6., UR.2.6.	Vehicle-mounted metering systems shall be equipped with a ticket printer. The ticket printer shall be used for all sales and a copy left with the customer at time of delivery or otherwise specified by the customer. Verify that the printer is functioning correctly by printing a ticket after each run.
Money-Values; Mathematical Agreement	S.1.1.5.	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 1 cent of money-value; except that a stationary retail computing-type device must compute and indicate to the nearest 1 cent of money-value.

TESTING PROCEDURES

Initial Testing Procedure Considerations:

- Vaporization and volume change. Care must be taken to minimize these factors. (Read the liquid level in the prover immediately upon filling prover.)
- Test draft size is to be equal to or exceed the amount delivered by the device in one minute when operating at full flow.
- If the unit under test is equipped with a fast/slow switch, it must be operable. All tests must be conducted with the switch in the fast position.
- Any tolerance inaccuracies must be verified with a subsequent test. Follow your agency's procedure on the action to be taken when out of tolerance results occur.
- When a product is being dispensed or returned, the inspector must always remain within the immediate area.
- An equalization run (wet down) must be conducted prior to testing each meter.
- NIST Handbook 130, Uniform Regulations for the Method of Sale of Commodities states:

  2.21. Liquified Petroleum Gas. All metered sales by the gallon, except those using meters with a maximum rated capacity of 20 gal/min or less, shall be accomplished by use of a meter that automatically compensates for temperature.

  Contact Supervisor prior to testing, if your agency has adopted this section of NIST Handbook 130 and the meter is not capable of temperature compensation.

- Determine appropriate tolerance to be applied.
- Determine performance test to be conducted.
    a. Devices equipped with automatic temperature compensation:
        i. normal - flow as found condition (compensated).
        ii. normal - flow uncompensated
        iii. special - slow flow uncompensated
    b. Devices without automatic temperature compensation (Meters Marked 20 gpm or less only)
        i. normal flow
        ii. slow flow

Applicable Tolerances T.2.

Type of Test	Acceptance Tolerance	Maintenance Tolerance
Normal tests	0.6%	1.0%
Special tests	1.0%	1.0%

Automatic temperature-compensating system T.4.

The difference between the meter error for results determined on the normal flow test with and without the automatic temperature-compensating system activated shall not exceed 1.0 percent of the test draft for mechanical automatic temperature-compensating systems. Electronic automatic temperature-compensating systems shall not exceed 0.50 percent of the test draft. The results of each test shall also be within the applicable acceptance or maintenance tolerance.

Totalizer		Note Totalizer Reading Record the totalizer indication before and after each draft to determine proper operation. Record final totalizer reading after the testing is complete.
After each test draft: Print a ticket If computing type, check price computation on indication and on recorded representations Check for agreement between indicators	G-S.5.2.2., G-S.5.6.	
Return to Zero	S.1.4.2.	a) Primary indicating elements shall be readily returnable to a definite zero indication. (b) Primary recording elements on a stationary retail device shall be readily returnable to a definite zero indication if the device is equipped to record. (c) 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. (d) Primary indicating elements shall not be resettable to zero during a delivery.

Level the prover empty and recheck the level when the prover is full of liquid.		
If prover is dry, wet prover. Follow proper draining procedures and allow a 30-second drain period each time the prover is emptied		The use of a stopwatch is to be used to ensure accurate and repeatable drain times.
Normal Tests (Non-ATC meters) Test Drafts Tolerances	N.2.,N.3., T.2.,Table T.2.	The "normal" test of a device shall be made at the maximum discharge flow rate developed under the conditions of the installation. Any additional tests conducted at flow rates down to and including one-half the sum of the maximum discharge flow rate and the rated minimum discharge flow rate shall be considered normal tests.
Automatic Temperature Compensation meters	N.4.1.1.	On devices equipped with automatic temperature-compensating systems, normal tests shall be conducted as follows: (a) by comparing the compensated volume indicated or recorded to the actual delivered volume adjusted to 15 °C (60 °F); 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.
Special Tests	N.4.2.	"Special" tests shall be made to develop the operating characteristics of a device 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 shall be considered a special test.
For Motor-Fuel-Devices	N.4.2.1.	A motor-fuel device shall be so tested at a minimum discharge rate of: (a) 20 L (5 gal) per minute; or (b) the minimum discharge rate marked on the device, whichever is less. **N.4.2.3.For Wholesale Devices.** – "Special" tests on a wholesale device shall include a test at, or slightly above, the minimum discharge rate marked on the

		device. In no case shall the test be performed at a flow rate less than the minimum discharge rate marked on the device.
For Other Retail Devices	N.4.2.2.	A retail device other than a motor-fuel device shall be tested at a minimum discharge rate of the: (a) minimum discharge rate that can be developed under the conditions of installation; or (b) minimum discharge rate marked on the device, whichever is greater.
For Wholesale Devices	N.4.2.3.	"Special" tests on a wholesale device shall include a test at, or slightly above, the minimum discharge rate marked on the device. In no case shall the test be performed at a flow rate less than the minimum discharge rate marked on the device,
Field Tests	N.4.3.2.	Field Tests. – In the conduct of field tests to determine compliance with paragraph S.1.5.2. Money-Value Computations the maximum allowable variation in the indicated sales price shall be as shown in Table 1. Money-Value Divisions and Maximum Allowable Variations for Money-Value Computations on Mechanical Analog Computers.
Repeatability Tests	N.4.4.,T.3	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 discharge rates shall be within the minimum and maximum discharge rates as marked by the manufacturer. For devices equipped with an automatic temperature compensator, results shall be based on the uncompensated (gross) volume (e.g., with the temperature compensator deactivated).
Intermediate Values	G-T.4.	For a capacity, indication, load, value, etc., intermediate between two capacities, indications, loads, values, etc., listed in a table of tolerances, the tolerance prescribed for the lower capacity, indication, load, value, etc., shall be applied.
Repeatability	T.3.	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 applicable tolerance. (Also see N.4.4. Repeatability Tests)

POST-TEST TASKS		
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 requirements, including, maintenance of equipment and use of adjustments.		Review your findings and confirm any law or HB-44 requirement citations before presenting it to the device owner/user.
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.		

LPG CHECK LIST			
Inspection of Test	Record description of the test (when applicable). For example, flow rates, etc. or any other relevant information.	Action, Inspection or Test Conducted? Yes or No	
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. As previously mentioned, it is recommended that the device owner must conduct an offboard remote shut off system in advance of any testing. The offboard remote will shut off the pump, close the internal valve stopping any product release, and shut off the vehicle's engine. Failure to operate, including each of the three required results should cause a cancellation of the test. Ensure you have the proper personal protection equipment and are using it. Do not conduct the test if a leak is found. The leak must be repaired before conducting tests.			
Inspect the prover to ensure it is certified, properly sealed and it is empty and clean. If the prover has been used prior to the current inspection, ensure that any residual			

product is compatible with the product to be used for testing. 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. Follow agency procedures, but it may be advisable to note this information on the official report.			
Suitability – if applicable, review the NTEP CC for information regarding application, features, sealing and other relevant information. It is advisable not to proceed with a test if the LPG meter is not suitable for its application to avoid having to explain why the LPG meter is accurate but cannot be used. The exception is if you are investigating a complaint. In that case, accuracy may be relevant.			
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.			
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.			
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.			

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.			
Determine the applicable tolerances to be applied. Refer to HB-44 section on tolerances: unmarked, marked, maintenance, acceptance tolerances.			
Verify operational features to understand their functions but rely on the operator to operate the LPG meter.			
Verify the options for providing the customer with 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.			
Know how to make corrections for changes in temperature			
Record totalizer reading.			
Level prover empty and verify when full.			
Wet prover if dry.			
Ensure you have the proper temperature correction tables and 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.			
Tests			
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.			
For Non-Temperature-Compensated Meters			
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.			
For Temperature-Compensated Meters			
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.			
Post Test			
Review Temperature Corrections to ensure accuracy before presenting the report the device owner/user.			
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.			

Link to: NIST LPG Meter Test Study Guide

NIST Article - Meter Testing and Corrections – Corrections During Liquid Meter Testing

Meter Testing and Corrections – Corrections During Liquid Meter Testing

By Tina Butcher

When conducting tests of liquid-measuring devices such as loading-rack meters, LPG meters, and vehicle-tank meters, several corrections are used to account for the effects of influences such as pressure (in a closed vessel such as an LPG prover) and temperature. It is necessary for the weights and measures official to understand why these corrections must be made.

Why Make Corrections?

To ensure a fair test of any weighing or measuring device, it is important that no aspect of the test procedure used by the inspector or service agent unfairly (or unreasonably) affects the results of the test. Test standards must be accurate and appropriate. The Fundamental Considerations of NIST Handbook 44 specify that, when a standard is used without correction, its combined error and uncertainty must be less than one-third of the applicable device tolerance. Likewise, the procedures used by the inspector or service agent should not introduce significant errors into the test process. For example, it is important that an inspector set up equipment correctly, read a prover accurately, adhere to established drain times, and follow recognized test procedures.

What Corrections Need to Be Made?

Influences in effect at the time of the test must also be accounted for. Temperature and pressure can affect measurement results, and corrections need to be made during some types of meter testing to account for the effects of these influences. Three corrections that should be considered, particularly during the testing of larger meters and LPG, are illustrated in the following diagram and explained in the text that follows. These corrections are particularly important for products such as LPG that have a high coefficient of expansion.

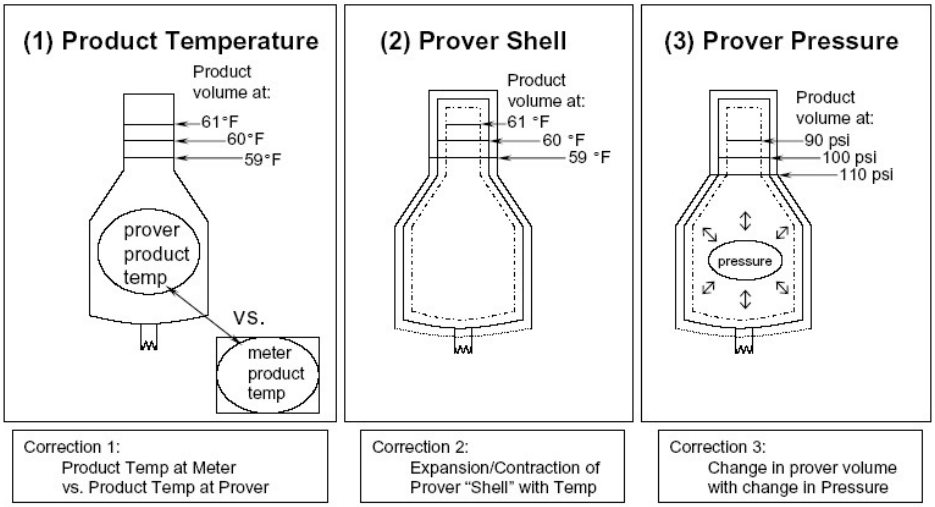

Fig. 1 – Three Corrections

(1) Correction for Product Temperature

This correction accounts for a change in product volume resulting from a difference between the temperature of the product at the meter and the temperature of the product at the prover.

Product expands as temperature increases and contracts as temperature decreases. For example, a given volume of product measured at 61 ºF occupies more space than that same product measured at 59 ºF or 60 ºF as illustrated in Figure 2.

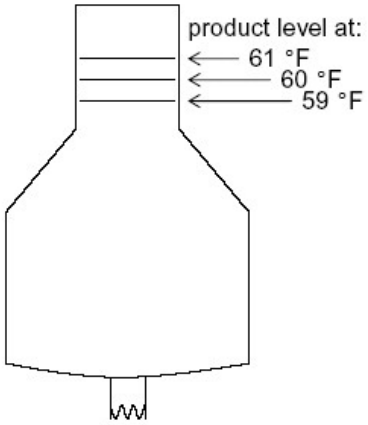

Fig. 2 – Effect of Temperature on Product Volume

The rate at which a product expands and contracts in response to temperature is referred to as its "coefficient of expansion." For reference, the widely accepted coefficient of expansion for gasoline is 0.00069/°F and for diesel is 0.00050/°F.

Consider an example where the meter measures the volume at a product temperature of 59 °F. What happens if the temperature of the product rises to 61 °F as it travels between the meter and the prover? As the temperature rises, the product will expand, raising the product level to a higher volume in the prover than it would have been had the temperature remained the same as it was at the meter. To compare the volume indicated on the prover with the volume indicated on the meter without making any adjustments or corrections would not be a fair test since you would essentially be comparing a 59 °F volume with a 61 °F volume. Consequently, for most meter tests, a correction must be made to ensure that the prover readings and the meter readings are both based upon volumes at the same temperature.

For a non-temperature compensated meter, there are two methods for accomplishing this correction. One is to adjust the product volume at the meter to its volume at 60 °F, adjust the volume at the prover to 60°F, and then compare the two adjusted volumes. The second method is to adjust the volume at the prover to the volume it would be if it were at the same temperature as the meter temperature and then compare the corrected value to the meter reading. Most NIST training courses on meters use the first method, which is illustrated in the example below. The American Petroleum Institute (API) publishes tables (including Table 6B, "Generalized products: Correction of Volume to 60 °F") that list factors used to correct volumes to 60 °F, making this method reasonably quick and easy. To obtain a temperature and pressure volume correction factors CD for generalized crude oils, refined products, and lubricating oils, contact either API or ASTM International (originally known as American Society for Testing and Materials) at http://api-ec.api.org or http://astm.org, respectively.

To adjust a volume to 60 °F using the API tables, first find the factor corresponding to the temperature of the product. Multiply the factor by the volume; the result is the "volume corrected to 60 °F." That is, what the volume would be if its temperature were actually adjusted to 60 °F.

Product Type:

Gasoline with an API gravity of 60.0:

Meter Indicated Volume:	200.0 gallons
Product Temperature at Meter:	59 °F
API Correction Factor for 59 EF:	1.0007
Meter Volume Corrected to 60EF:	200.0 x 1.0007 = 200.14 gallons

Prover Indicated Volume:	201.00 gallons
Product Temperature at Prover:	61 °F
API Correction Factor for 61 EF:	0.9993
Prover Volume Corrected to 60EF:	201.0 x 0.9993 = 200.9 gallons

The results of 200.14 gallons at the meter and 200.9 gallons at the prover can now be compared since both have been adjusted to the corresponding volumes at 60 °F.

Note that it is important to use "matched" thermometers (thermometers that read the same temperature within a certain allowance) during this process to ensure there are no significant differences between the thermometer used at the meter and the thermometer used at the prover.

(2) Correction for Prover Temperature

*This correction accounts for the change in prover volume due to the expansion or contraction of the **prover** with changes in temperature.*

Just like the product being metered expands or contracts with changes in temperature, the metal from which a prover is made will also expand or contract with temperature changes. Graduated neck-type volumetric field standards which are used to test meters measuring refined petroleum products are calibrated to deliver their nominal capacities at a reference temperature of 60 °F. If the temperature of the prover drops below 60 °F, the metal will contract, thus reducing the volume of the prover. If the temperature of the prover rises above 60 °F, the metal will expand, thereby increasing the volume of the prover.

The rate at which the prover metal expands and contracts in response to temperature is referred to as its "cubical coefficient of expansion." Provers are commonly constructed from stainless steel or mild steel. The coefficient of expansion for stainless steel is 2.65 x 10-5 (or 0.0000265) and for mild steel is 1.86 x 10-5 (or 0.0000186).

To correct for the effect of temperature on the prover metal, the following equation is used:

Coefficient of Expansion x (Temperature of Prover – 60 °F) x Prover Nominal Capacity

In the example above, for a 200-gallon prover at 61 °F, the correction would be calculated as follows if the prover were constructed of stainless steel:

0.0000265 x (61-60) x 200 = 0.0053 gallons x 231 = 1.22 cubic inches

This means that the volume of the prover has increased by 1.22 cubic inches at 61 ºF. Thus, the reading in the prover would be 1.22 cubic inches less than it would be if the temperature were at the prover reference temperature of 60 °F. To apply the correction, 1.22 cubic inches would be added to the prover reading of 201.00 gallons.

Consider what would happen if the temperature were 81 °F. The effect is much more significant:

$$0.0000265 \times (81\text{-}60) \times 200 = 0.1113 \text{ gallons} \times 231 \text{ in3/gal} = 25.7 \text{ cubic inches}$$

In this case, the prover would have increased its capacity by 25.7 cubic inches and this amount would need to be added to the prover reading in order to account for the effect of temperature on the prover metal.

For a more detailed description of this correction for vehicle-tank meter testing, see Dick

Suiter's February 2004 *W&M Quarterly* article, "Temperature is a Big Factor in Vehicle Tank Meter Test." To access the article, go to the WMD website at www.nist.gov/owm; select "Weights and Measures Quarterly Newsletter Archive" under the "Publications" section and look for Series B-007 under the "Measuring" category.

(3) Correction for Prover Pressure

This correction accounts for the change in prover volume due to the expansion or contraction of the prover with changes in pressure.

In a closed system such as that during LPG meter testing, pressure can affect measurement results. It is not necessary to make this correction to tests of "open" systems where pressure is not a factor, such as tests of vehicle-tank meters or loading rack meters delivering refined petroleum products which are liquids at atmospheric temperatures and pressures.

Volumetric field standards which are used to test meters measuring liquefied petroleum gas and anhydrous ammonia are calibrated at a reference pressure of 100 pounds per square inch (psi). If the pressure of the prover rises above 100 psi, the prover will expand, thus increasing its volume from its calibrated volume. Likewise, if the pressure drops below 100 psi, the prover will contract, thus decreasing the volume from its calibrated volume.

The rate at which this change occurs is not a linear function; the response of a particular prover to pressurization may be unique to that individual prover and is not predictable from its material or design. When a prover is calibrated, a pressure correction table is prepared, showing the appropriate corrections at various pressures. The correction for pressure is obtained from this chart and is added or subtracted from the prover reading according to the chart.

Note that a large difference between the product pressure at the meter and the product pressure in the prover may indicate a restriction in the system. A difference greater than about 5 psi should prompt you to investigate and correct any system problems prior to continuing with the test.

DATE: TIME:	DEPARTMENT HEADING LPG METER EXAMINATION REPORT	TEST NO:	TRUCK ID: LIC. NO.:
BUSINESS NAME:		INSPECTOR:	
STREET: CITY: STATE: ZIP:		BUSINESS OWNER'S NAME:	
METER MAKE: MODEL NO.: SN:		REGISTER MAKE: MODEL NO.: SERIAL NO.: NTEP CC#:	
METER SIZE (INCHES):	TOTALIZER FINISH:		
MANUFACTURER'S RATED FLOW CAP: MIN. GPM MAX. GPM	TOTALIZER START:	PRODUCT NAME: SPECIFIC GRAVITY:	
THERMOMETER WELL ☐ PRINTER ☐ ATC: ☐ ELECTRONIC ☐ MECHANICAL	TOTAL QUANTITY OF PRODUCT RETURNED TO STORAGE: _____ GALLONS	PROVER MATERIAL:	
TOLERANCE APPLIED: ACCEPTANCE ☐ MAINTENANCE ☐	SECURITY SEALS INTACT AS FOUND? YES ☐ NO ☐	PROVER'S NOMINAL CAPACITY: _____ GALLONS	

Test Data	1st run	2nd run	3rd run	4th run
1. TYPE OF TEST RUN	NORMAL ☐ SPEC ☐ ATC ☐	NORMAL ☐ SPEC ☐ ATC ☐	NORMAL ☐ SPEC ☐ ATC ☐	NORMAL ☐ SPEC ☐ ATC ☐
2. FLOW RATE (ACTUAL FLOW RATE AS INSTALLED)	GAL/MIN	GAL/MIN	GAL/MIN	GAL/MIN
3. METER TEMPERATURE (1/3 PROVER CAPACITY)	° F	° F	° F	° F
4. METER TEMPERATURE (2/3 PROVER CAPACITY)	° F	° F	° F	° F
5. STORAGE TANK PRESSURE (PSIG)	PSIG	PSIG	PSIG	PSIG
6. PROVER PRESSURE (PSIG)	PSIG	PSIG	PSIG	PSIG
7. TEMPERATURE OF THE LIQUID IN THE PROVER	° F	° F	° F	° F
8. METER INDICATION (GALLONS)	GAL	GAL	GAL	GAL
9. PROVER INDICATION TO NEAREST 0.05 GALLON	GAL	GAL	GAL	GAL
PROVER CORRECTIONS				
10. PROVER PRESSURE CORRECTION (TABLE 1)	GAL	GAL	GAL	GAL
11. PROVER TEMPERATURE CORRECTION (TABLE 2)	GAL	GAL	GAL	GAL
12. CORRECTED PROVER INDIC. (LINES 9+10+11)	GAL	GAL	GAL	GAL
USE FOR UNCOMPENSATED RUN				
13a. AVERAGE METER TEMP (Line 3 + Line 4) ÷ 2	° F	° F	° F	° F
13b. TEMP. DIFFERENCE (Line 13a – Line 7)	° F	° F	° F	° F
13c. TEMP. CORRECTION FACTOR (TABLE 4)	GAL/°F	GAL/°F	GAL/°F	GAL/°F
13d. TEMP. DIFF. CORR. (Line 13b x Line 13c)	GAL	GAL	GAL	GAL
14. TEMP CORR PROVER IND. (Line 13d + Line12)	GAL	GAL	GAL	GAL
USE FOR COMPENSATED RUN				
13. VOLUME CORR. FACTOR AT PROVER TEMP. (VOLUME REDUCTION TO 60 °F FOR LPG: TABLE 3)				
14.TEMP CORR PROVER INDIC. (LINE 13 X LINE 12)	GAL	GAL	GAL	GAL
USE FOR EITHER RUN				
15. TEMP CORR PROVER INDIC. (LINE 14)	GAL	GAL	GAL	GAL
16. METER INDICATION (LINE 8)	GAL	GAL	GAL	GAL
17. NET METER ERROR (LINE 15 - LINE 16)	GAL	GAL	GAL	GAL
18. PERCENT ERROR: (LINE 17 ÷ LINE 15) X 100= %	%	%	%	%
19. DIFFERENCE BETWEEN ATC AND NON- ATC TEST RUN(S):	(% ERROR ATC - % ERROR NON-ATC) = %			ATC TOL: %

REMARKS:

ACTION TAKEN: ☐ APPROVED ☐ REJECTED ☐ STOP USE (NIST OWM FORM REV 02-2022)

Table 1 – Pressure Correction

- This table is unique for each prover and is prepared by the metrology lab during calibration of the prover.
- This is used to adjust the prover readings for the effects of pressure at the time of a test.

Table 2 – Correction for Thermal Expansion and Contraction of the Prover

- This table is used to adjust the prover readings for the effects of the expansion of the metal in the prover "shell" on the volume.
- The coefficient of expansion used for this correction depends on the type of metal of the prover used in the test and the prover capacity.
- The metal expands and contracts at a specific rate depending on the metal the prover is made of and the temperature.
- There is an equation that is used to apply this correction, with a reference back to 60 degrees.
- However, rather than having the inspector use the equation to calculate the correction, we have prepared tables to make the process easier.
- There are multiple "Table 2's" in Appendix B.
    - Each table is for a different capacity of prover and a different metal.
    - You will see the coefficient of expansion listed at the top of each table.
- To use the tables, the inspector needs to determine the metal used for the prover and the coefficient of expansion for the metal. This information is typically listed on the prover nomenclature plate, though it may not be there for older provers.
    - With this information and the capacity of the prover, the inspector can locate the correct table.
    - Using the appropriate table, the inspector determines the temperature at which the reading is taken and looks up the corresponding correction to apply in the table.

Table 3 – Volume Reduction to 60 degrees F (Used for <u>Compensated</u> Runs)

- This table is used to adjust the prover readings to the volume at 60 degrees F.
- Note that, for a compensated run, the compensating system is activated, and the meter indicates a volume at 60 degrees F.
- The product's temperature in the prover may not be 60 degrees F, so the prover reading needs to be adjusted to reflect what the volume would be if we could change the liquid's temperature to 60 degrees F.
- This allows us to compare a 60-degree volume indication at the meter with a 60-degree volume indication at the prover.
- There are multiple versions of Table 3 in the Appendix, each for a different specific gravity.
- Using the appropriate table and the temperature difference between the meter and prover, the prover reading can be adjusted.

- Note that, unlike the ASTM tables for refined petroleum other than LPG, which are copyrighted, these tables were generated by NIST using instructions for developing software to generate the tables as outlined in ASTM/Gas Processors Association TP-27 (which we purchased). The latest versions of these tables were developed by Val Miller and Ross Andersen, but you can also find some "raw materials" and earlier iterations on Elwood that Marc Buttler worked on when he was with NIST. You can also find the license agreement from TP-27 there.
  L:\internal\OWM\NTP\Courses-CURRENT\Metering\LPG Meters\TP 27 Materials-Marc

Table 4 - Temperature Corrections to Indicated Volume of a XX-Gallon LPG Prover(Used for <u>Uncompensated</u> Runs)

- Like Table 3, Table 4 is used to adjust the prover reading to account for volume changes due to changes in temperature between the point at which the meter makes its measurement (meter indication) and the point at which the inspector takes the reading for the test (prover indication).
- However, for an uncompensated run, the meter will be indicating a volume at some temperature at which the product is measured; the meter is not adjusting its indications back to 60 degrees F.
- At present, the table and report form adjust the prover indication to a volume based on the temperature of the meter.
- We are considering making a change to this process and adjusting both the meter and the prover indications to the volume at 60 degrees F and then comparing the readings.

Table 1. Pressure Corrections to Indicated Volume of Prover

Use the pressure correction table that was prepared for your prover when it was calibrated.)

Table 2. Temperature Corrections to Indicated Volume of a 100-Gallon LPG Prover

Correction for 100-Gallon Per ºF Difference between Meter Temperature and Prover Temperature

Product Temperature in Prover F	Propane 0.500*	Propane 0.505*	Propane 0.510*	Butane 0.585*
Over -10 to 0	0.128	0.126	0.123	0.091
Over 0 to 10	0.133	0.130	0.127	0.093
Over 10 to 20	0.138	0.135	0.132	0.095
Over 20 to 30	0.144	0.140	0.137	0.097
Over 30 to 40	0.150	0.146	0.143	0.100
Over 40 to 50	0.157	0.153	0.149	0.102
Over 50 to 60	0.165	0.160	0.156	0.105
Over 60 to 70	0.174	0.169	0.164	0.108
Over 70 to 80	0.184	0.178	0.172	0.111
Over 80 to 90	0.195	0.189	0.183	0.115
Over 90 to 100	0.209	0.202	0.194	0.119
Over 100 to 110	0.225	0.217	0.208	0.123

***Approximate specific gravities for some commercial LPG & Butane products**

**** Butane boils at 31.1 ºF. Prover pressure will be less than one atmosphere below boiling point.**

Note: The appropriate correction factor should be multiplied by the number of degrees difference between the meter and prover temperatures. If the temperature at the meter is *higher* than the temperature of the prover, the correction should be *added* to the prover gauge reading to compensate for the contraction of the liquid that has taken place after it was measured by the meter. If the temperature at the meter is *lower* than the temperature of the prover, the correction should be *subtracted* from the prover gauge reading to compensate for the expansion of the liquid that has taken place after it was measured by the meter.

Table 2. Temperature Corrections to Indicated Volume of a 100-Gallon

Anhydrous Ammonia Prover
Correction for 100-Gallon Per ºF Difference between Meter Temperature and Prover Temperature

Product Temperature in Prover F	Anhydrous Ammonia #
Over -10 to 0	0.107
Over 0 to 10	0.109
Over 10 to 20	0.112
Over 20 to 30	0.116
Over 30 to 40	0.119
Over 40 to 50	0.123
Over 50 to 60	0.128
Over 60 to 70	0.133
Over 70 to 80	0.138
Over 80 to 90	0.144
Over 90 to 100	0.150
Over 100 to 110	0.157

Note: The appropriate correction factor should be multiplied by the number of degrees difference between the meter and prover temperatures. If the temperature at the meter is *higher* than the temperature of the prover, the correction should be *added* to the prover gauge reading to compensate for the contraction of the liquid that has taken place after it was measured by the meter. If the temperature at the meter is *lower* than the temperature of the prover, the correction should be *subtracted* from the prover gauge reading to compensate for the expansion of the liquid that has taken place after it was measured by the meter.

Values in the table derived from Table 4A. Volume Reduction to 60 ºF for Saturated Anhydrous Ammonia, based on 5th order fit of product density over range of -16 °F to 111 °F.
Reference: Haar and Gallagher, J. Phys. Chem. Ref. Data, Vol. 7, No. 3, 1978.

Table 3 (100 PVS): Volume Corrections for Thermal Expansion or Contraction of a 100-gallon Pressure Vessel Steel Prover

Coefficient of Expansion = 0.0000160 /°F

Temp °F	Correction gal	Correction in³
-10	-0.112	-25.9
-9	-0.110	-25.5
-8	-0.109	-25.1
-7	-0.107	-24.8
-6	-0.106	-24.4
-5	-0.104	-24.0
-4	-0.102	-23.7
-3	-0.101	-23.3
-2	-0.099	-22.9
-1	-0.098	-22.5
0	-0.096	-22.2
1	-0.094	-21.8
2	-0.093	-21.4
3	-0.091	-21.1
4	-0.090	-20.7
5	-0.088	-20.3
6	-0.086	-20.0
7	-0.085	-19.6
8	-0.083	-19.2
9	-0.082	-18.8
10	-0.080	-18.5
11	-0.078	-18.1
12	-0.077	-17.7
13	-0.075	-17.4
14	-0.074	-17.0
15	-0.072	-16.6
16	-0.070	-16.3
17	-0.069	-15.9
18	-0.067	-15.5
19	-0.066	-15.2
20	-0.064	-14.8
21	-0.062	-14.4
22	-0.061	-14.0
23	-0.059	-13.7
24	-0.058	-13.3
25	-0.056	-12.9
26	-0.054	-12.6
27	-0.053	-12.2
28	-0.051	-11.8
29	-0.050	-11.5
30	-0.048	-11.1

Temp °F	Correction gal	Correction in³
30	-0.048	-11.1
31	-0.046	-10.7
32	-0.045	-10.3
33	-0.043	-10.0
34	-0.042	-9.6
35	-0.040	-9.2
36	-0.038	-8.9
37	-0.037	-8.5
38	-0.035	-8.1
39	-0.034	-7.8
40	-0.032	-7.4
41	-0.030	-7.0
42	-0.029	-6.7
43	-0.027	-6.3
44	-0.026	-5.9
45	-0.024	-5.5
46	-0.022	-5.2
47	-0.021	-4.8
48	-0.019	-4.4
49	-0.018	-4.1
50	-0.016	-3.7
51	-0.014	-3.3
52	-0.013	-3.0
53	-0.011	-2.6
54	-0.010	-2.2
55	-0.008	-1.8
56	-0.006	-1.5
57	-0.005	-1.1
58	-0.003	-0.7
59	-0.002	-0.4
60	0.000	0.0
61	0.002	0.4
62	0.003	0.7
63	0.005	1.1
64	0.006	1.5
65	0.008	1.8
66	0.010	2.2
67	0.011	2.6
68	0.013	3.0
69	0.014	3.3
70	0.016	3.7

Temp °F	Correction gal	Correction in³
70	0.016	3.7
71	0.018	4.1
72	0.019	4.4
73	0.021	4.8
74	0.022	5.2
75	0.024	5.5
76	0.026	5.9
77	0.027	6.3
78	0.029	6.7
79	0.030	7.0
80	0.032	7.4
81	0.034	7.8
82	0.035	8.1
83	0.037	8.5
84	0.038	8.9
85	0.040	9.2
86	0.042	9.6
87	0.043	10.0
88	0.045	10.3
89	0.046	10.7
90	0.048	11.1
91	0.050	11.5
92	0.051	11.8
93	0.053	12.2
94	0.054	12.6
95	0.056	12.9
96	0.058	13.3
97	0.059	13.7
98	0.061	14.0
99	0.062	14.4
100	0.064	14.8
101	0.066	15.2
102	0.067	15.5
103	0.069	15.9
104	0.070	16.3
105	0.072	16.6
106	0.074	17.0
107	0.075	17.4
108	0.077	17.7
109	0.078	18.1
110	0.080	18.5

Table 3 (100 LCS): Volume Corrections for Thermal Expansion or Contraction of a 100-gallon Low Carbon Steel Prover

Coefficient of Expansion = 0.0000186 /°F

Temp °F	Correction gal	Correction in³
-10	-0.130	-30.1
-9	-0.128	-29.6
-8	-0.126	-29.2
-7	-0.125	-28.8
-6	-0.123	-28.4
-5	-0.121	-27.9
-4	-0.119	-27.5
-3	-0.117	-27.1
-2	-0.115	-26.6
-1	-0.113	-26.2
0	-0.112	-25.8
1	-0.110	-25.3
2	-0.108	-24.9
3	-0.106	-24.5
4	-0.104	-24.1
5	-0.102	-23.6
6	-0.100	-23.2
7	-0.099	-22.8
8	-0.097	-22.3
9	-0.095	-21.9
10	-0.093	-21.5
11	-0.091	-21.1
12	-0.089	-20.6
13	-0.087	-20.2
14	-0.086	-19.8
15	-0.084	-19.3
16	-0.082	-18.9
17	-0.080	-18.5
18	-0.078	-18.0
19	-0.076	-17.6
20	-0.074	-17.2
21	-0.073	-16.8
22	-0.071	-16.3
23	-0.069	-15.9
24	-0.067	-15.5
25	-0.065	-15.0
26	-0.063	-14.6
27	-0.061	-14.2
28	-0.060	-13.7
29	-0.058	-13.3
30	-0.056	-12.9

Temp °F	Correction gal	Correction in³
30	-0.056	-12.9
31	-0.054	-12.5
32	-0.052	-12.0
33	-0.050	-11.6
34	-0.048	-11.2
35	-0.047	-10.7
36	-0.045	-10.3
37	-0.043	-9.9
38	-0.041	-9.5
39	-0.039	-9.0
40	-0.037	-8.6
41	-0.035	-8.2
42	-0.033	-7.7
43	-0.032	-7.3
44	-0.030	-6.9
45	-0.028	-6.4
46	-0.026	-6.0
47	-0.024	-5.6
48	-0.022	-5.2
49	-0.020	-4.7
50	-0.019	-4.3
51	-0.017	-3.9
52	-0.015	-3.4
53	-0.013	-3.0
54	-0.011	-2.6
55	-0.009	-2.1
56	-0.007	-1.7
57	-0.006	-1.3
58	-0.004	-0.9
59	-0.002	-0.4
60	0.000	0.0
61	0.002	0.4
62	0.004	0.9
63	0.006	1.3
64	0.007	1.7
65	0.009	2.1
66	0.011	2.6
67	0.013	3.0
68	0.015	3.4
69	0.017	3.9
70	0.019	4.3

Temp °F	Correction gal	Correction in³
70	0.019	4.3
71	0.020	4.7
72	0.022	5.2
73	0.024	5.6
74	0.026	6.0
75	0.028	6.4
76	0.030	6.9
77	0.032	7.3
78	0.033	7.7
79	0.035	8.2
80	0.037	8.6
81	0.039	9.0
82	0.041	9.5
83	0.043	9.9
84	0.045	10.3
85	0.046	10.7
86	0.048	11.2
87	0.050	11.6
88	0.052	12.0
89	0.054	12.5
90	0.056	12.9
91	0.058	13.3
92	0.060	13.7
93	0.061	14.2
94	0.063	14.6
95	0.065	15.0
96	0.067	15.5
97	0.069	15.9
98	0.071	16.3
99	0.073	16.8
100	0.074	17.2
101	0.076	17.6
102	0.078	18.0
103	0.080	18.5
104	0.082	18.9
105	0.084	19.3
106	0.086	19.8
107	0.087	20.2
108	0.089	20.6
109	0.091	21.1
110	0.093	21.5

Table 3 (100 SS): Volume Corrections for Thermal Expansion or Contraction of a 100-gallon Stainless Steel Prover

Coefficient of Expansion = 0.0000265 /°F

Temp °F	Correction gal	Correction in³
-10	-0.186	-42.9
-9	-0.183	-42.2
-8	-0.180	-41.6
-7	-0.178	-41.0
-6	-0.175	-40.4
-5	-0.172	-39.8
-4	-0.170	-39.2
-3	-0.167	-38.6
-2	-0.164	-38.0
-1	-0.162	-37.3
0	-0.159	-36.7
1	-0.156	-36.1
2	-0.154	-35.5
3	-0.151	-34.9
4	-0.148	-34.3
5	-0.146	-33.7
6	-0.143	-33.1
7	-0.140	-32.4
8	-0.138	-31.8
9	-0.135	-31.2
10	-0.133	-30.6
11	-0.130	-30.0
12	-0.127	-29.4
13	-0.125	-28.8
14	-0.122	-28.2
15	-0.119	-27.5
16	-0.117	-26.9
17	-0.114	-26.3
18	-0.111	-25.7
19	-0.109	-25.1
20	-0.106	-24.5
21	-0.103	-23.9
22	-0.101	-23.3
23	-0.098	-22.6
24	-0.095	-22.0
25	-0.093	-21.4
26	-0.090	-20.8
27	-0.087	-20.2
28	-0.085	-19.6
29	-0.082	-19.0
30	-0.079	-18.4

Temp °F	Correction gal	Correction in³
30	-0.079	-18.4
31	-0.077	-17.8
32	-0.074	-17.1
33	-0.072	-16.5
34	-0.069	-15.9
35	-0.066	-15.3
36	-0.064	-14.7
37	-0.061	-14.1
38	-0.058	-13.5
39	-0.056	-12.9
40	-0.053	-12.2
41	-0.050	-11.6
42	-0.048	-11.0
43	-0.045	-10.4
44	-0.042	-9.8
45	-0.040	-9.2
46	-0.037	-8.6
47	-0.034	-8.0
48	-0.032	-7.3
49	-0.029	-6.7
50	-0.026	-6.1
51	-0.024	-5.5
52	-0.021	-4.9
53	-0.019	-4.3
54	-0.016	-3.7
55	-0.013	-3.1
56	-0.011	-2.4
57	-0.008	-1.8
58	-0.005	-1.2
59	-0.003	-0.6
60	0.000	0.0
61	0.003	0.6
62	0.005	1.2
63	0.008	1.8
64	0.011	2.4
65	0.013	3.1
66	0.016	3.7
67	0.019	4.3
68	0.021	4.9
69	0.024	5.5
70	0.026	6.1

Temp °F	Correction gal	Correction in³
70	0.026	6.1
71	0.029	6.7
72	0.032	7.3
73	0.034	8.0
74	0.037	8.6
75	0.040	9.2
76	0.042	9.8
77	0.045	10.4
78	0.048	11.0
79	0.050	11.6
80	0.053	12.2
81	0.056	12.9
82	0.058	13.5
83	0.061	14.1
84	0.064	14.7
85	0.066	15.3
86	0.069	15.9
87	0.072	16.5
88	0.074	17.1
89	0.077	17.8
90	0.080	18.4
91	0.082	19.0
92	0.085	19.6
93	0.087	20.2
94	0.090	20.8
95	0.093	21.4
96	0.095	22.0
97	0.098	22.6
98	0.101	23.3
99	0.103	23.9
100	0.106	24.5
101	0.109	25.1
102	0.111	25.7
103	0.114	26.3
104	0.117	26.9
105	0.119	27.5
106	0.122	28.2
107	0.125	28.8
108	0.127	29.4
109	0.130	30.0
110	0.133	30.6

Table 3 (100 304SS): Volume Corrections for Thermal Expansion or Contraction of a 100-gallon Stainless Steel Prover

Coefficient of Expansion = 0.0000288 /°F

Temp °F	Correction gal	Correction in³
-10	-0.202	-46.6
-9	-0.199	-45.9
-8	-0.196	-45.2
-7	-0.193	-44.6
-6	-0.190	-43.9
-5	-0.187	-43.2
-4	-0.184	-42.6
-3	-0.181	-41.9
-2	-0.179	-41.2
-1	-0.176	-40.6
0	-0.173	-39.9
1	-0.170	-39.3
2	-0.167	-38.6
3	-0.164	-37.9
4	-0.161	-37.3
5	-0.158	-36.6
6	-0.156	-35.9
7	-0.153	-35.3
8	-0.150	-34.6
9	-0.147	-33.9
10	-0.144	-33.3
11	-0.141	-32.6
12	-0.138	-31.9
13	-0.135	-31.3
14	-0.132	-30.6
15	-0.130	-29.9
16	-0.127	-29.3
17	-0.124	-28.6
18	-0.121	-27.9
19	-0.118	-27.3
20	-0.115	-26.6
21	-0.112	-25.9
22	-0.109	-25.3
23	-0.107	-24.6
24	-0.104	-24.0
25	-0.101	-23.3
26	-0.098	-22.6
27	-0.095	-22.0
28	-0.092	-21.3
29	-0.089	-20.6
30	-0.086	-20.0

Temp °F	Correction gal	Correction in³
30	-0.086	-20.0
31	-0.084	-19.3
32	-0.081	-18.6
33	-0.078	-18.0
34	-0.075	-17.3
35	-0.072	-16.6
36	-0.069	-16.0
37	-0.066	-15.3
38	-0.063	-14.6
39	-0.060	-14.0
40	-0.058	-13.3
41	-0.055	-12.6
42	-0.052	-12.0
43	-0.049	-11.3
44	-0.046	-10.6
45	-0.043	-10.0
46	-0.040	-9.3
47	-0.037	-8.6
48	-0.035	-8.0
49	-0.032	-7.3
50	-0.029	-6.7
51	-0.026	-6.0
52	-0.023	-5.3
53	-0.020	-4.7
54	-0.017	-4.0
55	-0.014	-3.3
56	-0.012	-2.7
57	-0.009	-2.0
58	-0.006	-1.3
59	-0.003	-0.7
60	0.000	0.0
61	0.003	0.7
62	0.006	1.3
63	0.009	2.0
64	0.012	2.7
65	0.014	3.3
66	0.017	4.0
67	0.020	4.7
68	0.023	5.3
69	0.026	6.0
70	0.029	6.7

Temp °F	Correction gal	Correction in³
70	0.029	6.7
71	0.032	7.3
72	0.035	8.0
73	0.037	8.6
74	0.040	9.3
75	0.043	10.0
76	0.046	10.6
77	0.049	11.3
78	0.052	12.0
79	0.055	12.6
80	0.058	13.3
81	0.060	14.0
82	0.063	14.6
83	0.066	15.3
84	0.069	16.0
85	0.072	16.6
86	0.075	17.3
87	0.078	18.0
88	0.081	18.6
89	0.084	19.3
90	0.086	20.0
91	0.089	20.6
92	0.092	21.3
93	0.095	22.0
94	0.098	22.6
95	0.101	23.3
96	0.104	24.0
97	0.107	24.6
98	0.109	25.3
99	0.112	25.9
100	0.115	26.6
101	0.118	27.3
102	0.121	27.9
103	0.124	28.6
104	0.127	29.3
105	0.130	29.9
106	0.132	30.6
107	0.135	31.3
108	0.138	31.9
109	0.141	32.6
110	0.144	33.3

Table 4. Volume Reduction to 60 ºF for Liquefied Petroleum Gas

From ASTM Table 24E

Propane - Specific Gravity 60/60 F= 0.500

Temp °F	Factor
-10	1.10625
-9	1.10486
-8	1.10346
-7	1.10207
-6	1.10067
-5	1.09927
-4	1.09786
-3	1.09645
-2	1.09504
-1	1.09363
0	1.09221
1	1.09079
2	1.08936
3	1.08794
4	1.08651
5	1.08507
6	1.08363
7	1.08219
8	1.08075
9	1.07930
10	1.07785
11	1.07640
12	1.07494
13	1.07348
14	1.07201
15	1.07054
16	1.06907
17	1.06759
18	1.06611
19	1.06463
20	1.06314
21	1.06165
22	1.06016
23	1.05866
24	1.05715
25	1.05565
26	1.05413
27	1.05262
28	1.05110
29	1.04958
30	1.04805

Temp °F	Factor
30	1.04805
31	1.04651
32	1.04498
33	1.04344
34	1.04189
35	1.04034
36	1.03879
37	1.03723
38	1.03567
39	1.03410
40	1.03253
41	1.03095
42	1.02937
43	1.02778
44	1.02619
45	1.02459
46	1.02299
47	1.02138
48	1.01977
49	1.01815
50	1.01653
51	1.01490
52	1.01327
53	1.01163
54	1.00998
55	1.00833
56	1.00668
57	1.00502
58	1.00335
59	1.00168
60	1.00000
61	0.99832
62	0.99663
63	0.99493
64	0.99323
65	0.99152
66	0.98980
67	0.98808
68	0.98635
69	0.98462
70	0.98288

Temp °F	Factor
70	0.98288
71	0.98113
72	0.97937
73	0.97761
74	0.97584
75	0.97407
76	0.97228
77	0.97049
78	0.96869
79	0.96689
80	0.96507
81	0.96325
82	0.96143
83	0.95959
84	0.95774
85	0.95589
86	0.95403
87	0.95216
88	0.95028
89	0.94840
90	0.94650
91	0.94460
92	0.94268
93	0.94076
94	0.93883
95	0.93689
96	0.93494
97	0.93298
98	0.93101
99	0.92903
100	0.92704
101	0.92504
102	0.92302
103	0.92100
104	0.91897
105	0.91692
106	0.91487
107	0.91280
108	0.91072
109	0.90863
110	0.90653

Table 4. Volume Reduction to 60 ºF for Liquefied Petroleum Gas
From ASTM Table 24E
Propane - Specific Gravity 60/60 F= 0.505

Temp °F	Factor
-10	1.10383
-9	1.10247
-8	1.10111
-7	1.09974
-6	1.09837
-5	1.09699
-4	1.09562
-3	1.09424
-2	1.09285
-1	1.09147
0	1.09008
1	1.08869
2	1.08729
3	1.08590
4	1.08449
5	1.08309
6	1.08168
7	1.08027
8	1.07886
9	1.07744
10	1.07602
11	1.07460
12	1.07317
13	1.07174
14	1.07031
15	1.06887
16	1.06743
17	1.06599
18	1.06454
19	1.06309
20	1.06163
21	1.06017
22	1.05871
23	1.05725
24	1.05578
25	1.05430
26	1.05283
27	1.05134
28	1.04986
29	1.04837
30	1.04688

Temp °F	Factor
30	1.04688
31	1.04538
32	1.04388
33	1.04237
34	1.04086
35	1.03935
36	1.03783
37	1.03631
38	1.03478
39	1.03325
40	1.03172
41	1.03018
42	1.02863
43	1.02708
44	1.02553
45	1.02397
46	1.02241
47	1.02084
48	1.01927
49	1.01769
50	1.01611
51	1.01452
52	1.01293
53	1.01133
54	1.00973
55	1.00812
56	1.00651
57	1.00489
58	1.00326
59	1.00163
60	1.00000
61	0.99836
62	0.99671
63	0.99506
64	0.99340
65	0.99174
66	0.99007
67	0.98840
68	0.98671
69	0.98503
70	0.98333

Temp °F	Factor
70	0.98333
71	0.98163
72	0.97993
73	0.97821
74	0.97649
75	0.97477
76	0.97304
77	0.97130
78	0.96955
79	0.96780
80	0.96604
81	0.96427
82	0.96249
83	0.96071
84	0.95892
85	0.95712
86	0.95532
87	0.95351
88	0.95168
89	0.94986
90	0.94802
91	0.94617
92	0.94432
93	0.94246
94	0.94059
95	0.93871
96	0.93682
97	0.93493
98	0.93302
99	0.93110
100	0.92918
101	0.92724
102	0.92530
103	0.92335
104	0.92138
105	0.91941
106	0.91742
107	0.91543
108	0.91342
109	0.91141
110	0.90938

Table 4. Volume Reduction to 60 ºF for Liquefied Petroleum Gas
From ASTM Table 24E
Propane - Specific Gravity 60/60 F= 0.510

Temp °F	Factor
-10	1.10116
-9	1.09982
-8	1.09849
-7	1.09715
-6	1.09581
-5	1.09447
-4	1.09313
-3	1.09178
-2	1.09043
-1	1.08908
0	1.08772
1	1.08636
2	1.08500
3	1.08363
4	1.08227
5	1.08090
6	1.07952
7	1.07815
8	1.07677
9	1.07538
10	1.07400
11	1.07261
12	1.07122
13	1.06982
14	1.06842
15	1.06702
16	1.06562
17	1.06421
18	1.06280
19	1.06138
20	1.05996
21	1.05854
22	1.05711
23	1.05569
24	1.05425
25	1.05282
26	1.05138
27	1.04993
28	1.04849
29	1.04704
30	1.04558

Temp °F	Factor
30	1.04558
31	1.04412
32	1.04266
33	1.04120
34	1.03973
35	1.03825
36	1.03677
37	1.03529
38	1.03381
39	1.03232
40	1.03082
41	1.02932
42	1.02782
43	1.02631
44	1.02480
45	1.02329
46	1.02177
47	1.02024
48	1.01872
49	1.01718
50	1.01564
51	1.01410
52	1.01255
53	1.01100
54	1.00944
55	1.00788
56	1.00632
57	1.00475
58	1.00317
59	1.00159
60	1.00000
61	0.99841
62	0.99681
63	0.99521
64	0.99360
65	0.99199
66	0.99037
67	0.98874
68	0.98711
69	0.98548
70	0.98384

Temp °F	Factor
70	0.98384
71	0.98219
72	0.98054
73	0.97888
74	0.97721
75	0.97554
76	0.97386
77	0.97218
78	0.97049
79	0.96879
80	0.96709
81	0.96538
82	0.96366
83	0.96194
84	0.96021
85	0.95847
86	0.95673
87	0.95498
88	0.95322
89	0.95145
90	0.94968
91	0.94790
92	0.94611
93	0.94432
94	0.94251
95	0.94070
96	0.93888
97	0.93705
98	0.93522
99	0.93337
100	0.93152
101	0.92966
102	0.92779
103	0.92591
104	0.92402
105	0.92212
106	0.92021
107	0.91829
108	0.91637
109	0.91443
110	0.91248

Table 4. Volume Reduction to 60 ºF for Liquefied Petroleum Gases
From ASTM Table 24E
Butane - Specific Gravity 60/60 F= 0.585

Temp °F	Factor
-10	1.07062
-9	1.06965
-8	1.06869
-7	1.06772
-6	1.06675
-5	1.06578
-4	1.06481
-3	1.06384
-2	1.06287
-1	1.06189
0	1.06092
1	1.05994
2	1.05896
3	1.05799
4	1.05701
5	1.05603
6	1.05504
7	1.05406
8	1.05308
9	1.05209
10	1.05111
11	1.05012
12	1.04913
13	1.04814
14	1.04715
15	1.04616
16	1.04516
17	1.04417
18	1.04317
19	1.04217
20	1.04117
21	1.04017
22	1.03917
23	1.03817
24	1.03716
25	1.03616
26	1.03515
27	1.03414
28	1.03313
29	1.03212
30	1.03111

Temp °F	Factor
30	1.03111
31	1.03009
32	1.02908
33	1.02806
34	1.02704
35	1.02602
36	1.02500
37	1.02398
38	1.02295
39	1.02193
40	1.02090
41	1.01987
42	1.01884
43	1.01781
44	1.01677
45	1.01574
46	1.01470
47	1.01366
48	1.01262
49	1.01158
50	1.01054
51	1.00949
52	1.00844
53	1.00739
54	1.00634
55	1.00529
56	1.00424
57	1.00318
58	1.00212
59	1.00106
60	1.00000
61	0.99894
62	0.99787
63	0.99680
64	0.99574
65	0.99466
66	0.99359
67	0.99252
68	0.99144
69	0.99036
70	0.98928

Temp °F	Factor
70	0.98928
71	0.98820
72	0.98711
73	0.98603
74	0.98494
75	0.98385
76	0.98275
77	0.98166
78	0.98056
79	0.97946
80	0.97836
81	0.97725
82	0.97615
83	0.97504
84	0.97393
85	0.97282
86	0.97170
87	0.97058
88	0.96946
89	0.96834
90	0.96722
91	0.96609
92	0.96496
93	0.96383
94	0.96270
95	0.96156
96	0.96042
97	0.95928
98	0.95813
99	0.95699
100	0.95584
101	0.95469
102	0.95353
103	0.95238
104	0.95122
105	0.95005
106	0.94889
107	0.94772
108	0.94655
109	0.94538
110	0.94420

Table 4A. Volume Reduction to 60 ºF for Saturated Anhydrous Ammonia Based on 5th Order Fit of Product Density Over Range of -16 °F to 111 °F Haar and Gallagher, J. Phys. Chem. Ref. Data, Vol. 7, No. 3, 1978

Temp °F	Factor
-10	1.08463
-9	1.08349
-8	1.08235
-7	1.08121
-6	1.08006
-5	1.07892
-4	1.07777
-3	1.07662
-2	1.07547
-1	1.07432
0	1.07316
1	1.07200
2	1.07085
3	1.06969
4	1.06853
5	1.06736
6	1.06620
7	1.06503
8	1.06387
9	1.06270
10	1.06152
11	1.06035
12	1.05917
13	1.05800
14	1.05682
15	1.05564
16	1.05445
17	1.05327
18	1.05208
19	1.05089
20	1.04970
21	1.04850
22	1.04731
23	1.04611
24	1.04491
25	1.04371
26	1.04250
27	1.04129
28	1.04008
29	1.03887
30	1.03766

Temp °F	Factor
30	1.03766
31	1.03644
32	1.03522
33	1.03400
34	1.03278
35	1.03155
36	1.03032
37	1.02909
38	1.02785
39	1.02662
40	1.02538
41	1.02414
42	1.02289
43	1.02164
44	1.02039
45	1.01914
46	1.01788
47	1.01662
48	1.01536
49	1.01410
50	1.01283
51	1.01156
52	1.01029
53	1.00901
54	1.00773
55	1.00645
56	1.00517
57	1.00388
58	1.00259
59	1.00129
60	1.00000
61	0.99870
62	0.99739
63	0.99609
64	0.99478
65	0.99346
66	0.99215
67	0.99083
68	0.98950
69	0.98818
70	0.98685

Temp °F	Factor
70	0.98685
71	0.98551
72	0.98418
73	0.98284
74	0.98149
75	0.98015
76	0.97880
77	0.97744
78	0.97608
79	0.97472
80	0.97336
81	0.97199
82	0.97062
83	0.96924
84	0.96786
85	0.96648
86	0.96509
87	0.96370
88	0.96231
89	0.96091
90	0.95951
91	0.95810
92	0.95669
93	0.95528
94	0.95386
95	0.95244
96	0.95102
97	0.94959
98	0.94815
99	0.94672
100	0.94528
101	0.94383
102	0.94238
103	0.94093
104	0.93947
105	0.93801
106	0.93654
107	0.93507
108	0.93360
109	0.93212
110	0.93064

Tables 2.&2A. Temperature Corrections to Indicated Volume of a 20-Gallon Prover

For Liquefied Petroleum Gasses and Anhydrous Ammonia

Gallon Per °F Difference between Meter Temperature and Prover Temperature

Product Temperature in Prover °F	Propane 0.500*	Propane 0.505*	Propane 0.510*	Butane** 0.585*	Anhydrous Ammonia#
Over -10 to 0	0.0256	0.0251	0.0246	0.0182	0.0213
Over 0 to 10	0.0265	0.0260	0.0255	0.0186	0.0219
Over 10 to 20	0.0276	0.0270	0.0264	0.0190	0.0225
Over 20 to 30	0.0287	0.0281	0.0274	0.0195	0.0231
Over 30 to 40	0.0299	0.0293	0.0285	0.0199	0.0239
Over 40 to 50	0.0314	0.0306	0.0298	0.0204	0.0247
Over 50 to 60	0.0329	0.0321	0.0312	0.0210	0.0256
Over 60 to 70	0.0347	0.0338	0.0327	0.0216	0.0266
Over 70 to 80	0.0368	0.0357	0.0345	0.0223	0.0276
Over 80 to 90	0.0391	0.0379	0.0365	0.0230	0.0288
Over 90 to 100	0.0418	0.0404	0.0388	0.0237	0.0300
Over 100 to 110	0.0451	0.0433	0.0415	0.0246	0.0313

***Approximate specific gravities for some commercial LPG & Butane products. Values in the table derived from ASTM Table24E.**

**** Butane boils at 31.1 °F. Prover pressure will be less than one atmosphere below boiling point.**

Liquefied Petroleum Gas values ASTM Table 24E.

 # Values in the table derived from Table 4A. Volume Reduction to 60 °F for Saturated Anhydrous Ammonia, Based on 5th order fit of product density over range of -16 °F to 111 °F.
Reference: Haar and Gallagher, J. Phys. Chem. Ref. Data, Vol. 7, No. 3, 1978.

Note: The appropriate correction factor should be multiplied by the number of degrees difference between the meter and prover temperatures. If the temperature at the meter is *higher* than the temperature of the prover, the correction should be *added* to the prover gauge reading to compensate for the contraction of the liquid that has taken place after it was measured by the meter. If the temperature at the meter is *lower* than the temperature of the prover, the correction should be *subtracted* from the prover gauge reading to compensate for the expansion of the liquid that has taken place after it was measured by the meter.

Tables 2.&2A. Temperature Corrections to Indicated Volume of a 25-Gallon Prover

For Liquefied Petroleum Gasses and Anhydrous Ammonia

Gallon Per °F Difference between Meter Temperature and Prover Temperature

Product Temperature in Prover °F	Propane 0.500*	Propane 0.505*	Propane 0.510*	Butane** 0.585*	Anhydrous Ammonia#
Over -10 to 0	0.0320	0.0314	0.0308	0.0228	0.0266
Over 0 to 10	0.0332	0.0325	0.0318	0.0233	0.0273
Over 10 to 20	0.0345	0.0338	0.0330	0.0238	0.0281
Over 20 to 30	0.0359	0.0351	0.0343	0.0243	0.0289
Over 30 to 40	0.0374	0.0366	0.0357	0.0249	0.0298
Over 40 to 50	0.0392	0.0383	0.0372	0.0256	0.0309
Over 50 to 60	0.0411	0.0401	0.0390	0.0263	0.0320
Over 60 to 70	0.0434	0.0422	0.0409	0.0270	0.0332
Over 70 to 80	0.0459	0.0446	0.0431	0.0278	0.0345
Over 80 to 90	0.0488	0.0473	0.0456	0.0287	0.0359
Over 90 to 100	0.0523	0.0505	0.0485	0.0297	0.0375
Over 100 to 110	0.0563	0.0542	0.0519	0.0307	0.0392

***Approximate specific gravities for some commercial LPG & Butane products. Values in the table derived from ASTM Table24E.**

**** Butane boils at 31.1 °F. Prover pressure will be less than one atmosphere below boiling point.**

Liquefied Petroleum Gas values ASTM Table 24E.

 # Values in the table derived from Table 4A. Volume Reduction to 60 °F for Saturated Anhydrous Ammonia, Based on 5th order fit of product density over range of -16 °F to 111 °F.
Reference: Haar and Gallagher, J. Phys. Chem. Ref. Data, Vol. 7, No. 3, 1978.

Note: The appropriate correction factor should be multiplied by the number of degrees difference between the meter and prover temperatures. If the temperature at the meter is *higher* than the temperature of the prover, the correction should be *added* to the prover gauge reading to compensate for the contraction of the liquid that has taken place after it was measured by the meter. If the temperature at the meter is *lower* than the temperature of the prover, the correction should be *subtracted* from the prover gauge reading to compensate for the expansion of the liquid that has taken place after it was measured by the meter.

Tables 2.&2a. Temperature Corrections to Indicated Volume of a 200-Gallon Prover

For Liquefied Petroleum Gasses and Anhydrous Ammonia

Gallon Per °F Difference between Meter Temperature and Prover Temperature

Product Temperature in Prover F	Propane 0.500*	Propane 0.505*	Propane 0.510*	Butane** 0.585*	Anhydrous Ammonia#
Over -10 to 0	0.256	0.251	0.246	0.182	0.213
Over 0 to 10	0.265	0.260	0.255	0.186	0.219
Over 10 to 20	0.276	0.270	0.264	0.190	0.225
Over 20 to 30	0.287	0.281	0.274	0.195	0.231
Over 30 to 40	0.299	0.293	0.285	0.199	0.239
Over 40 to 50	0.314	0.306	0.298	0.204	0.247
Over 50 to 60	0.329	0.321	0.312	0.210	0.256
Over 60 to 70	0.347	0.338	0.327	0.216	0.266
Over 70 to 80	0.368	0.357	0.345	0.223	0.276
Over 80 to 90	0.391	0.379	0.365	0.230	0.288
Over 90 to 100	0.418	0.404	0.388	0.237	0.300
Over 100 to 110	0.451	0.433	0.415	0.246	0.313

***Approximate specific gravities for some commercial LPG & Butane products. Values in the table derived from ASTM Table24E.**

**** Butane boils at 31.1 °F. Prover pressure will be less than one atmosphere below boiling point.**

 # Values in the table derived from Table 4A. Volume Reduction to 60 °F for Saturated Anhydrous Ammonia, Based on 5th order fit of product density over range of -16 °F to 111 °F.
Reference: Haar and Gallagher, J. Phys. Chem. Ref. Data, Vol. 7, No. 3, 1978.

Note: The appropriate correction factor should be multiplied by the number of degrees difference between the meter and prover temperatures. If the temperature at the meter is *higher* than the temperature of the prover, the correction should be *added* to the prover gauge reading to compensate for the contraction of the liquid that has taken place after it was measured by the meter. If the temperature at the meter is *lower* than the temperature of the prover, the correction should be *subtracted* from the prover gauge reading to compensate for the expansion of the liquid that has taken place after it was measured by the meter.

Table 3 (20 PVS): Volume Corrections for Thermal Expansion or Contraction of a 20-gallon Pressure Vessel Steel Prover

Coefficient of Expansion = 0.0000160 /°F

Temp °F	Correction gal	Correction in³
-10	-0.0224	-5.2
-9	-0.0221	-5.1
-8	-0.0218	-5.0
-7	-0.0214	-5.0
-6	-0.0211	-4.9
-5	-0.0208	-4.8
-4	-0.0205	-4.7
-3	-0.0202	-4.7
-2	-0.0198	-4.6
-1	-0.0195	-4.5
0	-0.0192	-4.4
1	-0.0189	-4.4
2	-0.0186	-4.3
3	-0.0182	-4.2
4	-0.0179	-4.1
5	-0.0176	-4.1
6	-0.0173	-4.0
7	-0.0170	-3.9
8	-0.0166	-3.8
9	-0.0163	-3.8
10	-0.0160	-3.7
11	-0.0157	-3.6
12	-0.0154	-3.5
13	-0.0150	-3.5
14	-0.0147	-3.4
15	-0.0144	-3.3
16	-0.0141	-3.3
17	-0.0138	-3.2
18	-0.0134	-3.1
19	-0.0131	-3.0
20	-0.0128	-3.0
21	-0.0125	-2.9
22	-0.0122	-2.8
23	-0.0118	-2.7
24	-0.0115	-2.7
25	-0.0112	-2.6
26	-0.0109	-2.5
27	-0.0106	-2.4
28	-0.0102	-2.4
29	-0.0099	-2.3
30	-0.0096	-2.2

Temp °F	Correction gal	Correction in³
30	-0.0096	-2.2
31	-0.0093	-2.1
32	-0.0090	-2.1
33	-0.0086	-2.0
34	-0.0083	-1.9
35	-0.0080	-1.8
36	-0.0077	-1.8
37	-0.0074	-1.7
38	-0.0070	-1.6
39	-0.0067	-1.6
40	-0.0064	-1.5
41	-0.0061	-1.4
42	-0.0058	-1.3
43	-0.0054	-1.3
44	-0.0051	-1.2
45	-0.0048	-1.1
46	-0.0045	-1.0
47	-0.0042	-1.0
48	-0.0038	-0.9
49	-0.0035	-0.8
50	-0.0032	-0.7
51	-0.0029	-0.7
52	-0.0026	-0.6
53	-0.0022	-0.5
54	-0.0019	-0.4
55	-0.0016	-0.4
56	-0.0013	-0.3
57	-0.0010	-0.2
58	-0.0006	-0.1
59	-0.0003	-0.1
60	0.0000	0.0
61	0.0003	0.1
62	0.0006	0.1
63	0.0010	0.2
64	0.0013	0.3
65	0.0016	0.4
66	0.0019	0.4
67	0.0022	0.5
68	0.0026	0.6
69	0.0029	0.7
70	0.0032	0.7

Temp °F	Correction gal	Correction in³
70	0.0032	0.7
71	0.0035	0.8
72	0.0038	0.9
73	0.0042	1.0
74	0.0045	1.0
75	0.0048	1.1
76	0.0051	1.2
77	0.0054	1.3
78	0.0058	1.3
79	0.0061	1.4
80	0.0064	1.5
81	0.0067	1.6
82	0.0070	1.6
83	0.0074	1.7
84	0.0077	1.8
85	0.0080	1.8
86	0.0083	1.9
87	0.0086	2.0
88	0.0090	2.1
89	0.0093	2.1
90	0.0096	2.2
91	0.0099	2.3
92	0.0102	2.4
93	0.0106	2.4
94	0.0109	2.5
95	0.0112	2.6
96	0.0115	2.7
97	0.0118	2.7
98	0.0122	2.8
99	0.0125	2.9
100	0.0128	3.0
101	0.0131	3.0
102	0.0134	3.1
103	0.0138	3.2
104	0.0141	3.3
105	0.0144	3.3
106	0.0147	3.4
107	0.0150	3.5
108	0.0154	3.5
109	0.0157	3.6
110	0.0160	3.7

Table 3 (20 LCS): Volume Corrections for Thermal Expansion or Contraction of a 20-gallon Low Carbon Steel Prover

Coefficient of Expansion = 0.0000186 /°F

Temp °F	Correction gal	Correction in³
-10	-0.0260	-6.0
-9	-0.0257	-5.9
-8	-0.0253	-5.8
-7	-0.0249	-5.8
-6	-0.0246	-5.7
-5	-0.0242	-5.6
-4	-0.0238	-5.5
-3	-0.0234	-5.4
-2	-0.0231	-5.3
-1	-0.0227	-5.2
0	-0.0223	-5.2
1	-0.0219	-5.1
2	-0.0216	-5.0
3	-0.0212	-4.9
4	-0.0208	-4.8
5	-0.0205	-4.7
6	-0.0201	-4.6
7	-0.0197	-4.6
8	-0.0193	-4.5
9	-0.0190	-4.4
10	-0.0186	-4.3
11	-0.0182	-4.2
12	-0.0179	-4.1
13	-0.0175	-4.0
14	-0.0171	-4.0
15	-0.0167	-3.9
16	-0.0164	-3.8
17	-0.0160	-3.7
18	-0.0156	-3.6
19	-0.0153	-3.5
20	-0.0149	-3.4
21	-0.0145	-3.4
22	-0.0141	-3.3
23	-0.0138	-3.2
24	-0.0134	-3.1
25	-0.0130	-3.0
26	-0.0126	-2.9
27	-0.0123	-2.8
28	-0.0119	-2.7
29	-0.0115	-2.7
30	-0.0112	-2.6

Temp °F	Correction gal	Correction in³
30	-0.0112	-2.6
31	-0.0108	-2.5
32	-0.0104	-2.4
33	-0.0100	-2.3
34	-0.0097	-2.2
35	-0.0093	-2.1
36	-0.0089	-2.1
37	-0.0086	-2.0
38	-0.0082	-1.9
39	-0.0078	-1.8
40	-0.0074	-1.7
41	-0.0071	-1.6
42	-0.0067	-1.5
43	-0.0063	-1.5
44	-0.0060	-1.4
45	-0.0056	-1.3
46	-0.0052	-1.2
47	-0.0048	-1.1
48	-0.0045	-1.0
49	-0.0041	-0.9
50	-0.0037	-0.9
51	-0.0033	-0.8
52	-0.0030	-0.7
53	-0.0026	-0.6
54	-0.0022	-0.5
55	-0.0019	-0.4
56	-0.0015	-0.3
57	-0.0011	-0.3
58	-0.0007	-0.2
59	-0.0004	-0.1
60	0.0000	0.0
61	0.0004	0.1
62	0.0007	0.2
63	0.0011	0.3
64	0.0015	0.3
65	0.0019	0.4
66	0.0022	0.5
67	0.0026	0.6
68	0.0030	0.7
69	0.0033	0.8
70	0.0037	0.9

Temp °F	Correction gal	Correction in³
70	0.0037	0.9
71	0.0041	0.9
72	0.0045	1.0
73	0.0048	1.1
74	0.0052	1.2
75	0.0056	1.3
76	0.0060	1.4
77	0.0063	1.5
78	0.0067	1.5
79	0.0071	1.6
80	0.0074	1.7
81	0.0078	1.8
82	0.0082	1.9
83	0.0086	2.0
84	0.0089	2.1
85	0.0093	2.1
86	0.0097	2.2
87	0.0100	2.3
88	0.0104	2.4
89	0.0108	2.5
90	0.0112	2.6
91	0.0115	2.7
92	0.0119	2.7
93	0.0123	2.8
94	0.0126	2.9
95	0.0130	3.0
96	0.0134	3.1
97	0.0138	3.2
98	0.0141	3.3
99	0.0145	3.4
100	0.0149	3.4
101	0.0153	3.5
102	0.0156	3.6
103	0.0160	3.7
104	0.0164	3.8
105	0.0167	3.9
106	0.0171	4.0
107	0.0175	4.0
108	0.0179	4.1
109	0.0182	4.2
110	0.0186	4.3

Table 3 (20 SS): Volume Corrections for Thermal Expansion or Contraction of a 20-gallon Stainless Steel Prover

Coefficient of Expansion = 0.0000265 /°F

Temp °F	Correction gal	Correction in³
-10	-0.0371	-8.6
-9	-0.0366	-8.4
-8	-0.0360	-8.3
-7	-0.0355	-8.2
-6	-0.0350	-8.1
-5	-0.0344	-8.0
-4	-0.0339	-7.8
-3	-0.0334	-7.7
-2	-0.0329	-7.6
-1	-0.0323	-7.5
0	-0.0318	-7.3
1	-0.0313	-7.2
2	-0.0307	-7.1
3	-0.0302	-7.0
4	-0.0297	-6.9
5	-0.0292	-6.7
6	-0.0286	-6.6
7	-0.0281	-6.5
8	-0.0276	-6.4
9	-0.0270	-6.2
10	-0.0265	-6.1
11	-0.0260	-6.0
12	-0.0254	-5.9
13	-0.0249	-5.8
14	-0.0244	-5.6
15	-0.0238	-5.5
16	-0.0233	-5.4
17	-0.0228	-5.3
18	-0.0223	-5.1
19	-0.0217	-5.0
20	-0.0212	-4.9
21	-0.0207	-4.8
22	-0.0201	-4.7
23	-0.0196	-4.5
24	-0.0191	-4.4
25	-0.0185	-4.3
26	-0.0180	-4.2
27	-0.0175	-4.0
28	-0.0170	-3.9
29	-0.0164	-3.8
30	-0.0159	-3.7

Temp °F	Correction gal	Correction in³
30	-0.0159	-3.7
31	-0.0154	-3.6
32	-0.0148	-3.4
33	-0.0143	-3.3
34	-0.0138	-3.2
35	-0.0132	-3.1
36	-0.0127	-2.9
37	-0.0122	-2.8
38	-0.0117	-2.7
39	-0.0111	-2.6
40	-0.0106	-2.4
41	-0.0101	-2.3
42	-0.0095	-2.2
43	-0.0090	-2.1
44	-0.0085	-2.0
45	-0.0080	-1.8
46	-0.0074	-1.7
47	-0.0069	-1.6
48	-0.0064	-1.5
49	-0.0058	-1.3
50	-0.0053	-1.2
51	-0.0048	-1.1
52	-0.0042	-1.0
53	-0.0037	-0.9
54	-0.0032	-0.7
55	-0.0026	-0.6
56	-0.0021	-0.5
57	-0.0016	-0.4
58	-0.0011	-0.2
59	-0.0005	-0.1
60	0.0000	0.0
61	0.0005	0.1
62	0.0011	0.2
63	0.0016	0.4
64	0.0021	0.5
65	0.0027	0.6
66	0.0032	0.7
67	0.0037	0.9
68	0.0042	1.0
69	0.0048	1.1
70	0.0053	1.2

Temp °F	Correction gal	Correction in³
70	0.0053	1.2
71	0.0058	1.3
72	0.0064	1.5
73	0.0069	1.6
74	0.0074	1.7
75	0.0080	1.8
76	0.0085	2.0
77	0.0090	2.1
78	0.0095	2.2
79	0.0101	2.3
80	0.0106	2.4
81	0.0111	2.6
82	0.0117	2.7
83	0.0122	2.8
84	0.0127	2.9
85	0.0132	3.1
86	0.0138	3.2
87	0.0143	3.3
88	0.0148	3.4
89	0.0154	3.6
90	0.0159	3.7
91	0.0164	3.8
92	0.0170	3.9
93	0.0175	4.0
94	0.0180	4.2
95	0.0185	4.3
96	0.0191	4.4
97	0.0196	4.5
98	0.0201	4.7
99	0.0207	4.8
100	0.0212	4.9
101	0.0217	5.0
102	0.0223	5.1
103	0.0228	5.3
104	0.0233	5.4
105	0.0238	5.5
106	0.0244	5.6
107	0.0249	5.8
108	0.0254	5.9
109	0.0260	6.0
110	0.0265	6.1

Table 3 (20 304SS): Volume Corrections for Thermal Expansion or Contraction of a 20-gallon Stainless Steel Prover

Coefficient of Expansion = 0.0000288 /°F

Temp °F	Correction gal	Correction in³
-10	-0.0403	-9.3
-9	-0.0397	-9.2
-8	-0.0392	-9.0
-7	-0.0386	-8.9
-6	-0.0380	-8.8
-5	-0.0374	-8.6
-4	-0.0369	-8.5
-3	-0.0363	-8.4
-2	-0.0357	-8.2
-1	-0.0351	-8.1
0	-0.0346	-8.0
1	-0.0340	-7.9
2	-0.0334	-7.7
3	-0.0328	-7.6
4	-0.0323	-7.5
5	-0.0317	-7.3
6	-0.0311	-7.2
7	-0.0305	-7.1
8	-0.0300	-6.9
9	-0.0294	-6.8
10	-0.0288	-6.7
11	-0.0282	-6.5
12	-0.0276	-6.4
13	-0.0271	-6.3
14	-0.0265	-6.1
15	-0.0259	-6.0
16	-0.0253	-5.9
17	-0.0248	-5.7
18	-0.0242	-5.6
19	-0.0236	-5.5
20	-0.0230	-5.3
21	-0.0225	-5.2
22	-0.0219	-5.1
23	-0.0213	-4.9
24	-0.0207	-4.8
25	-0.0202	-4.7
26	-0.0196	-4.5
27	-0.0190	-4.4
28	-0.0184	-4.3
29	-0.0179	-4.1
30	-0.0173	-4.0

Temp °F	Correction gal	Correction in³
30	-0.0173	-4.0
31	-0.0167	-3.9
32	-0.0161	-3.7
33	-0.0156	-3.6
34	-0.0150	-3.5
35	-0.0144	-3.3
36	-0.0138	-3.2
37	-0.0132	-3.1
38	-0.0127	-2.9
39	-0.0121	-2.8
40	-0.0115	-2.7
41	-0.0109	-2.5
42	-0.0104	-2.4
43	-0.0098	-2.3
44	-0.0092	-2.1
45	-0.0086	-2.0
46	-0.0081	-1.9
47	-0.0075	-1.7
48	-0.0069	-1.6
49	-0.0063	-1.5
50	-0.0058	-1.3
51	-0.0052	-1.2
52	-0.0046	-1.1
53	-0.0040	-0.9
54	-0.0035	-0.8
55	-0.0029	-0.7
56	-0.0023	-0.5
57	-0.0017	-0.4
58	-0.0012	-0.3
59	-0.0006	-0.1
60	0.0000	0.0
61	0.0006	0.1
62	0.0012	0.3
63	0.0017	0.4
64	0.0023	0.5
65	0.0029	0.7
66	0.0035	0.8
67	0.0040	0.9
68	0.0046	1.1
69	0.0052	1.2
70	0.0058	1.3

Temp °F	Correction gal	Correction in³
70	0.0058	1.3
71	0.0063	1.5
72	0.0069	1.6
73	0.0075	1.7
74	0.0081	1.9
75	0.0086	2.0
76	0.0092	2.1
77	0.0098	2.3
78	0.0104	2.4
79	0.0109	2.5
80	0.0115	2.7
81	0.0121	2.8
82	0.0127	2.9
83	0.0132	3.1
84	0.0138	3.2
85	0.0144	3.3
86	0.0150	3.5
87	0.0156	3.6
88	0.0161	3.7
89	0.0167	3.9
90	0.0173	4.0
91	0.0179	4.1
92	0.0184	4.3
93	0.0190	4.4
94	0.0196	4.5
95	0.0202	4.7
96	0.0207	4.8
97	0.0213	4.9
98	0.0219	5.1
99	0.0225	5.2
100	0.0230	5.3
101	0.0236	5.5
102	0.0242	5.6
103	0.0248	5.7
104	0.0253	5.9
105	0.0259	6.0
106	0.0265	6.1
107	0.0271	6.3
108	0.0276	6.4
109	0.0282	6.5
110	0.0288	6.7

Table 3 (25 PVS): Volume Corrections for Thermal Expansion or Contraction of a 25-gallon Pressure Vessel Steel Prover

Coefficient of Expansion = 0.0000160 /°F

Temp °F	Correction gal	Correction in³
-10	-0.0280	-6.5
-9	-0.0276	-6.4
-8	-0.0272	-6.3
-7	-0.0268	-6.2
-6	-0.0264	-6.1
-5	-0.0260	-6.0
-4	-0.0256	-5.9
-3	-0.0252	-5.8
-2	-0.0248	-5.7
-1	-0.0244	-5.6
0	-0.0240	-5.5
1	-0.0236	-5.5
2	-0.0232	-5.4
3	-0.0228	-5.3
4	-0.0224	-5.2
5	-0.0220	-5.1
6	-0.0216	-5.0
7	-0.0212	-4.9
8	-0.0208	-4.8
9	-0.0204	-4.7
10	-0.0200	-4.6
11	-0.0196	-4.5
12	-0.0192	-4.4
13	-0.0188	-4.3
14	-0.0184	-4.3
15	-0.0180	-4.2
16	-0.0176	-4.1
17	-0.0172	-4.0
18	-0.0168	-3.9
19	-0.0164	-3.8
20	-0.0160	-3.7
21	-0.0156	-3.6
22	-0.0152	-3.5
23	-0.0148	-3.4
24	-0.0144	-3.3
25	-0.0140	-3.2
26	-0.0136	-3.1
27	-0.0132	-3.0
28	-0.0128	-3.0
29	-0.0124	-2.9
30	-0.0120	-2.8

Temp °F	Correction gal	Correction in³
30	-0.0120	-2.8
31	-0.0116	-2.7
32	-0.0112	-2.6
33	-0.0108	-2.5
34	-0.0104	-2.4
35	-0.0100	-2.3
36	-0.0096	-2.2
37	-0.0092	-2.1
38	-0.0088	-2.0
39	-0.0084	-1.9
40	-0.0080	-1.8
41	-0.0076	-1.8
42	-0.0072	-1.7
43	-0.0068	-1.6
44	-0.0064	-1.5
45	-0.0060	-1.4
46	-0.0056	-1.3
47	-0.0052	-1.2
48	-0.0048	-1.1
49	-0.0044	-1.0
50	-0.0040	-0.9
51	-0.0036	-0.8
52	-0.0032	-0.7
53	-0.0028	-0.6
54	-0.0024	-0.6
55	-0.0020	-0.5
56	-0.0016	-0.4
57	-0.0012	-0.3
58	-0.0008	-0.2
59	-0.0004	-0.1
60	0.0000	0.0
61	0.0004	0.1
62	0.0008	0.2
63	0.0012	0.3
64	0.0016	0.4
65	0.0020	0.5
66	0.0024	0.6
67	0.0028	0.6
68	0.0032	0.7
69	0.0036	0.8
70	0.0040	0.9

Temp °F	Correction gal	Correction in³
70	0.0040	0.9
71	0.0044	1.0
72	0.0048	1.1
73	0.0052	1.2
74	0.0056	1.3
75	0.0060	1.4
76	0.0064	1.5
77	0.0068	1.6
78	0.0072	1.7
79	0.0076	1.8
80	0.0080	1.8
81	0.0084	1.9
82	0.0088	2.0
83	0.0092	2.1
84	0.0096	2.2
85	0.0100	2.3
86	0.0104	2.4
87	0.0108	2.5
88	0.0112	2.6
89	0.0116	2.7
90	0.0120	2.8
91	0.0124	2.9
92	0.0128	3.0
93	0.0132	3.0
94	0.0136	3.1
95	0.0140	3.2
96	0.0144	3.3
97	0.0148	3.4
98	0.0152	3.5
99	0.0156	3.6
100	0.0160	3.7
101	0.0164	3.8
102	0.0168	3.9
103	0.0172	4.0
104	0.0176	4.1
105	0.0180	4.2
106	0.0184	4.3
107	0.0188	4.3
108	0.0192	4.4
109	0.0196	4.5
110	0.0200	4.6

Table 3 (25 LCS): Volume Corrections for Thermal Expansion or Contraction of a 25-gallon Low Carbon Steel Prover

Coefficient of Expansion = 0.0000186 /°F

Temp °F	Correction gal	Correction in³
-10	-0.0326	-7.5
-9	-0.0321	-7.4
-8	-0.0316	-7.3
-7	-0.0312	-7.2
-6	-0.0307	-7.1
-5	-0.0302	-7.0
-4	-0.0298	-6.9
-3	-0.0293	-6.8
-2	-0.0288	-6.7
-1	-0.0284	-6.6
0	-0.0279	-6.4
1	-0.0274	-6.3
2	-0.0270	-6.2
3	-0.0265	-6.1
4	-0.0260	-6.0
5	-0.0256	-5.9
6	-0.0251	-5.8
7	-0.0246	-5.7
8	-0.0242	-5.6
9	-0.0237	-5.5
10	-0.0233	-5.4
11	-0.0228	-5.3
12	-0.0223	-5.2
13	-0.0219	-5.0
14	-0.0214	-4.9
15	-0.0209	-4.8
16	-0.0205	-4.7
17	-0.0200	-4.6
18	-0.0195	-4.5
19	-0.0191	-4.4
20	-0.0186	-4.3
21	-0.0181	-4.2
22	-0.0177	-4.1
23	-0.0172	-4.0
24	-0.0167	-3.9
25	-0.0163	-3.8
26	-0.0158	-3.7
27	-0.0153	-3.5
28	-0.0149	-3.4
29	-0.0144	-3.3
30	-0.0139	-3.2

Temp °F	Correction gal	Correction in³
30	-0.0139	-3.2
31	-0.0135	-3.1
32	-0.0130	-3.0
33	-0.0126	-2.9
34	-0.0121	-2.8
35	-0.0116	-2.7
36	-0.0112	-2.6
37	-0.0107	-2.5
38	-0.0102	-2.4
39	-0.0098	-2.3
40	-0.0093	-2.1
41	-0.0088	-2.0
42	-0.0084	-1.9
43	-0.0079	-1.8
44	-0.0074	-1.7
45	-0.0070	-1.6
46	-0.0065	-1.5
47	-0.0060	-1.4
48	-0.0056	-1.3
49	-0.0051	-1.2
50	-0.0047	-1.1
51	-0.0042	-1.0
52	-0.0037	-0.9
53	-0.0033	-0.8
54	-0.0028	-0.6
55	-0.0023	-0.5
56	-0.0019	-0.4
57	-0.0014	-0.3
58	-0.0009	-0.2
59	-0.0005	-0.1
60	0.0000	0.0
61	0.0005	0.1
62	0.0009	0.2
63	0.0014	0.3
64	0.0019	0.4
65	0.0023	0.5
66	0.0028	0.6
67	0.0033	0.8
68	0.0037	0.9
69	0.0042	1.0
70	0.0047	1.1

Temp °F	Correction gal	Correction in³
70	0.0047	1.1
71	0.0051	1.2
72	0.0056	1.3
73	0.0060	1.4
74	0.0065	1.5
75	0.0070	1.6
76	0.0074	1.7
77	0.0079	1.8
78	0.0084	1.9
79	0.0088	2.0
80	0.0093	2.1
81	0.0098	2.3
82	0.0102	2.4
83	0.0107	2.5
84	0.0112	2.6
85	0.0116	2.7
86	0.0121	2.8
87	0.0126	2.9
88	0.0130	3.0
89	0.0135	3.1
90	0.0140	3.2
91	0.0144	3.3
92	0.0149	3.4
93	0.0153	3.5
94	0.0158	3.7
95	0.0163	3.8
96	0.0167	3.9
97	0.0172	4.0
98	0.0177	4.1
99	0.0181	4.2
100	0.0186	4.3
101	0.0191	4.4
102	0.0195	4.5
103	0.0200	4.6
104	0.0205	4.7
105	0.0209	4.8
106	0.0214	4.9
107	0.0219	5.0
108	0.0223	5.2
109	0.0228	5.3
110	0.0233	5.4

Table 3 (25 SS): Volume Corrections for Thermal Expansion or Contraction of a 25-gallon Stainless Steel Prover

Coefficient of Expansion = 0.0000265 /°F

Temp °F	Correction gal	Correction in³
-10	-0.0464	-10.7
-9	-0.0457	-10.6
-8	-0.0450	-10.4
-7	-0.0444	-10.3
-6	-0.0437	-10.1
-5	-0.0431	-9.9
-4	-0.0424	-9.8
-3	-0.0417	-9.6
-2	-0.0411	-9.5
-1	-0.0404	-9.3
0	-0.0397	-9.2
1	-0.0391	-9.0
2	-0.0384	-8.9
3	-0.0378	-8.7
4	-0.0371	-8.6
5	-0.0364	-8.4
6	-0.0358	-8.3
7	-0.0351	-8.1
8	-0.0344	-8.0
9	-0.0338	-7.8
10	-0.0331	-7.7
11	-0.0325	-7.5
12	-0.0318	-7.3
13	-0.0311	-7.2
14	-0.0305	-7.0
15	-0.0298	-6.9
16	-0.0292	-6.7
17	-0.0285	-6.6
18	-0.0278	-6.4
19	-0.0272	-6.3
20	-0.0265	-6.1
21	-0.0258	-6.0
22	-0.0252	-5.8
23	-0.0245	-5.7
24	-0.0238	-5.5
25	-0.0232	-5.4
26	-0.0225	-5.2
27	-0.0219	-5.1
28	-0.0212	-4.9
29	-0.0205	-4.7
30	-0.0199	-4.6

Temp °F	Correction gal	Correction in³
30	-0.0199	-4.6
31	-0.0192	-4.4
32	-0.0186	-4.3
33	-0.0179	-4.1
34	-0.0172	-4.0
35	-0.0166	-3.8
36	-0.0159	-3.7
37	-0.0152	-3.5
38	-0.0146	-3.4
39	-0.0139	-3.2
40	-0.0132	-3.1
41	-0.0126	-2.9
42	-0.0119	-2.8
43	-0.0113	-2.6
44	-0.0106	-2.4
45	-0.0099	-2.3
46	-0.0093	-2.1
47	-0.0086	-2.0
48	-0.0080	-1.8
49	-0.0073	-1.7
50	-0.0066	-1.5
51	-0.0060	-1.4
52	-0.0053	-1.2
53	-0.0046	-1.1
54	-0.0040	-0.9
55	-0.0033	-0.8
56	-0.0027	-0.6
57	-0.0020	-0.5
58	-0.0013	-0.3
59	-0.0007	-0.2
60	0.0000	0.0
61	0.0007	0.2
62	0.0013	0.3
63	0.0020	0.5
64	0.0026	0.6
65	0.0033	0.8
66	0.0040	0.9
67	0.0046	1.1
68	0.0053	1.2
69	0.0060	1.4
70	0.0066	1.5

Temp °F	Correction gal	Correction in³
70	0.0066	1.5
71	0.0073	1.7
72	0.0080	1.8
73	0.0086	2.0
74	0.0093	2.1
75	0.0099	2.3
76	0.0106	2.4
77	0.0113	2.6
78	0.0119	2.8
79	0.0126	2.9
80	0.0132	3.1
81	0.0139	3.2
82	0.0146	3.4
83	0.0152	3.5
84	0.0159	3.7
85	0.0166	3.8
86	0.0172	4.0
87	0.0179	4.1
88	0.0186	4.3
89	0.0192	4.4
90	0.0199	4.6
91	0.0205	4.7
92	0.0212	4.9
93	0.0219	5.1
94	0.0225	5.2
95	0.0232	5.4
96	0.0238	5.5
97	0.0245	5.7
98	0.0252	5.8
99	0.0258	6.0
100	0.0265	6.1
101	0.0272	6.3
102	0.0278	6.4
103	0.0285	6.6
104	0.0292	6.7
105	0.0298	6.9
106	0.0305	7.0
107	0.0311	7.2
108	0.0318	7.3
109	0.0325	7.5
110	0.0331	7.7

Table 3 (25 304SS): Volume Corrections for Thermal Expansion or Contraction of a 25-gallon Stainless Steel Prover

Coefficient of Expansion = 0.0000288 /°F

Temp °F	Correction gal	Correction in³
-10	-0.0504	-11.6
-9	-0.0497	-11.5
-8	-0.0490	-11.3
-7	-0.0482	-11.1
-6	-0.0475	-11.0
-5	-0.0468	-10.8
-4	-0.0461	-10.6
-3	-0.0454	-10.5
-2	-0.0446	-10.3
-1	-0.0439	-10.1
0	-0.0432	-10.0
1	-0.0425	-9.8
2	-0.0418	-9.6
3	-0.0410	-9.5
4	-0.0403	-9.3
5	-0.0396	-9.1
6	-0.0389	-9.0
7	-0.0382	-8.8
8	-0.0374	-8.6
9	-0.0367	-8.5
10	-0.0360	-8.3
11	-0.0353	-8.1
12	-0.0346	-8.0
13	-0.0338	-7.8
14	-0.0331	-7.7
15	-0.0324	-7.5
16	-0.0317	-7.3
17	-0.0310	-7.2
18	-0.0302	-7.0
19	-0.0295	-6.8
20	-0.0288	-6.7
21	-0.0281	-6.5
22	-0.0274	-6.3
23	-0.0266	-6.2
24	-0.0259	-6.0
25	-0.0252	-5.8
26	-0.0245	-5.7
27	-0.0238	-5.5
28	-0.0230	-5.3
29	-0.0223	-5.2
30	-0.0216	-5.0

Temp °F	Correction gal	Correction in³
30	-0.0216	-5.0
31	-0.0209	-4.8
32	-0.0202	-4.7
33	-0.0194	-4.5
34	-0.0187	-4.3
35	-0.0180	-4.2
36	-0.0173	-4.0
37	-0.0166	-3.8
38	-0.0158	-3.7
39	-0.0151	-3.5
40	-0.0144	-3.3
41	-0.0137	-3.2
42	-0.0130	-3.0
43	-0.0122	-2.8
44	-0.0115	-2.7
45	-0.0108	-2.5
46	-0.0101	-2.3
47	-0.0094	-2.2
48	-0.0086	-2.0
49	-0.0079	-1.8
50	-0.0072	-1.7
51	-0.0065	-1.5
52	-0.0058	-1.3
53	-0.0050	-1.2
54	-0.0043	-1.0
55	-0.0036	-0.8
56	-0.0029	-0.7
57	-0.0022	-0.5
58	-0.0014	-0.3
59	-0.0007	-0.2
60	0.0000	0.0
61	0.0007	0.2
62	0.0014	0.3
63	0.0022	0.5
64	0.0029	0.7
65	0.0036	0.8
66	0.0043	1.0
67	0.0050	1.2
68	0.0058	1.3
69	0.0065	1.5
70	0.0072	1.7

Temp °F	Correction gal	Correction in³
70	0.0072	1.7
71	0.0079	1.8
72	0.0086	2.0
73	0.0094	2.2
74	0.0101	2.3
75	0.0108	2.5
76	0.0115	2.7
77	0.0122	2.8
78	0.0130	3.0
79	0.0137	3.2
80	0.0144	3.3
81	0.0151	3.5
82	0.0158	3.7
83	0.0166	3.8
84	0.0173	4.0
85	0.0180	4.2
86	0.0187	4.3
87	0.0194	4.5
88	0.0202	4.7
89	0.0209	4.8
90	0.0216	5.0
91	0.0223	5.2
92	0.0230	5.3
93	0.0238	5.5
94	0.0245	5.7
95	0.0252	5.8
96	0.0259	6.0
97	0.0266	6.2
98	0.0274	6.3
99	0.0281	6.5
100	0.0288	6.7
101	0.0295	6.8
102	0.0302	7.0
103	0.0310	7.2
104	0.0317	7.3
105	0.0324	7.5
106	0.0331	7.7
107	0.0338	7.8
108	0.0346	8.0
109	0.0353	8.1
110	0.0360	8.3

Table 3 (200 PVS): Volume Corrections for Thermal Expansion or Contraction of a 200-gallon Pressure Vessel Steel Prover

Coefficient of Expansion = 0.0000160 /°F

Temp °F	Correction gal	Correction in³
-10	-0.224	-51.7
-9	-0.221	-51.0
-8	-0.218	-50.3
-7	-0.214	-49.5
-6	-0.211	-48.8
-5	-0.208	-48.0
-4	-0.205	-47.3
-3	-0.202	-46.6
-2	-0.198	-45.8
-1	-0.195	-45.1
0	-0.192	-44.4
1	-0.189	-43.6
2	-0.186	-42.9
3	-0.182	-42.1
4	-0.179	-41.4
5	-0.176	-40.7
6	-0.173	-39.9
7	-0.170	-39.2
8	-0.166	-38.4
9	-0.163	-37.7
10	-0.160	-37.0
11	-0.157	-36.2
12	-0.154	-35.5
13	-0.150	-34.7
14	-0.147	-34.0
15	-0.144	-33.3
16	-0.141	-32.5
17	-0.138	-31.8
18	-0.134	-31.0
19	-0.131	-30.3
20	-0.128	-29.6
21	-0.125	-28.8
22	-0.122	-28.1
23	-0.118	-27.4
24	-0.115	-26.6
25	-0.112	-25.9
26	-0.109	-25.1
27	-0.106	-24.4
28	-0.102	-23.7
29	-0.099	-22.9
30	-0.096	-22.2

Temp °F	Correction gal	Correction in³
30	-0.096	-22.2
31	-0.093	-21.4
32	-0.090	-20.7
33	-0.086	-20.0
34	-0.083	-19.2
35	-0.080	-18.5
36	-0.077	-17.7
37	-0.074	-17.0
38	-0.070	-16.3
39	-0.067	-15.5
40	-0.064	-14.8
41	-0.061	-14.0
42	-0.058	-13.3
43	-0.054	-12.6
44	-0.051	-11.8
45	-0.048	-11.1
46	-0.045	-10.3
47	-0.042	-9.6
48	-0.038	-8.9
49	-0.035	-8.1
50	-0.032	-7.4
51	-0.029	-6.7
52	-0.026	-5.9
53	-0.022	-5.2
54	-0.019	-4.4
55	-0.016	-3.7
56	-0.013	-3.0
57	-0.010	-2.2
58	-0.006	-1.5
59	-0.003	-0.7
60	0.000	0.0
61	0.003	0.7
62	0.006	1.5
63	0.010	2.2
64	0.013	3.0
65	0.016	3.7
66	0.019	4.4
67	0.022	5.2
68	0.026	5.9
69	0.029	6.7
70	0.032	7.4

Temp °F	Correction gal	Correction in³
70	0.032	7.4
71	0.035	8.1
72	0.038	8.9
73	0.042	9.6
74	0.045	10.3
75	0.048	11.1
76	0.051	11.8
77	0.054	12.6
78	0.058	13.3
79	0.061	14.0
80	0.064	14.8
81	0.067	15.5
82	0.070	16.3
83	0.074	17.0
84	0.077	17.7
85	0.080	18.5
86	0.083	19.2
87	0.086	20.0
88	0.090	20.7
89	0.093	21.4
90	0.096	22.2
91	0.099	22.9
92	0.102	23.7
93	0.106	24.4
94	0.109	25.1
95	0.112	25.9
96	0.115	26.6
97	0.118	27.4
98	0.122	28.1
99	0.125	28.8
100	0.128	29.6
101	0.131	30.3
102	0.134	31.0
103	0.138	31.8
104	0.141	32.5
105	0.144	33.3
106	0.147	34.0
107	0.150	34.7
108	0.154	35.5
109	0.157	36.2
110	0.160	37.0

Table 3 (200 LCS): Volume Corrections for Thermal Expansion or Contraction of a 200-gallon Low Carbon Steel Prover

Coefficient of Expansion = 0.0000186 /°F

Temp °F	Correction gal	Correction in³
-10	-0.260	-60.2
-9	-0.257	-59.3
-8	-0.253	-58.4
-7	-0.249	-57.6
-6	-0.246	-56.7
-5	-0.242	-55.9
-4	-0.238	-55.0
-3	-0.234	-54.1
-2	-0.231	-53.3
-1	-0.227	-52.4
0	-0.223	-51.6
1	-0.219	-50.7
2	-0.216	-49.8
3	-0.212	-49.0
4	-0.208	-48.1
5	-0.205	-47.3
6	-0.201	-46.4
7	-0.197	-45.5
8	-0.193	-44.7
9	-0.190	-43.8
10	-0.186	-43.0
11	-0.182	-42.1
12	-0.179	-41.2
13	-0.175	-40.4
14	-0.171	-39.5
15	-0.167	-38.7
16	-0.164	-37.8
17	-0.160	-37.0
18	-0.156	-36.1
19	-0.153	-35.2
20	-0.149	-34.4
21	-0.145	-33.5
22	-0.141	-32.7
23	-0.138	-31.8
24	-0.134	-30.9
25	-0.130	-30.1
26	-0.126	-29.2
27	-0.123	-28.4
28	-0.119	-27.5
29	-0.115	-26.6
30	-0.112	-25.8

Temp °F	Correction gal	Correction in³
30	-0.112	-25.8
31	-0.108	-24.9
32	-0.104	-24.1
33	-0.100	-23.2
34	-0.097	-22.3
35	-0.093	-21.5
36	-0.089	-20.6
37	-0.086	-19.8
38	-0.082	-18.9
39	-0.078	-18.0
40	-0.074	-17.2
41	-0.071	-16.3
42	-0.067	-15.5
43	-0.063	-14.6
44	-0.060	-13.7
45	-0.056	-12.9
46	-0.052	-12.0
47	-0.048	-11.2
48	-0.045	-10.3
49	-0.041	-9.5
50	-0.037	-8.6
51	-0.033	-7.7
52	-0.030	-6.9
53	-0.026	-6.0
54	-0.022	-5.2
55	-0.019	-4.3
56	-0.015	-3.4
57	-0.011	-2.6
58	-0.007	-1.7
59	-0.004	-0.9
60	0.000	0.0
61	0.004	0.9
62	0.007	1.7
63	0.011	2.6
64	0.015	3.4
65	0.019	4.3
66	0.022	5.2
67	0.026	6.0
68	0.030	6.9
69	0.033	7.7
70	0.037	8.6

Temp °F	Correction gal	Correction in³
70	0.037	8.6
71	0.041	9.5
72	0.045	10.3
73	0.048	11.2
74	0.052	12.0
75	0.056	12.9
76	0.060	13.7
77	0.063	14.6
78	0.067	15.5
79	0.071	16.3
80	0.074	17.2
81	0.078	18.0
82	0.082	18.9
83	0.086	19.8
84	0.089	20.6
85	0.093	21.5
86	0.097	22.3
87	0.100	23.2
88	0.104	24.1
89	0.108	24.9
90	0.112	25.8
91	0.115	26.6
92	0.119	27.5
93	0.123	28.4
94	0.126	29.2
95	0.130	30.1
96	0.134	30.9
97	0.138	31.8
98	0.141	32.7
99	0.145	33.5
100	0.149	34.4
101	0.153	35.2
102	0.156	36.1
103	0.160	37.0
104	0.164	37.8
105	0.167	38.7
106	0.171	39.5
107	0.175	40.4
108	0.179	41.2
109	0.182	42.1
110	0.186	43.0

Table 3 (200 SS): Volume Corrections for Thermal Expansion or Contraction of a 200-gallon Stainless Steel Prover

Coefficient of Expansion = 0.0000265 /°F

Temp °F	Correction gal	Correction in³
-10	-0.371	-85.7
-9	-0.366	-84.5
-8	-0.360	-83.3
-7	-0.355	-82.0
-6	-0.350	-80.8
-5	-0.344	-79.6
-4	-0.339	-78.4
-3	-0.334	-77.1
-2	-0.329	-75.9
-1	-0.323	-74.7
0	-0.318	-73.5
1	-0.313	-72.2
2	-0.307	-71.0
3	-0.302	-69.8
4	-0.297	-68.6
5	-0.292	-67.3
6	-0.286	-66.1
7	-0.281	-64.9
8	-0.276	-63.7
9	-0.270	-62.4
10	-0.265	-61.2
11	-0.260	-60.0
12	-0.254	-58.8
13	-0.249	-57.5
14	-0.244	-56.3
15	-0.239	-55.1
16	-0.233	-53.9
17	-0.228	-52.6
18	-0.223	-51.4
19	-0.217	-50.2
20	-0.212	-49.0
21	-0.207	-47.7
22	-0.201	-46.5
23	-0.196	-45.3
24	-0.191	-44.1
25	-0.185	-42.9
26	-0.180	-41.6
27	-0.175	-40.4
28	-0.170	-39.2
29	-0.164	-38.0
30	-0.159	-36.7

Temp °F	Correction gal	Correction in³
30	-0.159	-36.7
31	-0.154	-35.5
32	-0.148	-34.3
33	-0.143	-33.1
34	-0.138	-31.8
35	-0.132	-30.6
36	-0.127	-29.4
37	-0.122	-28.2
38	-0.117	-26.9
39	-0.111	-25.7
40	-0.106	-24.5
41	-0.101	-23.3
42	-0.095	-22.0
43	-0.090	-20.8
44	-0.085	-19.6
45	-0.079	-18.4
46	-0.074	-17.1
47	-0.069	-15.9
48	-0.064	-14.7
49	-0.058	-13.5
50	-0.053	-12.2
51	-0.048	-11.0
52	-0.042	-9.8
53	-0.037	-8.6
54	-0.032	-7.3
55	-0.026	-6.1
56	-0.021	-4.9
57	-0.016	-3.7
58	-0.011	-2.4
59	-0.005	-1.2
60	0.000	0.0
61	0.005	1.2
62	0.011	2.4
63	0.016	3.7
64	0.021	4.9
65	0.027	6.1
66	0.032	7.3
67	0.037	8.6
68	0.042	9.8
69	0.048	11.0
70	0.053	12.2

Temp °F	Correction gal	Correction in³
70	0.053	12.2
71	0.058	13.5
72	0.064	14.7
73	0.069	15.9
74	0.074	17.1
75	0.079	18.4
76	0.085	19.6
77	0.090	20.8
78	0.095	22.0
79	0.101	23.3
80	0.106	24.5
81	0.111	25.7
82	0.117	26.9
83	0.122	28.2
84	0.127	29.4
85	0.132	30.6
86	0.138	31.8
87	0.143	33.1
88	0.148	34.3
89	0.154	35.5
90	0.159	36.7
91	0.164	38.0
92	0.170	39.2
93	0.175	40.4
94	0.180	41.6
95	0.185	42.9
96	0.191	44.1
97	0.196	45.3
98	0.201	46.5
99	0.207	47.7
100	0.212	49.0
101	0.217	50.2
102	0.223	51.4
103	0.228	52.6
104	0.233	53.9
105	0.238	55.1
106	0.244	56.3
107	0.249	57.5
108	0.254	58.8
109	0.260	60.0
110	0.265	61.2

Table 3 (200 304SS): Volume Corrections for Thermal Expansion or Contraction of a 200-gallon Stainless Steel Prover

Coefficient of Expansion = 0.0000288 /°F

Temp °F	Correction gal	Correction in³
-10	-0.403	-93.1
-9	-0.397	-91.8
-8	-0.392	-90.5
-7	-0.386	-89.1
-6	-0.380	-87.8
-5	-0.374	-86.5
-4	-0.369	-85.2
-3	-0.363	-83.8
-2	-0.357	-82.5
-1	-0.351	-81.2
0	-0.346	-79.8
1	-0.340	-78.5
2	-0.334	-77.2
3	-0.328	-75.8
4	-0.323	-74.5
5	-0.317	-73.2
6	-0.311	-71.9
7	-0.305	-70.5
8	-0.300	-69.2
9	-0.294	-67.9
10	-0.288	-66.5
11	-0.282	-65.2
12	-0.276	-63.9
13	-0.271	-62.5
14	-0.265	-61.2
15	-0.259	-59.9
16	-0.253	-58.5
17	-0.248	-57.2
18	-0.242	-55.9
19	-0.236	-54.6
20	-0.230	-53.2
21	-0.225	-51.9
22	-0.219	-50.6
23	-0.213	-49.2
24	-0.207	-47.9
25	-0.202	-46.6
26	-0.196	-45.2
27	-0.190	-43.9
28	-0.184	-42.6
29	-0.179	-41.2
30	-0.173	-39.9

Temp °F	Correction gal	Correction in³
30	-0.173	-39.9
31	-0.167	-38.6
32	-0.161	-37.3
33	-0.156	-35.9
34	-0.150	-34.6
35	-0.144	-33.3
36	-0.138	-31.9
37	-0.132	-30.6
38	-0.127	-29.3
39	-0.121	-27.9
40	-0.115	-26.6
41	-0.109	-25.3
42	-0.104	-24.0
43	-0.098	-22.6
44	-0.092	-21.3
45	-0.086	-20.0
46	-0.081	-18.6
47	-0.075	-17.3
48	-0.069	-16.0
49	-0.063	-14.6
50	-0.058	-13.3
51	-0.052	-12.0
52	-0.046	-10.6
53	-0.040	-9.3
54	-0.035	-8.0
55	-0.029	-6.7
56	-0.023	-5.3
57	-0.017	-4.0
58	-0.012	-2.7
59	-0.006	-1.3
60	0.000	0.0
61	0.006	1.3
62	0.012	2.7
63	0.017	4.0
64	0.023	5.3
65	0.029	6.7
66	0.035	8.0
67	0.040	9.3
68	0.046	10.6
69	0.052	12.0
70	0.058	13.3

Temp °F	Correction gal	Correction in³
70	0.058	13.3
71	0.063	14.6
72	0.069	16.0
73	0.075	17.3
74	0.081	18.6
75	0.086	20.0
76	0.092	21.3
77	0.098	22.6
78	0.104	24.0
79	0.109	25.3
80	0.115	26.6
81	0.121	27.9
82	0.127	29.3
83	0.132	30.6
84	0.138	31.9
85	0.144	33.3
86	0.150	34.6
87	0.156	35.9
88	0.161	37.3
89	0.167	38.6
90	0.173	39.9
91	0.179	41.2
92	0.184	42.6
93	0.190	43.9
94	0.196	45.2
95	0.202	46.6
96	0.207	47.9
97	0.213	49.2
98	0.219	50.6
99	0.225	51.9
100	0.230	53.2
101	0.236	54.6
102	0.242	55.9
103	0.248	57.2
104	0.253	58.5
105	0.259	59.9
106	0.265	61.2
107	0.271	62.5
108	0.276	63.9
109	0.282	65.2
110	0.288	66.5

Table 3A. Volume Correction Factors for Thermal Expansion or Contraction of a Pressure Vessel Steel Prover

Multiply Prover Volume by the Factor
Coefficient of Expansion = 0.0000160 /°F

Temp °F	Factor
-10	0.99888
-9	0.99890
-8	0.99891
-7	0.99893
-6	0.99894
-5	0.99896
-4	0.99898
-3	0.99899
-2	0.99901
-1	0.99902
0	0.99904
1	0.99906
2	0.99907
3	0.99909
4	0.99910
5	0.99912
6	0.99914
7	0.99915
8	0.99917
9	0.99918
10	0.99920
11	0.99922
12	0.99923
13	0.99925
14	0.99926
15	0.99928
16	0.99930
17	0.99931
18	0.99933
19	0.99934
20	0.99936
21	0.99938
22	0.99939
23	0.99941
24	0.99942
25	0.99944
26	0.99946
27	0.99947
28	0.99949
29	0.99950
30	0.99952

Temp °F	Factor
30	0.99952
31	0.99954
32	0.99955
33	0.99957
34	0.99958
35	0.99960
36	0.99962
37	0.99963
38	0.99965
39	0.99966
40	0.99968
41	0.99970
42	0.99971
43	0.99973
44	0.99974
45	0.99976
46	0.99978
47	0.99979
48	0.99981
49	0.99982
50	0.99984
51	0.99986
52	0.99987
53	0.99989
54	0.99990
55	0.99992
56	0.99994
57	0.99995
58	0.99997
59	0.99998
60	1.00000
61	1.00002
62	1.00003
63	1.00005
64	1.00006
65	1.00008
66	1.00010
67	1.00011
68	1.00013
69	1.00014
70	1.00016

Temp °F	Factor
70	1.00016
71	1.00018
72	1.00019
73	1.00021
74	1.00022
75	1.00024
76	1.00026
77	1.00027
78	1.00029
79	1.00030
80	1.00032
81	1.00034
82	1.00035
83	1.00037
84	1.00038
85	1.00040
86	1.00042
87	1.00043
88	1.00045
89	1.00046
90	1.00048
91	1.00050
92	1.00051
93	1.00053
94	1.00054
95	1.00056
96	1.00058
97	1.00059
98	1.00061
99	1.00062
100	1.00064
101	1.00066
102	1.00067
103	1.00069
104	1.00070
105	1.00072
106	1.00074
107	1.00075
108	1.00077
109	1.00078
110	1.00080

Table 3A. Volume Correction Factors for Thermal Expansion or Contraction of a Low-Carbon Steel Prover

Multiply Prover Volume by the Factor
Coefficient of Expansion = 0.0000186 /°F

Temp °F	Factor
-10	0.99870
-9	0.99872
-8	0.99874
-7	0.99875
-6	0.99877
-5	0.99879
-4	0.99881
-3	0.99883
-2	0.99885
-1	0.99887
0	0.99888
1	0.99890
2	0.99892
3	0.99894
4	0.99896
5	0.99898
6	0.99900
7	0.99901
8	0.99903
9	0.99905
10	0.99907
11	0.99909
12	0.99911
13	0.99913
14	0.99914
15	0.99916
16	0.99918
17	0.99920
18	0.99922
19	0.99924
20	0.99926
21	0.99927
22	0.99929
23	0.99931
24	0.99933
25	0.99935
26	0.99937
27	0.99939
28	0.99940
29	0.99942
30	0.99944

Temp °F	Factor
30	0.99944
31	0.99946
32	0.99948
33	0.99950
34	0.99952
35	0.99954
36	0.99955
37	0.99957
38	0.99959
39	0.99961
40	0.99963
41	0.99965
42	0.99967
43	0.99968
44	0.99970
45	0.99972
46	0.99974
47	0.99976
48	0.99978
49	0.99980
50	0.99981
51	0.99983
52	0.99985
53	0.99987
54	0.99989
55	0.99991
56	0.99993
57	0.99994
58	0.99996
59	0.99998
60	1.00000
61	1.00002
62	1.00004
63	1.00006
64	1.00007
65	1.00009
66	1.00011
67	1.00013
68	1.00015
69	1.00017
70	1.00019

Temp °F	Factor
70	1.00019
71	1.00020
72	1.00022
73	1.00024
74	1.00026
75	1.00028
76	1.00030
77	1.00032
78	1.00033
79	1.00035
80	1.00037
81	1.00039
82	1.00041
83	1.00043
84	1.00045
85	1.00047
86	1.00048
87	1.00050
88	1.00052
89	1.00054
90	1.00056
91	1.00058
92	1.00060
93	1.00061
94	1.00063
95	1.00065
96	1.00067
97	1.00069
98	1.00071
99	1.00073
100	1.00074
101	1.00076
102	1.00078
103	1.00080
104	1.00082
105	1.00084
106	1.00086
107	1.00087
108	1.00089
109	1.00091
110	1.00093

Table 3A. Volume Correction Factors for Thermal Expansion or Contraction of a Stainless Steel Prover

Multiply Prover Volume by the Factor
Coefficient of Expansion = 0.0000265 /°F

Temp °F	Factor
-10	0.99814
-9	0.99817
-8	0.99820
-7	0.99822
-6	0.99825
-5	0.99828
-4	0.99830
-3	0.99833
-2	0.99836
-1	0.99838
0	0.99841
1	0.99844
2	0.99846
3	0.99849
4	0.99852
5	0.99854
6	0.99857
7	0.99860
8	0.99862
9	0.99865
10	0.99868
11	0.99870
12	0.99873
13	0.99875
14	0.99878
15	0.99881
16	0.99883
17	0.99886
18	0.99889
19	0.99891
20	0.99894
21	0.99897
22	0.99899
23	0.99902
24	0.99905
25	0.99907
26	0.99910
27	0.99913
28	0.99915
29	0.99918
30	0.99921

Temp °F	Factor
30	0.99921
31	0.99923
32	0.99926
33	0.99928
34	0.99931
35	0.99934
36	0.99936
37	0.99939
38	0.99942
39	0.99944
40	0.99947
41	0.99950
42	0.99952
43	0.99955
44	0.99958
45	0.99960
46	0.99963
47	0.99966
48	0.99968
49	0.99971
50	0.99974
51	0.99976
52	0.99979
53	0.99981
54	0.99984
55	0.99987
56	0.99989
57	0.99992
58	0.99995
59	0.99997
60	1.00000
61	1.00003
62	1.00005
63	1.00008
64	1.00011
65	1.00013
66	1.00016
67	1.00019
68	1.00021
69	1.00024
70	1.00027

Temp °F	Factor
70	1.00027
71	1.00029
72	1.00032
73	1.00034
74	1.00037
75	1.00040
76	1.00042
77	1.00045
78	1.00048
79	1.00050
80	1.00053
81	1.00056
82	1.00058
83	1.00061
84	1.00064
85	1.00066
86	1.00069
87	1.00072
88	1.00074
89	1.00077
90	1.00080
91	1.00082
92	1.00085
93	1.00087
94	1.00090
95	1.00093
96	1.00095
97	1.00098
98	1.00101
99	1.00103
100	1.00106
101	1.00109
102	1.00111
103	1.00114
104	1.00117
105	1.00119
106	1.00122
107	1.00125
108	1.00127
109	1.00130
110	1.00133

Table 3A. Volume Correction Factors for Thermal Expansion or Contraction of a 304 Stainless Steel Prover

Multiply Prover Volume by the Factor
Coefficient of Expansion = 0.0000288 /°F

Temp °F	Factor
-10	0.99798
-9	0.99801
-8	0.99804
-7	0.99807
-6	0.99810
-5	0.99813
-4	0.99816
-3	0.99819
-2	0.99821
-1	0.99824
0	0.99827
1	0.99830
2	0.99833
3	0.99836
4	0.99839
5	0.99842
6	0.99844
7	0.99847
8	0.99850
9	0.99853
10	0.99856
11	0.99859
12	0.99862
13	0.99865
14	0.99868
15	0.99870
16	0.99873
17	0.99876
18	0.99879
19	0.99882
20	0.99885
21	0.99888
22	0.99891
23	0.99893
24	0.99896
25	0.99899
26	0.99902
27	0.99905
28	0.99908
29	0.99911
30	0.99914

Temp °F	Factor
30	0.99914
31	0.99916
32	0.99919
33	0.99922
34	0.99925
35	0.99928
36	0.99931
37	0.99934
38	0.99937
39	0.99940
40	0.99942
41	0.99945
42	0.99948
43	0.99951
44	0.99954
45	0.99957
46	0.99960
47	0.99963
48	0.99965
49	0.99968
50	0.99971
51	0.99974
52	0.99977
53	0.99980
54	0.99983
55	0.99986
56	0.99988
57	0.99991
58	0.99994
59	0.99997
60	1.00000
61	1.00003
62	1.00006
63	1.00009
64	1.00012
65	1.00014
66	1.00017
67	1.00020
68	1.00023
69	1.00026
70	1.00029

Temp °F	Factor
70	1.00029
71	1.00032
72	1.00035
73	1.00037
74	1.00040
75	1.00043
76	1.00046
77	1.00049
78	1.00052
79	1.00055
80	1.00058
81	1.00060
82	1.00063
83	1.00066
84	1.00069
85	1.00072
86	1.00075
87	1.00078
88	1.00081
89	1.00084
90	1.00086
91	1.00089
92	1.00092
93	1.00095
94	1.00098
95	1.00101
96	1.00104
97	1.00107
98	1.00109
99	1.00112
100	1.00115
101	1.00118
102	1.00121
103	1.00124
104	1.00127
105	1.00130
106	1.00132
107	1.00135
108	1.00138
109	1.00141
110	1.00144

Inspector Notes