PROPERTY OF U.S. GOVT.
MFG. BY
COLUMBIA
N.Y. U.S.A.
PROPERTY OF U.S. GOVT.
MFG. BY
COLUMBIA
N.Y. U.S.A.

NATIONAL BUREAU OF STANDARDS HANDBOOK 44—3d EDITION 1965

Superseding Handbook 44—2d Edition

SPECIFICATIONS, TOLERANCES, AND OTHER TECHNICAL REQUIREMENTS FOR COMMERCIAL WEIGHING AND MEASURING DEVICES

ADOPTED BY THE

NATIONAL CONFERENCE ON WEIGHTS AND MEASURES

U.S. DEPARTMENT OF COMMERCE • John T. Connor, Secretary

NATIONAL BUREAU OF STANDARDS • A. V. Astin, Director

Issued October 12, 1965

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price $2.00

FOREWORD

This Handbook supersedes National Bureau of Standards Handbook 44—Second Edition, published in 1955, and presents a complete revision of technical requirements for commercial weighing and measuring devices. This revision was developed by the Committee on Specifications and Tolerances of the National Conference on Weights and Measures with the assistance of the Office of Weights and Measures of the Bureau, and was adopted by the 50th National Conference in 1965.

Handbook 44 was first issued in 1949, having been preceded by similar Handbooks of various designations and in several forms beginning in 1918. Handbook 44 was revised and reissued as the second edition in 1955. This third edition represents in many respects an entirely new approach to code requirements.

The National Bureau of Standards has a statutory responsibility for "cooperation with the States in securing uniformity of weights and measures laws and methods of inspection." In partial fulfillment of this responsibility, the NBS is pleased to publish these recommendations of the National Conference.

Special mention for the efforts in the development of these Codes of specifications, tolerances, and other technical requirements for commercial weighing and measuring devices, is due the following members of the National Conference on Weights and Measures, who served on the Conference Committee on Specifications and Tolerances during the development of the Code material: R. E. Meek of Indiana, J. F. McCarthy of Boston, Mass., H. D. Robinson of Maine, G. L. Johnson of Kentucky, and H. J. McDade of San Diego County, Calif.; and M. W. Jensen and D. R. Mackay of the staff of the National Bureau of Standards.

A. V. Astin, *Director*,
National Bureau of Standards.

Library of Congress Catalog Card Number: 14-10563

IMPORTANT NOTICE FOR THE HOLDERS OF THIS HANDBOOK

In order that your Handbook may be kept current and most useful, it is imperative that the following steps be taken:

1. Promptly fill in and mail the rust-colored postcard found just before the title page. (This will assure your annual receipt—without charge—of Replacement Sheets including code changes.)
2. Place the Handbook in a standard 3-ring binder—8 by 5 inches.
3. Immediately upon receipt of a set of Replacement Sheets, insert the individual sheets and discard the replaced sheets.
4. Notify the Office of Weights and Measures, National Bureau of Standards, Washington, D.C., 20234, of any address change.
5. If ownership of the Handbook is transferred, direct the attention of the new owner to this list of instructions.

CONTENTS

SPECIFICATIONS, TOLERANCES, AND OTHER TECHNICAL REQUIREMENTS

for

COMMERCIAL WEIGHING AND MEASURING DEVICES

As Adopted by the

NATIONAL CONFERENCE ON WEIGHTS AND MEASURES

NBS Handbook 44—3d Edition, *Specifications, Tolerances, and Other Technical Requirements for Commercial Weighing and Measuring Devices*, is a revision of the second edition of Handbook 44. This third edition was adopted by the 50th National Conference on Weights and Measures and thus will be given legal status in practically every State in the United States.

INTRODUCTION

SOURCE.—The specifications, tolerances, and other technical requirements published herein comprise, in their latest form, all of the current codes as adopted by the National Conference on Weights and Measures,[1] the latest action reported having been taken by the Fiftieth National Conference on Weights and Measures in 1965.

The Conference Committee on Specifications and Tolerances,[2] acting at the request of the Conference or upon its

[1] The National Conference on Weights and Measures is a body made up of State and local weights and measures officials from all parts of the United States, which normally meets annually under the sponsorship of the National Bureau of Standards. For a more detailed description of the Conference and its activities, see chapter 13, National Bureau of Standards Handbook 82, *Weights and Measures Administration*. Inquiries regarding Handbook 82 may be addressed to Office of Weights and Measures, National Bureau of Standards, Washington, D.C., 20234.

[2] A standing committee of the National Conference consisting of five members. Communications to this committee may be addressed as follows: Executive Secretary, National Conference on Weights and Measures, National Bureau of Standards, Washington, D.C., 20234.

own initiative, prepares from time to time, with the cooperation of the National Bureau of Standards, proposed revisions, amendments, or additions to the material previously adopted by the Conference. Such revisions, amendments, or additions are then presented to the Conference as a whole, where they are discussed by weights and measures officials and representatives of interested manufacturers and industries. Eventually the proposals of the Committee, which may have been amended on the floor, are voted upon by the weights and measures officials, a majority vote being required for adoption.

All of the specifications, tolerances, and other technical requirements given herein are recommended by the National Conference on Weights and Measures for official promulgation in and use by the several States in exercising their control of commercial weighing and measuring apparatus. A similar recommendation is made with respect to the local jurisdictions within a State, in the absence of the promulgation of specifications, tolerances, and other technical requirements by a State agency.

PURPOSE.—The purpose of these technical requirements is to eliminate from use, without prejudice to apparatus that conforms as closely as practicable to the official standards, weights and measures and weighing and measuring devices 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.

CLASSIFICATION OF SPECIFICATIONS.—The classification into "retroactive" and "nonretroactive" requirements is made in order that the requirements may be put into force and effect without unnecessary hardship and without wholesale condemnation of apparatus that, while not of the best construction, is nevertheless fairly satisfactory and may be used for some time without greatly prejudicing the rights of buyers or sellers. Nonretroactive specifications are those that, while clearly desirable, are not so vital that they should at once be enforced with respect to all apparatus.

It is not to be expected, however, that, after their promulgation in a given jurisdiction, nonretroactive specifications shall always remain nonretroactive. It is entirely proper that a weights and measures official, following a careful analysis of existing conditions, fix reasonable periods for the continuance of the nonretroactive application of particular

specifications, at the expiration of which periods such specifications will become retroactive in their application. These periods should be of such length as to avoid undue hardship on the owners of apparatus and, in the case of some specifications, should approximate the average useful life of the apparatus in question. In order that all parties at interest may have timely and ample notice of impending changes in the status of specifications, the following procedure is suggested for the official who plans to change the classification of specifications: If sufficient data are at hand to make such action feasible, publish in combination with the codes themselves the date or dates at which nonretroactive specifications are to become retroactive. In other cases, give equally effective notice at the earliest practicable date.

In 1955, with the development of the second edition of Handbook 44, the National Conference considered the appropriateness of the nonretroactive character of the requirements so designated, and a number of such requirements were made retroactive in application.

With the issuance of this third edition of Handbook 44, a general rule has been agreed upon, and, under this rule, all nonretroactive requirements adopted previous to 1956 have been given retroactive status. Each remaining nonretroactive requirement is dated to indicate the year it was adopted by the Conference and added to the code. (It is planned that each existing nonretroactive requirement will be reviewed after it has been effective for 10 years, and thus reasonable currency can be assured.)

REVISED FORM OF CODES.—In this edition of the Handbook the order of presentation of the several codes has been changed somewhat. Codes covering devices of a similar character are grouped together, with weighing devices coming first, devices for the measurement of liquids second, devices for the measurement of length third, and dry measures and berry boxes last. It is believed that the new arrangement will contribute to the convenience of those using the Handbook.

The General Code, applicable to all devices, has been reduced somewhat by removing from it and placing in appropriate individual codes technical requirements that are either numerical or quite specific in character. The former Code for Mileage Measuring Devices has been separated into two codes—one for taximeters and one for odometers.

Definitions, which heretofore have been an integral part of each code, with paragraph letter and number designations, have been placed at the end of the code in alphabetical order. Additional definitions have been added as the need for these has become apparent.

The **REGULATION** paragraphs, directed to users of devices, have been expanded considerably and have been given the new paragraph designation **UR**, representing **USER REQUIREMENTS.** These include requirements pertaining to selection, installation, use, and maintenance. This change was decided upon because some confusion had arisen from the use of "Regulation" in the Handbook when, in most instances, the Handbook itself is given official status through promulgation as a regulation.

The series of weights and measures tables, comprising (1) general tables of weight and measure, (2) tables of interrelation of units of length, area, volume, liquid measure, dry measure, and mass, and (3) tables of equivalents, introduced with the 1955 edition, have been updated and retained as Appendix 1.

LOOSELEAF VERSION.—The second edition of Handbook 44, issued in 1955, was published in two editions, bound and looseleaf. Because of the superiority of the looseleaf version as a working document and the difficulty of updating the bound version, the 1965 edition is issued only in looseleaf form.

REPLACEMENT SHEETS.—Amendments to the Handbook normally occur annually through adoptions by the National Conference on Weights and Measures. A corrected replacement sheet is issued for each old looseleaf sheet requiring one or more corrections. The replacement sheet is simply to be substituted for the old sheet. The year of adoption is printed in parentheses at the end of a paragraph in whic han amendment is made, and in the lower lefthand corner on the odd-numbered page of each replacement sheet there is printed the year of its issuance followed by "Replacement Sheet."

Replacement sheets are supplied without charge to holders of the Handbook. However, distribution of these sheets is made only on the basis of specific requests therefor. With each Handbook a postcard is included to facilitate requesting replacement sheets. If the postcard is not used, a request for replacement sheets may be addressed to the Office of Weights

and Measures, National Bureau of Standards, Washington, D.C. 20234. The number of sets of replacement sheets required should be stipulated in the request.

THE 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 a code are divided into sections. Each section is designated by a letter and a name, and each section within a section is given a letter-number designation and a side title. There is thus provided an orderly and correlated system of requirement presentation.

The letter that appears first in a paragraph designation has a specific meaning.

G. The letter **G** is a prefix and indicates that the requirement is part of the General Code.

A. APPLICATION. Those paragraphs pertaining to the application of the requirements of the particular code.

S. SPECIFICATION. Those paragraphs that relate to the design of equipment. Specification paragraphs are directed particularly to manufacturers of devices.

N. NOTE. Notes paragraphs are applicable with respect to the official testing of devices.

SR. SENSITIVITY REQUIREMENT. Paragraphs in the Scale Code only that set forth requirements as to the sensitiveness of nonautomatic-indicating scales.

T. TOLERANCE. Tolerances are performance requirements; they fix the limit of allowable error or departure from true performance or value.

UR. USER REQUIREMENT. Those paragraphs directed particularly to the owner and operator of a device. User requirements are applicable with respect to the selection, installation, use, and maintenance of devices.

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. Thus, in the Scale Code, under Specifications, where there is found

S.1. DESIGN OF INDICATING AND RECORDING ELEMENTS AND OF RECORDED REPRESENTATIONS.

S.1.1. ZERO INDICATION.—
S.1.2. GRADUATIONS.—
S.1.2.1. LENGTH.—
S.1.2.2. WIDTH.—
each paragraph starting with **S.1.** is directed to, and limited to, the design of indicating and recording elements and of recorded representations. Likewise, those paragraphs beginning with **S.1.2.** are directly related to each other but are limited to the design of **GRADUATIONS.**

USING THE HANDBOOK.—Handbook 44, as were all of its predecessors, is designed as a working tool of the weights and measures official and the equipment manufacturer, installer, and repairman. The usefulness of the Handbook to an individual largely will be predicated upon the familiarity of the contents gained by that individual. The section on **FUNDAMENTAL CONSIDERATIONS** which follows this introduction should be studied until its contents are well known. The General Code, with general requirements pertaining to all devices and quite general in nature, 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 with considerable frequency. If the Handbook is to serve its purpose, it should be at hand when any of its requirements are being applied, and reference directly to the requirements is the only sure way (1) to apply the requirement properly and (2) to check to see if there are other applicable requirements.

MECHANISM FOR AMENDING THE HANDBOOK.—The Committee on Specifications and Tolerances of the National Conference on Weights and Measures stands continually and provides the mechanism for consideration of amendments to the code provisions. Recommendations as to amendments and suggestions concerning investigations that might lead either to amendments or to new provisions should be directed to the Chief, Office of Weights and Measures, National Bureau of Standards, U.S. Department of Commerce, Washington, D.C., 20234. Recommendations or suggestions with supporting data, including test results, are most helpful.

FUNDAMENTAL CONSIDERATIONS ASSOCIATED WITH THE ENFORCEMENT OF SPECIFICATIONS, TOLERANCES, AND OTHER TECHNICAL REQUIREMENTS

1. UNIFORMITY OF REQUIREMENTS

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

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

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

1.2. FORM OF PROMULGATION.—A convenient and very effective form of promulgation already successfully used in a considerable number of States is promulgation by citation of National Bureau of Standards Handbook 44. It is especially helpful when the citation is so made that, as amendments are adopted from time to time by the National Conference on Weights and Measures, these automatically go into effect in the State in question without the need for further promulgation by 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 commercial weighing and measuring devices, together with amendments thereto, as adopted by the National Conference on Weights and Measures, and published in National Bureau of Standards Handbook 44 and supplements thereto, or in any publication revising or superseding Handbook 44, shall be the specifications, tolerances, and other technical requirements for commercial weighing and measuring devices in the State of [insert name of State].

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

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

2. TOLERANCES FOR COMMERCIAL EQUIPMENT

2.1. ACCEPTANCE AND MAINTENANCE TOLERANCES.—The official tolerances prescribed by a weights and measures jurisdiction for commercial equipment are the limits of inaccuracy officially permissible within that jurisdiction. It is recognized that errorless value or performance of mechanical equipment is unattainable. Tolerances are established, therefore, to fix the range of inaccuracy within which equipment will be officially approved for commercial use. In the case of classes of equipment on which the magnitude of the errors of value or performance may be expected to change as a result of use, two sets of tolerances are established, "acceptance" tolerances and "maintenance" tolerances. Acceptance tolerances are applied to new or newly reconditioned or adjusted equipment and are smaller than (usually one-half of) the maintenance tolerances. Maintenance tolerances thus provide an additional range of inaccuracy within which equipment will be approved on subsequent tests, permitting a limited amount of "deterioration" before the equipment will be officially rejected for inaccuracy, and before reconditioning or adjustment will be required. In effect, there is assured a reasonable period of use for equipment after it is placed in service before reconditioning will be officially required. The foregoing comments do not apply, of course, when only a single set of tolerance values is established, as is the case with such equipment as, for example, 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 effort 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 repairman or serviceman bring equipment merely within tolerance range when it is possible to adjust closer to zero error.[3]

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.

3.2. TOLERANCES FOR STANDARDS.[4]—A general principle that has long been recognized by the National Bureau of Standards is that the error in a standard used by a weights and measures official should be known and corrected for when the standard is used; or if the standard is to be used "without correction," its error should be not greater than 25 percent of the smallest tolerance to be applied when the standard is used. The reason for this is to keep at a minimum the proportion of the tolerance on the item being tested that will be "used up" by the error of the standard. Expressed differently, the reason is to give the item being tested as nearly as practicable the full benefit of its own tolerance.

Field testing operations are complicated to some degree when corrections to standards are applied. Except for work of relatively high precision, it is recommended that the ac-

---

[3] See General User Requirement G–UR.4.2.

[4] The numerical values of the tolerances observed by the National Bureau of Standards for the standards of length, mass, and capacity used by weights and measures officials may be obtained upon request made to the Office of Weights and Measures of the Bureau.

curacy of standards used in testing commercial weighing and measuring equipment be so established and maintained that the use of corrections is not necessary. Also, whenever it can readily be done, it will be desirable to reduce the error on a standard below the 25-percent point previously mentioned.

3.3. ACCURACY OF STANDARDS.—The accuracy of testing apparatus should invariably be verified prior to the official use of the apparatus. Standards should be reverified as often as circumstances require. By their nature, metal volumetric standards are more susceptible to damage in handling than are standards of some other types. Whenever damage to a standard is known or suspected to have occurred, and whenever repairs that might affect the accuracy of a standard have been made, the standard should be recalibrated. Routine recalibration of standards, particularly volumetric standards, even when a change of value is not anticipated, should be made 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. If use is made of "secondary" standards, such as special fabric testing tapes, these should be verified much more frequently than such basic standards as steel tapes or volumetric provers to demonstrate their constancy of value or performance.

It may be appropriate to mention here the lack of attention to the accuracy of their standards shown by some repairmen and servicemen and by some weights and measures officials, and the inadequate amount of testing apparatus with which servicemen and officials are sometimes provided. Accurate and dependable results cannot be obtained with faulty or inadequate standards. If either serviceman or official is poorly equipped, it cannot be expected that their results will check consistently. Disagreements between servicemen and officials can be avoided, and the servicing of commercial equipment can be expedited and improved if servicemen and officials will give equal attention to the adequacy and maintenance of their testing apparatus.

4. INSPECTION OF COMMERCIAL EQUIPMENT

4.1. INSPECTION VERSUS TESTING.—A distinction may be made between the "inspection" and the "testing" of commercial equipment which should be useful in differentiating between the two principal groups of official requirements—"specifications" and "performance requirements." Although frequently the term "inspection" is 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 use 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.[5]

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 equally as important as are tolerance requirements, and both 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.

---

[5] The testing of commercial weighing equipment is treated in detail in National Bureau of Standards Handbook 94, *Examination of Weighing Equipment.* A series of small handbooks, each one covering an individual measuring device, is at present being prepared. Handbooks in this series issued to date include Handbook 98, *Examination of Farm Milk Tanks,* and Handbook 99, *Examination of Liquefied Petroleum Gas Liquid-Measuring Devices.*

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 requirement may be overlooked. As experience is gained, the official will become progressively less dependent on "the book," 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. It is vitally important that the book of specifications, tolerances, and other technical requirements be kept fully up to date by posting therein all changes that are adopted from time to time.

4.4. GENERAL CONSIDERATIONS.—The simpler the commercial device, the fewer, generally speaking, are the specification requirements affecting it and the more easily and quickly can an adequate inspection be made. As a device increases in complexity, inspection demands more and more time and effort. Moreover, inspection becomes increasingly important as mechanical complexity increases, because the opportunities for the existence of faulty conditions are multiplied. It is on the relatively complex device, too, that the unscrupulous operator is most apt to attempt some modification to gain an advantage to which he is not lawfully entitled. Of course, not every modification made by an operator is made with dishonest intentions. But sometimes a change, made innocently enough, has most unfortunate results, because the operator does not thoroughly understand his equipment and so fails to appreciate the effects of what seems to him to be a simple and desirable modification. So it behooves the official to be alert to discover all of the "home-made" alterations that may be made to commercial equip-

787-784 O—65——2

ment, in order that he may eliminate all that are fraudulent, all that facilitate or are conducive to the perpetration of fraud, and all that are otherwise objectionable from a weights and measures viewpoint.

It is essential for the official to know how a particular commercial device is normally designed and constructed, in order to discover, upon inspection, deviations from standard practice. Such knowledge can be obtained from the catalogs and advertising literature of manufacturing plants, from observation of the operations performed by servicemen when reconditioning equipment in the field, and from study of the commercial devices themselves. Furthermore, to determine the effect of some deviation from accepted design, the official must know the operating principles of the device in question and be able to deduce or demonstrate how these are or may be violated by the alteration of the original mechanism. Much helpful information on the design and operating characteristics of commercial equipment can be obtained from the trained service mechanics and from the engineers of the equipment manufacturers. It is recommended that officials take advantage of every opportunity to "talk shop" with such men and so add to their knowledge of the construction and operation of weighing and measuring equipment of different kinds and makes.

Inspection should be extended beyond the instrument itself to include any auxiliary equipment the performance of which has a bearing on the performance characteristics of the instrument under examination or has any weights and measures significance in relation to the operation of the instrument under examination. General conditions external to the equipment should likewise be observed, to learn any adverse effects that they may have, from the weights and measures point of view, upon the installation as a whole.

It is important not only that the required elements of a commercial instrument be provided, but also that these be in proper condition to function as intended. Inspection will frequently disclose the need for maintenance work before deterioration has progressed to the point of failure or before official rejection of the equipment becomes necessary. Mechanical parts may be worn or weakened. Leaks may be developing in volumetric equipment. Certain elements may be in need of cleaning or refinishing. Evidence may be found of poor general maintenance that is shortening the useful life of the equipment.

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.' "[6] "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.' "[7] Only equipment that is "correct" should be sealed and approved for commercial use.

---

[6] See General Code—Definitions of Terms.
[7] *Ibid.*

5. CORRECTION OF COMMERCIAL EQUIPMENT

5.1. ADJUSTABLE ELEMENTS.—Many types of weighing and measuring instruments are not susceptible of adjustment for accuracy by means of adjustable elements. Linear measures, liquid measures, graduates, measure-containers, milk and lubricating-oil bottles, farm milk tanks, dry measures, and some of the more simple types of scales are in this category. Other types—for example, taximeters and odometers and some metering devices—may be adjusted in the field, but only by changing certain parts such as gears in gear trains. Some types, of which fabric-measuring devices and cordage-measuring devices are examples, are not intended to be adjusted in the field and, if inaccurate, require reconditioning in shop or factory. 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 are applicable to adjustments on any commercial equipment, by whatever means accomplished.

5.2. WHEN CORRECTIONS SHOULD BE MADE.—The weights and measures official should remember that, when he examines commercial equipment, his *duty* is merely to determine that the equipment is or is not suitable for commercial use, and to approve or reject it accordingly. If a device conforms to all of the official requirements, it is approved for use and is "sealed" to indicate this approval. If a device is incorrect in that it fails to meet one or more of the applicable requirements, basically the official is *required* only to reject it and prohibit its use until it is brought into conformance with all applicable requirements. The point of importance to this discussion is that the official is *not required* to undertake adjustments or other corrections on equipment found to be faulty.

Whether or not the official *should* at times make adjustments or other corrections on equipment found to be incorrect is a moot question. Some officials contend that this should never be done and that an official should confine himself strictly to those duties imposed upon him by his statute. Other officials hold that under some circumstances a weights and measures officer is serving the best interests of all con-

cerned by making such minor corrections and such adjustments (when adjustment is called for) as may be required to correct equipment found to be faulty and thus to keep it in commercial service.

An official should never undertake repairs of a major character. Such repairs should always be left to commercial agencies.

The official should refrain from making even minor corrections when the services of commercial agencies are readily available. The justification for the undertaking, by the official, of minor corrections lies in the delay and the expense that would be incurred if these corrections were required to be made by a service agency and the nearest service agency were located at a considerable distance. The saving to the equipment owner is a consideration, as is also the saving in time and expense on the part of the official, who may thus avoid a return visit for a retest. Another consideration is that the equipment may be kept in service without interruption. This is of particular importance if the owner happens to be dependent upon only a single item of equipment and would be "out of business" while this was tied up for repairs.

The official is cautioned about turning too quickly to the adjustable elements of a commercial device to correct for inaccuracies. Many times the cause of inaccurate performance of such an instrument as, for example, a liquid meter or a scale lies not in a faulty positioning of the adjustable elements, but in some fault of installation or some defective part. Any faulty installation conditions should be corrected and any defective parts should be renewed or suitably repaired before adjustments are undertaken. In other words, adjustment should be made only when it is certain that by this means the real cause of the inaccuracy will be corrected.

Under no circumstances should the official undertake an adjustment or other correction on commercial equipment unless he thoroughly understands what he is doing and is competent to complete successfully what he undertakes. He should not experiment with equipment belonging to a commercial user, with the possibility of leaving it in worse shape than that in which he found it. Even when he is fully competent to make minor corrections and adjustments, the official should undertake them only with the express permission of the owner or his representative and with the definite understanding that there is no guarantee of a successful outcome.

5.3. GAGING.—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 value of the device is first fixed or its performance first established. The most common example of such "gaging" is in connection with vehicle tanks the compartments of which are used as measures. Not infrequently the official makes the first determination to be made 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" under discussion above.

6. REJECTION OF COMMERCIAL EQUIPMENT

6.1. REDUCTION AND CONDEMNATION.—The weights and measures law usually contains a provision to the general effect that the director "shall reject and mark or tag as 'rejected' such weights and measures as he finds, upon inspection or test, to be 'incorrect' . . . but which in his best judgment are susceptible of satisfactory repair: . . . The director shall condemn, and may seize and may destroy, weights and measures found to be incorrect that in his best judgment are not susceptible of satisfactory repair."[8] This provision is customarily followed by others requiring that equipment that has been "rejected" be corrected within such reasonable period as may be specified by the official; that, if not so repaired, the equipment shall be confiscated; and that, pending repairs, the equipment shall be neither used nor disposed of in any way, but shall be held at the disposal of the official.

These broad powers should be used by the official with discretion. He should keep always 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 con-

[8] Quoted from the Model State Law on Weights and Measures as adopted by the National Conference on Weights and Measures.

demn outright. Destruction of equipment is a harsh procedure, as is also confiscation. 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 numerous items of measuring equipment. This is true in the case of most linear measures, of many liquid and dry measures, and 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 so long as the official is assured that they will not get into commercial use. Thus the official can protect the owner financially and can make possible the conservation of at least some of the material of which the equipment is constructed. In rare instances, confiscation and destruction are justified as a method of control where 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.

7. TAGGING OF EQUIPMENT

7.1. "REJECTED" AND "CONDEMNED."—It will ordinarily be practicable to mark or tag as "rejected" each item of equipment found to be incorrect and considered susceptible of proper reconditioning, and this should always be done unless the repairs are to be begun immediately. However, the tagging of equipment as "condemned" to indicate that it is permanently out of service is not to be recom-

mended if there is any other way in which the equipment can definitely be put out of service. When it is decided that equipment cannot successfully be repaired, dismantling, removal from the premises, or confiscation by the official are preferable to mere marking.

7.2. "NONSEALED" AND "NONCOMMERCIAL."—It sometimes happens that measuring equipment cannot be tested by the official at the time of his regular visit to the premises where the equipment is located. This situation can arise, for example, when there is no gasoline in the supply tank of a gasoline-dispensing device, or when the supply of lubricant for a lubricant-measuring device is exhausted. In such circumstances, rejection is not appropriate. 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 form of marking is recommended whenever, in a case of this kind, any considerable time will necessarily elapse before the device can be tested.

A somewhat similar situation is occasionally met in an establishment with commercial equipment in use but having also on hand some equipment that is not in service and that may never be put into service, but that is of a type suitable for commercial use and that might be so used at some future time. Such equipment (1) may be tested and otherwise treated by the official just as he treats equipment in commercial service, (2) if readily portable may be removed from the premises to eliminate possibility of its inadvertent use for commercial purposes, or (3) may be marked "nonsealed."

Finally, there are instances of noncommercial equipment and commercial equipment installed or used in close proximity. In such a case, if there is a reasonable probability that the noncommercial equipment might be used for commercial purposes, (1) the noncommercial equipment should be treated by the official as commercial equipment, (2) a physical separation of the two groups of equipment should be effected so that misuse of the noncommercial equipment will be effectively prevented, or (3) the noncommercial equipment should be tagged to show that it is in noncommercial service, has not been officially tested, and is not to be used commercially.

8. RECORDS OF EQUIPMENT

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

9. SEALING OF EQUIPMENT

9.1. TYPES OF SEALS AND THEIR LOCATION.—All equipment that is officially approved for commercial use (with certain exceptions to be pointed out later) normally is suitably marked or "sealed" to show this fact. Because it is desirable that the public be advised that the equipment that is used to serve them has been officially examined and approved, the seal of approval should, within reasonable limits, be as conspicuous as circumstances permit and should be of such a character and so applied that it will be reasonably permanent. The seal should be so positioned on a piece of equipment that it will be conspicuous, particularly to the public. Uniformity of position of the seal on similar types of equipment is also desirable, and this is an aid to the public in determining quickly that a piece of equipment has been tested and found correct.

It will be necessary for the official to have more than one form of seal to meet the requirements of different kinds of equipment. For instruments such as fabric-measuring devices, liquid-measuring devices, taximeters, and most scales, good quality, weather-resistant, water-adhesive, or pressure-sensitive seals or decalcomania seals are used. These may be somewhat more expensive than other types, but their qualities of permanence and good appearance recommend them highly. 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.—Certain types of equipment approved for commercial use, such as measure-containers, milk bottles, and lubricating-oil bottles, are not tested individually, as such individual testing would require an unreasonable expenditure of time. Because manufacturing processes for these items can be and 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

10.1. DEFINITION.—To "round off" or "round" a numerical value is to reduce the number of recorded digits to some predetermined point considered desirable or adequate for the purpose at hand, by dropping or raising certain figures. For example, if a computed, observed, or accumulated value is 4,738,221, this can be rounded off to the nearest million, to the nearest hundred thousand, to the nearest ten thousand, etc., as desired. Such rounded-off values would be, respectively, 5,000,000, 4,700,000, 4,740,000 etc. Similarly, a value such as 47.382 can be rounded off to two decimal places, to one decimal place, to the units place, etc. The rounded-off figures in this example would be, respectively, 47.38, 47.4, 47, etc.

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 4,738,221 to the nearest hundred thousand, 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 4,700,000. 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 4,738,221 to the nearest million, 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 5,000,000. 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 4,500,001 to the nearest million, 1 is added to the millions figure and the result becomes 5,000,000.

(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, "If odd, then add." Thus, rounding off to the first decimal place, 47.25 would become 47.2; 47.15 would become 47.2; 47.05 would become 47.0; and 47.95 would become 48.0. Also, rounded to the nearest thousand, 4,500 would become 4,000; 2,500 would become 2,000; 9,500 would become 10,000; and 5,500 would become 6,000.

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, 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. APPLICATION TO 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; or 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 two's, 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.

10.4. APPLICATION OF RULES TO ROUNDING OFF OF 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 "5's" 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 $1\frac{1}{32}$, $1\frac{2}{32}$, $1\frac{3}{32}$, $1\frac{4}{32}$, $1\frac{5}{32}$, $1\frac{6}{32}$, $1\frac{7}{32}$, $1\frac{8}{32}$, $1\frac{9}{32}$, etc. Assume that these values are to be rounded off to the nearest eighth ($\frac{4}{32}$). Then,

$1\frac{1}{32}$ becomes 1. ($\frac{1}{32}$ is less than half of $\frac{4}{32}$, and accordingly is dropped.)

$1\frac{2}{32}$ becomes 1. ($\frac{2}{32}$ is exactly one-half of $\frac{4}{32}$; it is dropped because it is rounded [down] to the "even" eighth, which in this instance is $\frac{0}{8}$.)

$1\frac{3}{32}$ becomes $1\frac{4}{32}$ or $1\frac{1}{8}$. ($\frac{3}{32}$ is more than half of $\frac{4}{32}$, and accordingly is rounded [up] to $\frac{4}{32}$ or $\frac{1}{8}$.

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

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

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

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

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

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

SPECIFICATIONS, TOLERANCES, AND OTHER TECHNICAL REQUIREMENTS

GENERAL CODE

G–A. APPLICATION. (Pertaining to the application of the requirements.)

G–A.1. COMMERCIAL AND LAW-ENFORCEMENT EQUIPMENT.—These specifications, tolerances, and other technical requirements apply as follows:

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

(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.

(c) To weighing and measuring equipment in official use for the enforcement of law.

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

G–A.2. CODE APPLICATION.—This General Code shall apply to all classes of devices, and, in addition, the specific code shall apply to a device falling clearly within the class of devices intended to be covered by that particular code.

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.

G–A.4. METRIC EQUIPMENT.—It is lawful throughout the United States to employ the weights and measures of the metric system, and 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 customary system.

G–A.5. RETROACTIVE REQUIREMENTS.—"Retroactive" requirements are enforceable with respect to all equipment. Retroactive requirements are printed herein in ordinary roman type.

G–A.6. NONRETROACTIVE REQUIREMENTS.—"Nonretroactive" requirements are enforceable after the effective date and only with respect to devices that are manufactured in or brought into the State after that date. 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 herein in italic type.* (NOTE: With the issuance of this edition of Handbook 44, all nonretroactive requirements adopted previous to 1956 have been given retroactive status.)

G–S. SPECIFICATIONS. (Applicable with respect to the design of weighing and measuring equipment.)

G–S.1. IDENTIFICATION.—All commercial equipment except weights shall be clearly and permanently marked on an exterior surface for purposes of identification with the name, initials, or trademark of the manufacturer and with the manufacturer's designation that positively identifies the pattern or the design of the device.

G–S.2. FACILITATION OF FRAUD.—All commercial equipment and all mechanisms and devices attached thereto or used in connection therewith shall be so constructed, assembled, and installed for use that they do not facilitate the perpetration of fraud.

G–S.3. PERMANENCE.—All commercial 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 so constructed that their interchange or reversal will not materially affect the performance of the device. Parts that may be interchanged or reversed in normal field assembly 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 ELEMENTS AND RECORDED REPRESENTATIONS.

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

G–S.5.2. GRADUATIONS.

G–S.5.2.1. ANALOG INDICATION AND REPRESENTATION.—Graduations and a suitable indicator shall be provided in connection with indications and recorded representations designed to advance continuously.

G–S.5.2.2. DIGITAL INDICATION AND REPRESENTATION.—Graduations shall not be required in connection with digital indications or recorded digital representations.

G–S.5.2.3. SIZE AND CHARACTER.—In any series of graduations, corresponding graduations shall be uniform in size and character.

G–S.5.2.4. VALUES.—If graduations are intended to have specific values, these shall be adequately defined by

787–784 O—65——3

a sufficient number of figures, words, symbols, or combinations thereof, uniformly placed with reference to the graduations 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 and their defining figures, words, and symbols shall be of such character that they will not tend easily to become obliterated or illegible.

G–S.5.3. VALUES OF GRADUATED INTERVALS.—In any series of graduations, the values of the graduated intervals shall be uniform throughout the series.

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.

G–S.5.5. MONEY VALUES, MATHEMATICAL AGREEMENT.—Any recorded money value and any digital money-value indication on a computing-type weighing or measuring device used in retail trade shall be in mathematical agreement with its associated quantity representation or indication to the nearest one cent of money value.

G–S.5.6. RECORDED REPRESENTATIONS.—Insofar as they are appropriate, the requirements for indicating and recording elements shall be applicable also to recorded representations.

G–S.5.7. MAGNIFIED GRADUATIONS AND INDICATIONS.—When, in normal usage, a series of graduations and an indicator are necessarily viewed as magnified by an optical system or as magnified and projected on a screen, all particulars of the magnified image shall conform to all appropriate requirements for graduations and indications.

G–S.6. LETTERING.—All required markings and instructions shall be distinct and easily readable and shall be of such

character that they will not tend easily to become obliterated or illegible.

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; and such suspension shall not affect the validity or enforcement of the remaining provisions of these specifications, tolerances, and other requirements.

G–T. TOLERANCES. (Applicable with respect to the performance or accuracy of devices.)

G–T.1. ACCEPTANCE TOLERANCES.—Acceptance tolerances shall apply as follows:

(a) To any equipment about to be put into commercial use for the first time.

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

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

G–T.2. MAINTENANCE TOLERANCES.—Maintenance tolerances shall apply to equipment in actual use, except as provided in G–T.1.

G–T.3. APPLICATION.—Tolerances "in excess" and tolerances "in deficiency" shall apply to errors in excess and to errors in deficiency, respectively. Tolerances "on overregistration" and tolerances "on underregistration" shall apply to errors in the direction of overregistration and of underregistration, respectively. (See Definitions of Terms.)

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.

G–UR. USER REQUIREMENTS. (Applicable with respect to the selection, installation, use, and maintenance of weighing and measuring devices.)

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 rate of flow (for liquid-measuring devices), the character, number, size, and location of its indicating or recording elements, and the value of its minimum graduated interval.

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 so installed that neither its operation nor its performance will be adversely affected by any characteristic of the foundation, supports, or any other detail of the installation.

G–UR.2.2. ACCESSIBILITY FOR TESTING PURPOSES.—A device shall be so located, or such facilities for normal access thereto shall be provided, that the testing equipment of the weights and measures official, in the amount or size deemed necessary by such official for the proper conduct of the test, may readily be brought to the device by customary means. Otherwise, it shall be the responsibility of the device owner or operator to supply such special facilities, including necessary labor as may be needed, to transport the testing equipment to and from the device, as required by the weights and measures official.

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.

G–UR.3.2. POSITION OF EQUIPMENT.—A device equipped with a primary indicating element and used in retail trade, except a prepackaging, check-weighing, or prescription scale, shall be so positioned that its indications may be accurately read and the weighing or measuring operation may be observed from some reasonable "customer" position. The permissible distance between the equipment and a reasonable customer position shall be determined in each case upon the basis of the individual

circumstances, particularly the size and character of the indicating elements.

G–UR.4. MAINTENANCE REQUIREMENTS.

G–UR.4.1. MAINTENANCE OF EQUIPMENT.—All equipment in commercial service and all mechanisms and devices attached thereto or used in connection therewith shall continuously be maintained in proper operating condition throughout the period of such service.

G–UR.4.2. 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.

G–UR.4.3. 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.4.4. REPLACEMENT OF SECURITY SEAL.—A security seal shall be appropriately affixed to any mechanism for adjusting a measurement element following service, repair, or replacement that requires the mutilation or destruction of the official seal.

DEFINITIONS OF TERMS

GENERAL

The terms defined here have a special and technical meaning when used in the codes. Whenever a defined term is used, it has the particular meaning given here.

accurate. 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." (See also correct.)

analog type. Refers to a system of indication or recording in which values are presented as a series of graduations in combination with an indicator, or in which the most sensitive element of an indicating system moves continuously during the operation of the device.

approval seal. A label, tag, stamped or etched impression, or the like, indicating official approval of a device. (See also security seal.)

basic tolerances. Basic tolerances are those tolerances on underregistration and on overregistration, or in excess and in deficiency, that are established by a particular code for a particular device under all normal tests, whether maintenance or acceptance. Basic tolerances include minimum tolerance values when these are specified. Special tolerances, identified as such and pertaining to special tests, are not basic tolerances.

binary submultiples. Fractional parts obtained by successively dividing by the number 2. Thus, one-half, one-fourth, one-eighth, one-sixteenth, and so on, are binary submultiples.

clear interval between graduations. The interval between adjacent edges of successive graduations of a series of graduations. If the graduations are "staggered," the interval shall be measured, if necessary, between a graduation and an extension of the adjacent graduation.

coin-operated type. Refers to a device designed to be released for use by the insertion of a coin, or to be actuated by the insertion of a coin to make deliveries of product corresponding to specific money values at a definite unit price.

computing type. Refers to a device designed to indicate, in addition to weight or measure, the total money value of product weighed or measured, for one of a series of unit prices.

correct. 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." (See also accurate.)

deficiency. See excess and deficiency.

digital type. Refers to a system of indication or recording of the selector type or one that advances intermittently in which all values are presented digitally, or in numbers. In a digital indicating or recording element, or in digital representation, there are no graduations.

excess and deficiency. When an instrument or device is of such a character that it has a value of its own that can be determined, its error is said to be "in excess" or "in deficiency" depending upon whether its actual value is, respectively, greater or less than its nominal value. Examples of instruments having errors "in excess" are: A linear measure that is too long; a liquid measure that is too large; and a weight that is "heavy." Examples of instruments having errors "in deficiency" are: A lubricating-oil bottle that is too small; a vehicle-tank compartment that is too small; and a weight that is "light."

graduated interval. The distance from the center of one graduation to the center of the next graduation of a series of graduations. (See also value of graduated interval.)

graduation. A defining line, or one of the lines defining the subdivisions of a graduated series. The term includes such special forms as raised or indented or scored reference "lines" and special characters such as dots. (See also main graduation, subordinate graduation.)

index of an indicator. The particular portion of an indicator that is directly utilized in making a reading.

indicating element. An element incorporated in a weighing or measuring device by means of which its performance relative to quantity or money value is "read" from the device itself as, for example, an index-and-graduated-scale combination, a weighbeam-and-poise combination, a digital indicator, and the like. (See also primary indicating or recording element.)

interval, clear, between graduations. See clear interval between graduations.

interval, graduated. See graduated interval.

main graduation. One of those defining the primary or principal subdivisions of a graduated series. (See also graduation.)

multiple. An integral multiple; that is, a result obtained by multiplying by a whole number. (For multiple of a scale, see Scale Code Definitions of Terms.)

nominal. Refers to "intended" or "named" or "stated," as opposed to "actual." For example, the "nominal value of something is the value that it is supposed or intended to have, the value that it is claimed or stated to have, or the value by which it is commonly known." Thus, "1-pound weight," "1-gallon measure," "1-yard indication," and "500-pound scale" are statements of nominal values; corresponding actual values may differ from these by greater or lesser amounts. (For nominal capacity of a scale, see Scale Code Definitions of Terms.)

nonretroactive. "Nonretroactive" requirements are enforceable only with respect to equipment that is manufactured or placed in commercial service after the effective date. *Nonretroactive requirements are printed herein in italic type.* (See G–A6.) (See also retroactive.)

notes. A section included in each of a number of codes, containing instructions, pertinent directives, and other specific information pertaining to the testing of devices. Notes are primarily directed to weights and measures officials.

overregistration and underregistration. When an instrument or device is of such a character that it indicates or records values as a result of its operation, its error is said to be in the direction of overregistration or underregistration, depending upon whether the indications are, respectively, greater or less than they should be. Examples of devices having errors of "overregistration" are: A fabric-measuring device that indicates more than the true length of material passed through it; and a liquid-measuring device that indicates more than the true amount of the liquid delivered by the device. Examples of devices having errors of "underregistration" are: A meter that indicates less than the true amount of product that it delivers; and a weighing scale that indicates or records less than the true value of the applied load.

parallax. The apparent displacement, or apparent difference in height or width, of a graduation or other object with respect to a fixed reference, as viewed from different points.

primary indicating or recording elements. The term "primary" is applied to those principal indicating elements (visual) and recording elements that are designed to, or may, be used by the operator in the normal commercial use of a device. The term "primary" is applied to any element or elements that may be the determining factor in arriving at the sale representation when the device is used commercially. (Examples of primary elements are the visual indicators for meters or scales not equipped with ticket printers or other recording elements, and both the visual indicators and the ticket printers or other recording elements for meters or scales so equipped.) The term "primary" is not applied to such auxiliary elements as, for example, the totalizing register or predetermined-stop mechanism on a meter or the means for producing a running record of successive weighing operations, these elements being supplementary to those that are the determining factors in sales representations of individual deliveries or weights. (See indicating element, recording element.)

reading-face. That portion of an automatic-indicating weighing or measuring device that gives a visible indication of the quantity weighed or measured. A reading-face may include an indicator and a series of graduations or may present values digitally, and may provide money-value indications.

reading-face capacity. The largest value that may be indicated on the reading-face, exclusive of the application or addition of any supplemental or accessory elements.

recorded representation. Refers to the printed, embossed, or other representation that is recorded as a quantity by a weighing or measuring device.

recording element. An element incorporated in a weighing or measuring device by means of which its performance relative to quantity or money value is permanently recorded on a tape, ticket, card, or the like, in the form of a printed, stamped, punched, or perforated representation.

retroactive. "Retroactive" requirements are enforceable with respect to all equipment. Retroactive requirements

are printed herein in ordinary roman type. (See also nonretroactive.)

seal. See approval seal, security seal.

security seal. A lead-and-wire seal, or similar device, attached to a device for protection against access, removal, or adjustment. (See also approval seal.)

selector-type. Refers to a system of indication or recording in which the mechanism selects, by means of a ratchet-and-pawl combination or by other means, one or the other of any two successive values that can be indicated or recorded.

specification. A requirement usually dealing with the design, construction, or marking of a weighing or measuring device. Specifications are primarily directed to the manufacturers of devices.

subordinate graduation. Any graduation other than a main graduation. (See also graduation.)

tolerance. A value fixing the limit of allowable error or departure from true performance or value. (See also basic tolerances.)

underregistration. See overregistration and underregistration.

user requirement. A requirement dealing with the selection, installation, use, or maintenance of a weighing or measuring device. User requirements are primarily directed to the users of devices.

value of minimum graduated interval. The smallest value represented by the interval from the center of one graduation to the center of the succeeding graduation. Also, the smallest increment of recorded value. (See also graduated interval.)

SCALES

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1. GENERAL.—This code applies to all types of weighing devices. The code comprises general requirements that are generally applicable to all classes of weighing devices, and specific requirements for certain individual classes of such devices. Such specific requirements supersede general scale requirements in all cases of conflict.

A.2. WHEEL-LOAD WEIGHERS AND AXLE-LOAD SCALES.—The requirements for wheel-load weighers and axle-load scales apply only to such scales in official use for the enforcement of traffic and highway laws.

S. SPECIFICATIONS. (Applicable with respect to the design of scales.)

S.1. DESIGN OF INDICATING AND RECORDING ELEMENTS AND OF RECORDED REPRESENTATIONS.

S.1.1. ZERO INDICATION.—On an automatic-indicating scale and a balance indicator, provision shall be made

(a) to indicate or record zero, and
(b) to indicate or record an out-of-balance condition on either side of zero.

S.1.2. GRADUATIONS.

S.1.2.1. LENGTH.—Graduations shall be so varied in length that they may be conveniently read.

S.1.2.2. WIDTH.—In any series of graduations, the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations, and the width of main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Graduations shall in no case be less than 0.008 inch in width.

S.1.2.3. CLEAR INTERVAL BETWEEN GRADUATIONS.—The clear interval shall be not less than 0.02 inch for graduations representing money values and not less than 0.03 inch for other graduations. If the graduations are not parallel, the measurement shall be made

(a) along the line of relative movement between the graduations and 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 with which it is associated and at least throughout that portion of its length that is associated with the graduations.

S.1.3.2. LENGTH.—The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case the distance between the end of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 0.04 inch.

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 widest graduation,
(b) the width of the minimum clear interval between weight graduations, and
(c) three-fourths of the width of the minimum clear interval between money-value 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 0.06 inch.

S.1.3.5. PARALLAX.—Parallax effects shall be reduced to the practicable minimum.

S.1.4. WEIGHT RANGES AND UNIT WEIGHTS.—The total value of weight ranges and of unit weights in effect or in place at any time shall automatically be accounted for on the reading face and on any recorded representation.

S.1.5. FOR COMPUTING SCALES ONLY.

S.1.5.1. VALUE GRADUATIONS AND GRADUATED INTERVALS.—The value of the graduated intervals representing money values on a computing scale shall be as follows:

(a) Not more than 1 cent at all unit prices of 25 cents per pound and less.

(b) Not more than 2 cents at unit prices of between 26 cents per pound and $1.25 per pound. (Special graduations defining 5-cent intervals may be employed, but not in the spaces between regular graduations.)

(c) Not more than 5 cents at unit prices above $1.25 per pound.

Value figures and graduations shall not be duplicated in any column or row on the graduated chart. (See also G–S.5.5.1. and G–S.5.5.2.)

S.1.5.2. CUSTOMERS' INDICATIONS.—Weight indications shall be shown on the customers' side of computing scales when these are used for direct sales to retail customers.

S.1.6. FOR PREPACKAGING SCALES ONLY.

S.1.6.1. VALUE OF GRADUATED INTERVAL.—*On a prepackaging scale, the graduated intervals representing weight values shall be uniform throughout the entire reading face, and any recorded representation shall present weight values identical with those on the reading face.* [1961]

S.1.6.2. LABEL PRINTER.—*A prepackaging scale that, as a part of the scale itself or of any auxiliary device attached thereto or used in connection therewith, produces a printed ticket to be used as the label for a package shall print all values digitally and of such size, style of type, and color as to be clear and conspicuous on the label.* [1962]

S.2. DESIGN OF BALANCE, LEVEL, DAMPING, AND ARRESTING MECHANISMS.

S.2.1. ZERO-LOAD ADJUSTMENT.

S.2.1.1. GENERAL.—A scale shall be equipped with means by which the zero-load balance may be adjusted, and any loose material used for this purpose shall be so enclosed that it cannot shift in position in such a way that the balance condition of the scale is altered.

S.2.1.2. BALANCE BALL.—*Except on cream-test, moisture-test, jewelers, prescription, prepackaging, and checkweighing scales, a balance ball or similar device shall not itself be rotatable unless the balancing device is automatic in operation or it is enclosed in a cabinet.* [1956]

S.2.1.3. BENCH, COUNTER, AND HANGING SCALES.—Except on cream-test, moisture-test, jewelers, prescription, prepackaging, and checkweighing scales, a mechanical device for adjusting zero-load balance shall be operable or accessible only by a tool outside of, and entirely separate from, the zero-adjusting element.

S.2.2. BALANCE INDICATOR.—On a balance indicator consisting of two indicating edges, lines, or points, the ends of the indicators shall be sharply defined and shall be separated by not more than 0.04 inch, measured horizontally, when the scale is in balance.

S.2.3. LEVEL-INDICATING MEANS.—If the weighing performance of a bench or counter scale (except a prescription, jewelers, cream-test, or moisture-test scale) is changed by an amount greater than the appropriate acceptance tolerance when it is moved from a level position and rebalanced in a position that is out of level in any direction by 5 percent or approximately 3 degrees, the scale shall be equipped with level-indicating means. The indications of this level-indicating means shall be readily observable without the necessity of disassembly of any scale parts requiring the use of mechanical means separate from the scale.

S.2.4. DAMPING MEANS.—An automatic-indicating scale, and a balance indicator, shall be equipped with effective means (such as a dashpot) for damping the oscillations whenever such means are necessary to bring the indicating elements quickly to rest.

S.2.5. FOR PREPACKAGING AND CHECKWEIGHING SCALES ONLY.

S.2.5.1. BALANCING DEVICE.—A prepackaging and a checkweighing scale may be equipped with an auxiliary, manually-operable balancing device if this is so designed that it will operate only in a backward direction (that is, in the direction of underregistration) with respect to the balance condition established by the principal tool-operated balancing device of the scale.

S.2.6. FOR CREAM-TEST, JEWELERS, MOISTURE-TEST, AND PRESCRIPTION SCALES ONLY.

S.2.6.1. BALANCE INDICATOR.—A cream-test, jewelers, moisture-test, or prescription scale shall be equipped with a balance indicator. If this consists of an indicator and a graduated scale that are not in the same plane, the clearance between the indicator and the graduations shall be not more than 0.04 inch.

S.2.7. FOR JEWELERS AND PRESCRIPTION SCALES ONLY.

S.2.7.1. ARRESTING MEANS.—A jewelers or prescription scale shall be equipped with appropriate means for arresting the oscillation of the mechanism.

S.3. DESIGN OF LOAD-RECEIVING ELEMENTS.

S.3.1. TRAVEL OF PANS OF EQUAL-ARM SCALE.—The travel, between limiting stops of the pans of a nonautomatic-indicating equal-arm scale not equipped with a balance indicator shall be not less than the minimum travel shown in table 1.

TABLE 1.—MINIMUM TRAVEL OF PANS OF NONAUTOMATIC-INDICATING EQUAL-ARM SCALE WITHOUT BALANCE INDICATOR

Nominal capacity	Minimum travel of pans
Pounds	*Inch*
4 or less	0. 35
5 to 12, incl	. 5
13 to 26, incl	. 75
Over 26	1. 0

S.3.2. DRAINAGE.—A load-receiving element intended to receive wet commodities shall be so constructed as to drain effectively.

S.3.3. SCOOP COUNTERBALANCE.—A scoop on a scale used for direct sales to retail customers shall not be counterbalanced by a removable weight. A permanently attached scoop-counterbalance shall indicate clearly on both the dealer's and customer's sides of the scale whether it is positioned for the scoop to be on or off the scale.

S.4. DESIGN OF WEIGHING ELEMENTS.

S.4.1. ANTIFRICTION ELEMENTS.—At all points at which a live part of the mechanism may come into contact with another part in the course of normal usage, frictional effects shall be reduced to a minimum by means of suitable antifriction elements, opposing surfaces and points being properly shaped, finished, and hardened. A platform scale having a frame around the platform shall be equipped with means to prevent interference between platform and frame.

S.4.2. ADJUSTABLE WEIGHING ELEMENTS.—An adjustable weighing element such as a nose-iron, a pendulum, or a spring (but not an element for adjusting level or zero-load balance) shall be held securely in adjustment and shall not be adjustable from the outside of the scale. The position of a nose-iron on a scale of more than 500 pounds capacity, as determined by the factory adjustment, shall be accurately, clearly, and permanently defined.

S.5. DESIGN OF WEIGHBEAMS AND POISES.

S.5.1. WEIGHBEAMS.

S.5.1.1. NORMAL BALANCE POSITION.—The normal balance position of the weighbeam of a beam scale shall be horizontal.

S.5.1.2. TRAVEL.—The weighbeam of a beam scale shall have equal travel above and below the horizontal. The total travel of the weighbeam of a beam scale in a trig loop or between other limiting stops near the weighbeam tip shall be not less than the minimum travel shown in table 2. When such limiting stops are not provided, the total travel at the weighbeam tip shall be not less than 8 percent of the distance from the weighbeam fulcrum to the weighbeam tip.

TABLE 2.—MINIMUM TRAVEL OF WEIGHBEAM OF BEAM SCALE BETWEEN LIMITING STOPS

Distance from weighbeam fulcrum to limiting stops	Minimum travel between limiting stops
Inches	*Inch*
12 or less	0. 4
13 to 20, incl	. 5
21 to 40, incl	. 7
Over 40	. 9

S.5.1.3. SUBDIVISION.—A subdivided weightbeam bar shall be subdivided by means of graduations, notches, or a combination of both. Graduations on a particular bar shall be of uniform width and perpendicular to the top edge of the bar. Notches on a particular bar shall be uniform in shape and dimensions and perpendicular to the face of the bar. When a combination of graduations and notches is employed, the graduations shall be so positioned in relation to the notches as to indicate notch values clearly and accurately.

S.5.1.4. READABILITY.—A subdivided weighbeam bar shall be so subdivided and marked, and a weighbeam poise shall be so constructed, that the weight corresponding to any normal poise position can easily and accurately be read directly from the beam, whether or not provision is made for the optional recording of representations of weight.

S.5.1.5. CAPACITY.—On an automatic-indicating scale having a nominal capacity of 30 pounds or less and used for direct sales to retail customers,

(a) the capacity of any weighbeam bar shall be a multiple of the reading-face capacity,
(b) each bar shall be subdivided throughout or shall be subdivided into notched intervals each equal to the reading-face capacity, and
(c) the value of any turnover poise shall be equal to the reading-face capacity.

S.5.1.6. POISE STOP.—Except on a steelyard with no zero graduation, a shoulder or stop shall be provided on each weighbeam bar to prevent a poise from traveling and remaining back of the zero graduation.

S.5.2. POISES.

S.5.2.1. GENERAL.—No part of a poise shall be readily detachable. A locking screw shall be perpendicular to the longitudinal axis of the weighbeam and shall not be removable. Except on a steelyard with no zero graduation, a poise shall not be readily removable from a weighbeam. The knife edge of a hanging poise shall be hard and sharp and so constructed as to allow the poise to swing freely on the bearing surfaces in the weighbeam notches.

S.5.2.2. ADJUSTING MATERIAL.—The adjusting material in a poise shall be securely enclosed and firmly fixed in position, and if softer than brass it shall not be in contact with the weighbeam.

787–784 O—65——4

S.5.2.3. PAWL.—A poise, other than a hanging poise, on a notched weighbeam bar shall have a pawl that will seat the poise in a definite and correct position in any notch, wherever in the notch the pawl is placed, and hold it there firmly and without appreciable movement. That dimension of the tip of the pawl that is transverse to the longitudinal axis of the weighbeam shall be at least equal to the corresponding dimension of the notches.

S.5.2.4. READING EDGE OR INDICATOR.—The reading edge or indicator of a poise shall be sharply defined, and a reading edge shall be parallel to the graduations on the weighbeam.

S.6. MARKING REQUIREMENTS. (See also G–S.1.)

S.6.1. NOMINAL CAPACITY.—The nominal capacity shall be conspicuously marked as follows:

(a) On any scale equipped with unit weights or weight ranges.

(b) On any scale with which counterpoise or equal-arm weights are intended to be used.

(c) On any automatic-indicating or recording scale so constructed that the capacities of the several individual indicating and recording elements are not immediately apparent.

S.6.2. FOR PREPACKAGING SCALES ONLY.—A prepackaging scale shall be conspicuously marked on the operator's side and on the opposite side with the words "For Prepackaging Use Only" or with a similar and suitable statement.

N. NOTES. (Applicable with respect to the testing of scales.)

N.1. TESTING PROCEDURES.

N.1.1. INCREASING-LOAD TEST.—The increasing-load test shall be conducted on all scales with the test loads approximately centered on the load-receiving element of the scale, except on a scale having a nominal capacity greater than the total available known test load, in which case the available test load is used to greatest advantage by concentrating it, within prescribed load limits, over the main load supports of the scale.

N.1.2. DECREASING-LOAD TEST.—The decreasing-load test shall be conducted on automatic-indicating scales only and with a test load equal to one-half of the maximum applied test load, approximately centered on the load-receiving element of the scale.

N.1.3. SHIFT TEST.

N.1.3.1. ON BENCH OR COUNTER SCALES.—The shift test shall be conducted with a half-capacity test load centered successively at four points equidistant between the center and the front, left, back, and right edges of the load-receiving element.

N.1.3.2. ON CREAM-TEST OR MOISTURE-TEST SCALES.—The shift test shall be conducted with a test load of 18 grams, this load being successively positioned at all points at which a weight might reasonably be placed in the course of normal use of the scale.

N.1.3.3 ON EQUAL-ARM SCALES.—The shift test shall be conducted with a half-capacity test load shifted, as prescribed in N.1.3.1., on each pan, with an equal test load centered on the other pan.

N.1.3.4. ON VEHICLE AND RAILWAY TRACK SCALES.—The shift test shall be conducted with at least two different test loads successively distributed between the two load bearings (or other weighing elements) that support each section of the scale.

N.1.3.5. ON ALL OTHER SCALES EXCEPT CRANE SCALES AND HANGING SCALES.—The shift test shall be conducted on all other scales, except crane scales and hanging scales, with a half-capacity test load centered, as nearly as possible, successively at the center of each quarter of the load-receiving element, or with a quarter-capacity test load centered, as nearly as possible, successively over each main load support.

N.1.4. TEST FOR SENSITIVENESS FOR NON-AUTOMATIC-INDICATING SCALES.—The test for sensitiveness shall be conducted on all nonautomatic-indicating scales. SR tests shall be made at zero load and at the maximum test load applied to the scale by either increasing or decreasing (in appropriate amount) the test-weight load on the load-receiving element of the scale. The response of the scale shall be as follows:

(a) **ON A SCALE WITH A TRIG LOOP BUT WITHOUT A BALANCE INDICATOR.**—The position of rest of the weighbeam shall change from the center of the trig loop to the top or bottom, as the case may be.

(b) **ON A SCALE WITH A SINGLE BALANCE INDICATOR AND HAVING A NOMINAL CAPACITY OF LESS THAN 500 POUNDS.**—The position of rest of a single indicator on a scale having a nominal capacity of less than 500 pounds shall change at least 0.04 inch **or** at least one division on the graduated scale, **whichever is greater.**

(c) **ON A SCALE WITH A SINGLE BALANCE INDICATOR AND HAVING A NOMINAL CAPACITY OF 500 POUNDS OR GREATER.**—The position of rest of a single indicator on a scale having a nominal capacity of 500 pounds or greater shall change at least 0.25 (¼) inch **or** at least one division on the graduated scale (or the width of the central target area), **whichever is greater.** However, the indicator on a batching scale shall change at least 0.12 (⅛) inch or at least one division on the graduated scale, **whichever is greater.**

(d) **ON A SCALE WITH TWO OPPOSITE-MOVING BALANCE INDICATORS.**—The position of rest of the two indicators moving in opposite directions shall change, with respect to each other, by at least 0.04 inch.

(e) **ON A SCALE WITH NEITHER A TRIG LOOP NOR A BALANCE INDICATOR.**—The position of rest of the weighbeam or lever system shall change from the horizontal, or midway between limiting stops, to either limit of motion.

N.1.5. RATIO TEST.—A ratio test shall be conducted on all scales employing counterpoise weights and on nonautomatic-indicating equal-arm scales.

N.2. MINIMUM TEST-WEIGHT LOAD FOR RAILWAY TRACK SCALES.—In the test of a railway track scale, the test-weight load shall be not less than 30,000 pounds.

N.3. NOMINAL CAPACITY OF CLASS A PRESCRIPTION SCALES.—In the absence of information to the contrary, the nominal capacity of a Class A prescription scale shall be assumed to be ½ apothecaries ounce.

SR. SENSITIVITY REQUIREMENTS. (Applicable with respect to the sensitiveness of nonautomatic-indicating scales.)

SR.1. APPLICATION.—The SR is applicable to a scale to which acceptance tolerances apply and to a scale to which maintenance tolerances apply.

SR.2. GENERAL.—Except for vehicle, axle-load, livestock, animal, railway track, prescription, jewelers, cream-test, and moisture-test scales, the SR on a nonautomatic-indicating scale shall be the value of the minimum graduated interval on the weighbeam **or** 0.1 percent of the test load, **whichever is greater.**

SR.3. FOR VEHICLE, AXLE-LOAD, LIVESTOCK, AND ANIMAL SCALES.

SR.3.1. FOR VEHICLE AXLE-LOAD, LIVESTOCK, AND ANIMAL SCALES NOT EQUIPPED WITH BALANCE INDICATORS.—The SR on a scale not equipped with a balance indicator shall be twice the value of the minimum graduated interval on the weigh-beam, **or** 0.2 percent of the nominal capacity of the scale, **whichever is less.**

SR.3.2. FOR VEHICLE, AXLE-LOAD, LIVESTOCK, AND ANIMAL SCALES EQUIPPED WITH BALANCE INDICATORS.—The SR on a scale equipped with a balance indicator shall be the value of the minimum graduated interval on the weighbeam.

SR.4. FOR RAILWAY TRACK SCALES.—The SR shall be 100 pounds.

SR.5. FOR CLASS A PRESCRIPTION SCALES AND JEWELERS SCALES.—The SR shall be 0.1 grain (6 milligrams).

SR.6. FOR CREAM-TEST SCALES.—The SR shall be 0.5 grain (32 milligrams).

SR.7. FOR MOISTURE-TEST SCALES.—The SR shall be 0.3 grain (19 milligrams).

SR.8. FOR CREAM-TEST SCALES.—The SR shall be 0.5 grain (32 milligrams).

SR.9. FOR MOISTURE-TEST SCALES.—The SR shall be 0.3 grain (19 milligrams).

T. TOLERANCES. (Applicable with respect to the performance of scales.)

T.1. TOLERANCE APPLICATION.

T.1.1. TO UNDERREGISTRATION AND TO OVERREGISTRATION.—The tolerances hereinafter prescribed shall be applied equally to errors of underregistration and errors of overregistration.

T.1.2. TO TESTS INVOLVING DIGITAL INDICATIONS OR REPRESENTATIONS.—To the tolerances that would otherwise be applied, there shall be added an amount equal to one-half the minimum value that can be indicated or recorded.

T.1.3. TO INCREASING-LOAD TESTS.—Basic tolerances shall be applied.

T.1.4. TO SHIFT TESTS.—Basic tolerances shall be applied.

T.1.5. TO RATIO TESTS.—Three-fourths (0.75) of basic tolerances shall be applied.

T.1.6. TO DECREASING-LOAD TESTS ON AUTOMATIC-INDICATING SCALES.—One and one-half (1.5) times basic tolerances shall be applied.

T.2. MINIMUM TOLERANCE VALUES.

T.2.1. GENERAL.—Except for livestock, animal, crane, railway track, prescription, and jewelers scales, the maintenance tolerance and the acceptance tolerance applied to a scale shall be not smaller than the appropriate value shown in table 3, **or** one-half the value of the minimum graduated interval, **whichever is less.**

T.2.2. FOR LIVESTOCK SCALES.—The minimum maintenance tolerance and acceptance tolerance shall be 2 pounds.

T.2.3. FOR ANIMAL SCALES.—The minimum maintenance tolerance and acceptance tolerance shall be 1 pound.

T.2.4. FOR CRANE SCALES.—The minimum tolerance shall be 0.1 percent of the reading-face capacity of the scale.

T.2.5. FOR RAILWAY TRACK SCALES.—The minimum tolerance shall be 25 pounds.

T.2.6. FOR CLASS A PRESCRIPTION SCALES.—The minimum tolerance shall be 0.1 grain (6 milligrams).

T.2.7. FOR CREAM-TEST SCALES AND MOISTURE-TEST SCALES.—The minimum tolerance shall be 0.2 grain (13 milligrams).

T.2.8. FOR JEWELERS SCALES.—The minimum tolerance shall be 0.1 grain (6 milligrams).

TABLE 3.—MINIMUM TOLERANCE VALUES FOR SCALES EXCEPT LIVESTOCK, ANIMAL, CRANE, RAILWAY TRACK, PRESCRIPTION, AND JEWELERS

(This table applies where the appropriate value in the table is smaller than one-half the value of the minimum graduated interval on the device under test.)

Nominal capacity for non-automatic-indicating scales* or Reading-face capacity for automatic-indicating scales**	Minimum tolerance value		
Pounds	*Expressed in grains*	*Expressed in ounces*	*Expressed in pounds*
0 to 4, incl	15	1/32	0. 002
5 to 10, incl	30	1/16	. 004
11 to 20, incl	------	1/8	. 008
21 to 30, incl	------	3/16	. 012
31 to 50, incl	------	1/2	. 031
51 to 100, incl	------	3/4	. 047
101 to 150, incl	------	1 1/4	. 078
151 to 250, incl	------	2	. 125
251 to 500, incl	------	4	. 250
501 to 1,000, incl	------	8	. 500
1,001 to 2,500, incl	------	------	1
2,501 to 5,000, incl	------	------	2 1/2
5,001 to 10,000, incl	------	------	5
10,001 to 20,000, incl	------	------	10
20,001 to 50,000, incl	------	------	20
Above 50,000	------	------	25

*Including, in addition, scales equipped with over-and-under indicators.
**Excluding scales equipped with over-and-under indicators. (The reading-face capacity of a multi-revolution scale shall be the total capacity of the scale.)

T.3. BASIC TOLERANCE VALUES.

T.3.1. APPLICATION.—Basic tolerance values shall be applied to weighbeam, reading-face, and unit-weight indications, and to recorded representations.

T.3.2. GENERAL.—Except for vehicle, axle-load, livestock, animal, railway track, crane, prescription, jewelers, cream-test, and moisture-test scales, and wheel-load weighers, the basic maintenance and acceptance tolerances shall be as shown in table 4 (for scales indicating or recording in avoirdupois units) and table 5 (for scales indicating or recording in apothecaries or metric units).

TABLE 4.—BASIC TOLERANCES FOR SCALES INDICATING OR RECORDING IN AVOIRDUPOIS UNITS, EXCEPT FOR VEHICLE, AXLE-LOAD, LIVESTOCK, ANIMAL, RAILWAY TRACK, CRANE, PRESCRIPTION, JEWELERS, CREAM-TEST, AND MOISTURE-TEST SCALES, AND WHEEL-LOAD WEIGHERS (See T.3.2.)

Test load		Maintenance tolerances			Acceptance tolerances		
From	to but not including	*Expressed in grains*	*Expressed in ounces*	*Expressed in pounds*	*Expressed in grains*	*Expressed in ounces*	*Expressed in pounds*
Ounces avdp.							
0	2	2	----------	----------	1	----------	----------
2	4	4	----------	----------	2	----------	----------
4	8	8	----------	----------	4	----------	----------
8	16	16	----------	----------	8	----------	----------
Pounds avdp.							
1	2	25	1/16	0. 004	13	1/32	0. 002
2	4	----------	1/8	. 008	----------	1/16	. 004
4	7	----------	3/16	. 012	----------	3/32	. 006
7	10	----------	1/4	. 016	----------	1/8	. 008
10	15	----------	5/16	. 020	----------	5/32	. 010
15	20	----------	3/8	. 024	----------	3/16	. 012
20	30	----------	1/2	. 031	----------	1/4	. 016
30	40	----------	5/8	. 039	----------	5/16	. 020
40	50	----------	3/4	. 047	----------	3/8	. 024
50	75	----------	1	. 062	----------	1/2	. 031
75	100	----------	1 1/2	. 094	----------	3/4	. 047
100	150	----------	2	. 125	----------	1	. 062
150	200	----------	3	. 188	----------	1 1/2	. 094
200	300	----------	4	. 250	----------	2	. 125
300	400	----------	6	. 375	----------	3	. 188
400	600	----------	8	. 500	----------	4	. 250
600	800	----------	12	. 750	----------	6	. 375
800	1, 000	----------	14	. 875	----------	7	. 438
1, 000 and over		0. 1 percent of test load			0. 05 percent of test load		

TABLE 5.—BASIC TOLERANCES FOR SCALES INDICATING OR RECORDING IN EITHER APOTHECARIES OR METRIC UNITS, EXCEPT VEHICLES, AXLE-LOAD, LIVESTOCK, ANIMAL, RAILWAY TRACK, CRANE, PRESCRIPTION, JEWELERS, CREAM-TEST, AND MOISTURE-TEST SCALES AND WHEEL-LOAD WEIGHERS

(See T.3.2.)

Test load		Maintenance tolerances	Acceptance tolerances
From	to but not including	*Expressed in Grains*	*Expressed in Grains*
Ounces apoth.			
0	1	1	0. 5
1	2	2	1. 0
2	4	4	2. 0
4	6	7	3. 5
6	8	10	5. 0
8	12	12	6. 0
Grams		*Milligrams*	*Milligrams*
0	10	15	8
10	20	50	25
20	40	100	50
40	60	150	75
60	100	250	125
100	150	350	175
150	200	500	250
200	300	650	325
300	400	800	400
		Grams	*Grams*
400	500	1. 0	0. 5
500	750	1. 5	0. 75
750	1, 000	2. 0	1. 0
Kilograms			
1	2	4. 0	2. 0
2	3	5. 5	2. 8
3	5	7. 5	3. 8
5	10	11. 0	6. 0
10	15	15. 0	7. 5
15	20	19. 0	8. 5
20	30	25. 0	12. 5
30	40	35. 0	17. 5
40	50	45. 0	22. 5
50 kilograms and over		0.1 percent of test load	0.05 percent of test load

T.3.3. FOR VEHICLE, AXLE-LOAD, LIVESTOCK, ANIMAL, CRANE, AND RAILWAY TRACK SCALES.—The basic maintenance tolerance on vehicle, axle-load, livestock, animal, crane, and railway track scales shall be 2 pounds per 1,000 pounds of test load (0.2 percent). The acceptance tolerance shall be one-half the basic maintenance tolerance.

T.3.4. FOR CLASS A PRESCRIPTION SCALES.—The basic maintenance and acceptance tolerance shall be 0.1 percent of the test load.

T.3.5. FOR JEWELERS SCALES.—The basic maintenance and acceptance tolerance shall be 0.1 percent of the test load.

T.3.6. FOR CREAM-TEST AND MOISTURE-TEST SCALES.—The basic maintenance tolerance for cream-test and moisture-test scales (applied on an 18-gram load) shall be 0.5 grain (32 milligrams). The basic acceptance tolerance shall be 0.3 grain (19 milligrams).

T.3.7. FOR WHEEL-LOAD WEIGHERS.—The basic maintenance tolerance for individual wheel-load weighers shall be 3 percent of the known test load. The basic acceptance tolerance shall be 2 percent of the known test load. When two wheel-load weighers are marked and tested as a pair, the tolerance shall be applied to the sum of the indications of the two weighers, and the pair shall be approved or rejected upon the basis of the combined indications.

UR. USER REQUIREMENTS. (Applicable with respect to the selection, installation, use, and maintenance of scales.)

UR.1. SELECTION REQUIREMENTS.

UR.1.1. VALUE OF MINIMUM GRADUATED INTERVALS ON PRIMARY INDICATING AND RECORDING ELEMENTS.

UR.1.1.1. FOR ANIMAL SCALES ONLY.—The value of the minimum graduated interval shall be not greater than 1 pound.

UR.1.1.2. FOR CRANE SCALES ONLY.—*The value of the minimum graduated interval shall be not greater than 0.2 percent of the nominal capacity of the scale.* [1961]

UR.1.1.3. FOR HAND-OPERATED GRAIN HOPPER SCALES ONLY.—The value of the minimum graduated interval shall be not greater than 5 pounds.

UR.1.1.4. FOR LIVESTOCK SCALES ONLY.—The value of the minimum graduated interval shall be not greater than 5 pounds.

UR.1.1.5. FOR RETAIL FOOD SCALES ONLY.—The value of the minimum graduated interval on a scale used for the retail sale of foodstuffs, with a nominal capacity of 50 pounds or less, shall be not greater than 1 ounce.

UR.1.1.6. FOR VEHICLE SCALES, AXLE-LOAD SCALES, AND WHEEL-LOAD WEIGHERS ONLY.—The value of the minimum graduated interval shall be not greater than 20 pounds.

UR.1.1.7. FOR SCALES WITH NOMINAL CAPACITIES OF 500 POUNDS OR MORE, OTHER THAN ANIMAL, CRANE, HAND-OPERATED GRAIN HOPPER, LIVESTOCK, RAILWAY TRACK, VEHICLE, AND AXLE-LOAD SCALES AND WHEEL-LOAD WEIGHERS.—*The value of the minimum graduated interval shall be not greater than 0.1 percent of the nominal capacity of the scale* ***or*** *¼ pound,* ***whichever is greater,*** *and in any case* ***not greater than*** *50 pounds.* [1960]

UR.2. INSTALLATION REQUIREMENTS.

UR.2.1. SUPPORTS.—A scale that is portable and that is being used on a counter or table or on the floor shall be so positioned that it is firmly and securely supported.

UR.2.2. SUSPENSION OF HANGING SCALE.—A hanging scale shall be freely suspended from a fixed support when in use.

UR.2.3. PROTECTION AGAINST WIND AND WEATHER EFFECTS.—The indicating elements, the lever system or load cells, and the under side of the load-receiving element of a permanently installed scale shall be adequately protected against wind and weather effects.

UR.2.4. FOUNDATION, SUPPORTS, AND CLEARANCE.—The foundation and supports of any scale installed in a fixed location shall be such as to provide strength, rigidity, and permanence of all components, and clearance shall be provided around all live parts to the extent that no contacts may result when the load-receiving element is empty and throughout the weighing range of the scale.

UR.2.5. ACCESS TO PIT.—Adequate provision shall be made for ready access to the pit of a vehicle, livestock, or animal scale for purposes of inspection and maintenance.

UR.2.6. APPROACHES TO AXLE-LOAD SCALES.—At each end of an axle-load scale there shall be a straight approach in the same plane as the platform, of sufficient length and width to insure the level positioning of vehicles during weight determinations.

UR.2.7. STOCK RACKS.—A livestock or animal scale shall be equipped with a suitable stock rack, with gates as required, which shall be securely mounted on the scale platform. Adequate clearances shall be maintained around the outside of the rack.

UR.3. USE REQUIREMENTS.

UR.3.1. PREPACKAGING SCALE.—A scale marked with the words "For Prepackaging Use Only" or with a statement of similar meaning shall be used only for putting up packages and shall not be used for direct sales of commodities not in package form to retail customers.

UR.3.2. MINIMUM LOAD ON VEHICLE SCALE.—A vehicle scale shall not be used for weighing a load smaller than 1,000 pounds.

UR.3.3. WET COMMODITIES.—Wet fish and other wet commodities shall be weighed only on scales on which the pans or platforms will drain properly.

UR.3.4. LADING.—A scale shall not be used for weighing a load totaling more than the nominal capacity of the scale.

UR.3.5. FOR WHEEL-LOAD WEIGHERS ONLY.—When wheel-load weighers are to be regularly used in pairs, both weighers of each such pair shall be appropriately marked to identify them as weighers intended to be used in combination.

UR.4. MAINTENANCE REQUIREMENTS.

UR.4.1. BALANCE CONDITION.—A scale shall be maintained in balance.

UR.4.2. LEVEL CONDITION.—If a scale is equipped with a level-indicating means, the scale shall be maintained in level.

UR.4.3. LENGTHENING AND WIDENING OF PLATFORMS.—Neither the length nor the width of the load-receiving element of a scale shall be increased beyond the manufacturer's designed dimension, except when the modification has been approved by competent scale-engineering authority, preferably that of the engineering department of the manufacturer of the scale and by the weights and measures authority having jurisdiction over the scale.

UR.4.4 SINGLE-DRAFT VEHICLE WEIGHING.—A highway vehicle or a coupled highway-vehicle combination shall be commercially weighed on a vehicle scale only as a single draft. That is, the total weight of such a vehicle or combination shall not be determined by adding together the results obtained by separately and not simultaneously weighing each end of such vehicle or individual elements of such coupled combination. However,

(a) the weight of a coupled combination may be determined by uncoupling the various elements (tractor, semitrailer, trailer), weighing each unit separately as a single draft, and adding together the results, and

(b) the weight of a vehicle or coupled-vehicle combination may be determined by adding together the weights obtained while all individual elements are resting simultaneously on more than one scale platform.

DEFINITIONS OF TERMS

SCALES

The terms defined here have a special and technical meaning when used in the Scale Code. Whenever a defined term is used in the Scale Code, it has the particular meaning given here.

animal scale. A livestock scale adapted to weighing single heads of livestock.

automatic hopper scale. One adapted to the automatic weighing of bulk commodity in successive drafts of predetermined amounts. (This is not an "automatic-indicating scale" as defined.)

automatic-indicating scale. One on which the weights of applied loads of various magnitudes are automatically indicated throughout all or a portion of the weighing range of the scale. (A scale that automatically weighs out commodity in predetermined drafts, such as an automatic hopper scale, a packaging scale, and the like, is not an "automatic-indicating" scale.)

axle-load scale. A scale, permanently installed in a fixed location, having a load-receiving element specially adapted to determining the combined load of all wheels (1) on a single axle or (2) on a tandem axle, of a highway vehicle.

balance indicator. A combination of elements, one or both of which will oscillate with respect to the other, for indicating the balance condition of a nonautomatic-indicating scale. The combination may consist of two indicating edges, lines, or points, or a single edge, line, or point and a graduated scale.

balance, zero-load. See zero-load balance.

beam. See weighbeam.

beam scale. One on which the weights of loads of various magnitudes are indicated solely by means of one or more weighbeam bars either alone or in combination with counterpoise weights.

checkweighing scale. One used to verify predetermined weight within prescribed limits.

coal-mine scale. One used at a coal mining operation for determining the basic wages of miners on a production basis.

computing scale. One that indicates the money values of amounts of commodity weighed, at predetermined unit prices, throughout all or part of the weighing range of the scale.

counterbalance weight. One intended for application near the butt of a weighbeam for zero-load balancing purposes.

counterpoise weight. A slotted or "hanger" weight intended for application near the tip of the weighbeam of a scale having a multiple greater than 1.

crane scale. One with a nominal capacity of 5,000 pounds or more designed to weigh loads while these are suspended freely from an overhead, track-mounted crane.

cream-test scale. One adapted to determining the butterfat content of milk, cream, or butter.

decreasing-load test. A special supplementary test for automatic-indicating scales only, during which the performance of the scale is tested when loads are being reduced. In this test, observations are made as decrements of test-weight load are successively removed from the load-receiving element of the scale.

equal-arm scale. A scale having only a single lever with equal arms (that is, with a multiple of 1), equipped with two similar or dissimilar load-receiving elements (pan, plate, platter, scoop, or the like), one intended to receive material being weighed and the other intended to receive weights. There may or may not be a weighbeam ("side bar").

fractional bar. A weighbeam bar of relatively small capacity, for obtaining indications intermediate between notches or graduations on a main or tare bar.

hand-operated grain hopper scale. One adapted to the manual weighing of individual loads of grain of varying magnitude.

hopper scale, automatic. See automatic hopper scale.

hopper scale, hand-operated grain. See hand-operated grain hopper scale.

increasing-load test. The normal basic performance test for a scale, in which observations are made as increments of test-weight load are successively added to the load-receiving element of the scale.

indicator, balance. See balance indicator.

jewelers scale. One adapted to weighing gems and precious metals.

livestock scale. One equipped with stock racks and gates and adapted to weighing livestock standing on the scale platform.

load cell. The basic weighing element of a load-cell scale. The load cell, whether electric, hydraulic, or pneumatic, produces a signal proportional to the load applied.

main bar. A principal weighbeam bar, usually of relatively large capacity as compared with other bars of the same weighbeam. (On an automatic-indicating scale equipped with a weighbeam, the main weighbeam bar is frequently called the "capacity" bar.)

main-weighbeam elements. The combination of a main bar and its fractional bar, or a main bar alone if this has no fractional bar associated with it.

moisture-test scale. One adapted to determining the moisture content of butter or cheese.

multiple of a scale. In general, the multiplying power of the entire system of levers or other basic weighing elements. (On a beam scale, the multiple of the scale is the number of pounds on the load-receiving element that will be counterpoised by 1 pound applied to the tip pivot of the weighbeam.)

multi-revolution scale. An automatic-indicating scale having a nominal capacity that is a multiple of the reading-face capacity and that is achieved by more than one complete revolution of the indicator.

nominal capacity. The nominal capacity of a scale is the largest weight indication that can be obtained by the use of all of the reading or recording elements in combination, including the amount represented by any removable weights furnished or ordinarily furnished with the scale, but excluding the amount represented by any extra removable weights not ordinarily furnished with the scale, and excluding also the capacity of any auxiliary weighing attachment not contemplated by the original design of the scale. However, in applying this definition, the capacity of any fractional bar is to be included only when this exceeds 2 ½ percent of the sum of the capacities of the remaining reading elements. (See also nominal capacity, batching scale; nominal capacity, hopper scale.)

nominal capacity, batching scale. The nominal capacity of a batching scale is the capacity as marked on the scale by the scale manufacturer, **or** the sum of the products of the volume of each of the individual hoppers, in terms of cubic feet, times the weight per cubic foot of the heaviest material weighed in each hopper, **whichever is less.**

nominal capacity, hopper scale. The nominal capacity of a hopper scale is the capacity as marked on the scale by the scale manufacturer, **or** the product of the volume of the hopper in bushels or cubic feet times the maximum weight per bushel or cubic foot, as the case may be, of the commodity normally weighed, **whichever is less.**

nose-iron. A slidably-mounted, manually-adjustable pivot assembly for changing the multiple of a lever.

over-and-under indicator. An automatic-indicating element incorporated in or attached to a scale and comprising an indicator and a graduated scale with a central or intermediate "zero" graduation and a limited range of weight graduations on either side of the zero graduation, for indicating weights greater than and less than the predetermined values for which other elements of the scale may be set. (A scale having an over-and-under indicator is classed as an automatic-indicating scale.)

poise. A movable weight mounted upon or suspended from a weighbeam bar and used in combination with graduations, and frequently with notches, on the bar to indicate weight values. (A suspended poise is commonly called a "hanging" poise.)

prepackaging scale. A computing scale specially designed for putting up packages of random weights in advance of sale.

prescription scale. A scale or balance adapted to weighing the ingredients of medicinal and other formulas prescribed by physicians and others and used or intended to be used in the ordinary trade of pharmacists.

ranges, weight. See weight ranges.

ratio test. A test to determine the accuracy with which the actual multiple of a scale agrees with its designed multiple. This test is utilized in the case of scales employing counterpoise weights and is made with standard test weights substituted in all cases for the weights commercially used on the scale. (It is appropriate to utilize this test in the case of some scales not employing counterpoise weights.)

787–784 O—65——5

reading-face. That element of an automatic-indicating scale on which weight values are automatically indicated.

reading-face capacity. The largest weight that may be indicated on the reading face, exclusive of the application of any unit weights, weight ranges, or other elements.

recording scale. One on which the weights of applied loads may be permanently recorded on a tape, ticket, card, or the like in the form of a printed, stamped, punched, or perforated representation.

scale. See specific type of scale.

sensitivity requirement (SR). A performance requirement for a nonautomatic-indicating scale. The maximum change in load that will cause a specified change in the position of rest of the indicating element or elements of the scale. (See N. 1.4.)

shift test. A test intended to disclose the weighing performance of a scale under off-center loading.

tare bar. An auxiliary weighbeam bar, primarily for the purpose of determining, or balancing out, the weights of empty containers or vehicles.

tare-weighbeam elements. The combination of a tare bar and its fractional bar, or a tare bar alone if this has no fractional bar associated with it.

unit weight. One contained within the housing of an automatic-indicating scale and mechanically applied to and removed from the mechanism. The application of a unit weight will increase the range of automatic indication, normally in increments equal to the reading-face capacity.

vehicle scale. One adapted to weighing highway vehicles, loaded or unloaded.

weighbeam. An element comprising one or more bars, equipped with movable poises or means for applying counterpoise weights or both.

weight ranges. Electrical or electro-mechanical elements incorporated in an automatic-indicating scale through the application of which the range of automatic indication of the scale is increased, normally in increments equal to the reading-face capacity.

weight, unit. See unit weight.

wheel-load weigher. A compact, self-contained, portable scale specially adapted to determining the wheel loads of vehicles on highways.

zero-load balance. A correct weight indication or representation of zero when there is no load on the load-receiving element. (See also zero-load balance for an automatic-indicating scale, zero-load balance for a non-automatic-indicating scale, zero-load balance for a recording scale.)

zero-load balance for an automatic-indicating scale. A condition in which the indicator is at rest at or oscillates through approximately equal arcs on either side of the zero graduation.

zero-load balance for a nonautomatic-indicating scale. A condition in which (a) the weighbeam is at rest at or oscillates through approximately equal arcs above and below the center of a trig loop, (b) the weighbeam or lever system is at rest at or oscillates through approximately equal arcs above and below a horizontal position or a position midway between limiting stops, or (c) the indicator of a balance indicator is at rest at or oscillates through approximately equal arcs on either side of the zero graduation.

zero-load balance for a recording scale. A condition in which the scale will record a representation of zero load.

WEIGHTS

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1. GENERAL.—This code applies to commercial weights; that is, weights used in connection with commercial weighing devices. It **does not** apply to test weights or to other "standards" of mass.

S. SPECIFICATIONS. (Applicable with respect to the materials for, and design of, weights.)

S.1. MATERIAL.—The material used for weights shall be as follows:

(a) Weights of 100 grains or 6 grams and larger shall be made of a metal, or a metal alloy, not softer than brass.

(b) Weights of less than 100 grains may be made of aluminum, but shall not be made of iron or of unplated steel, except stainless steel.

S.2. DESIGN.

S.2.1. SURFACE.—The surface of a weight shall be smooth and shall not be coated with thick, soft, or brittle material. A weight of more than 30 grains or 2 grams shall not have sharp edges, points, or corners.

S.2.2. RING.—A ring on a weight shall not be split or removable.

S.3. ADJUSTING MATERIAL.—Adjusting material shall be securely positioned and shall not project beyond the surface of the weight.

S.4. MARKING REQUIREMENTS.

S.4.1. GENERAL.—A weight shall be marked to show clearly its nominal value, which shall include identification of the unit; however, the nominal value of a weight of 30 grains or 2 grams, or less, may be designated by dots, lines, figures, distinctive shape, or other appropriate means.

S.4.2. APOTHECARIES WEIGHTS.—On apothecaries dram, ounce, and pound weights, the letters "ap" shall be used in combination with the nominal value and the appropriate abbreviation of or symbol for the unit.

S.4.3. TROY WEIGHTS.—On troy ounce and pound weights, the letter "t" shall be used in combination with the nominal value and the appropriate abbreviation of the unit.

S.4.4. METRIC WEIGHTS.—On metric weights, the abbreviations "kg", "g", and "mg" shall be used in combination with the nominal value on kilograms, grams, and milligrams, respectively.

S.4.5. CARAT WEIGHTS.—On carat weights, the letter "c" shall be used in combination with the nominal value.

S.4.6. COUNTERPOISE WEIGHT.—A counterpoise weight shall be marked to show clearly both its nominal value and the value it represents when used on the multiplying-lever scale for which it is intended.

N. NOTES. (Applicable with respect to the testing of weights.)

N.1. TESTING PROCEDURES.—Commercial weights should be tested on a precision balance using weights which meet NBS Class B tolerances or equivalent.

T. TOLERANCES. (Applicable with respect to the accuracy of weights.)

T.1. IN EXCESS AND IN DEFICIENCY.—The tolerances hereinafter prescribed shall be applied equally to errors in excess and errors in deficiency.

T.2. ON AVOIRDUPOIS WEIGHTS.—The maintenance tolerances shall be as shown in table 1. Acceptance tolerances shall be one-half the maintenance tolerances.

T.3. ON METRIC WEIGHTS.—The maintenance tolerances shall be as shown in table 2. Acceptance tolerances shall be one-half the maintenance tolerances.

T.4. ON CARAT WEIGHTS.—The maintenance tolerances shall be as shown in table 2. Acceptance tolerances shall be one-half the maintenance tolerances.

T.5. ON APOTHECARIES AND TROY WEIGHTS.—The maintenance tolerance shall be as shown in table 3. Acceptance tolerances shall be one-half the maintenance tolerances.

TABLE 1.—MAINTENANCE TOLERANCES FOR AVOIRDUPOIS WEIGHTS

Nominal value	Maintenance tolerance		
	Equal-arm weights	Counterpoise weights	
		For scales with multiples of less than 1,000	For scales with multiples of 1,000 and over
Ounces	*Grains*	*Grains*	*Grains*
1/64	0.1	----------	----------
1/32	.3	----------	----------
1/16	.4	----------	----------
1/8	.5	----------	----------
1/4	1.0	----------	----------
1/2	1.5	1.0	----------
1	1.7	1.0	----------
2	2.0	1.0	----------
3	2.0	1.5	----------
4	3.0	1.5	1.0
5	3.5	1.5	1.0
6	3.5	1.5	----------
8	4.0	2.0	1.5
10	4.0	2.5	2.0
12	5.0	2.5	2.0
Pounds			
1	5.0	3.0	2.5
2	7.0	6.0	4.0
3	9.0	9.0	5.0
4	11.0	11.0	6.0
5	15	12.0	6.5
6	17	----------	----------
7	19	----------	----------
8	21	15.0	9.0
9	23	----------	----------
10	25	18.0	10.0
15	28	----------	----------
20	30	----------	----------
25	35	----------	----------
30	40	----------	----------
40	45	----------	----------
50	50	----------	----------

TABLE 2.—MAINTENANCE TOLERANCES FOR METRIC WEIGHTS

Nominal value	Maintenance tolerance
Milligrams	*Milligrams*
5 or less	0. 1
10	. 3
20	. 4
30	. 6
50	. 8
100	1. 0
200	1. 5
300	2. 0
500	3. 0
Grams	
1	4
2	6
3	8
5	10
10	15
20	20
30	30
50	40
100	70
200	100
300	150
500	175
Kilograms	
1	250
2	400
3	500
5	800
10	1, 000
20	1, 500
Carats	*Milligrams*
0. 25 (25 points) or less	0. 6
. 5 (50 points)	1. 0
1. 0	1. 5
2. 0	2. 0
3. 0	3. 0
5. 0	4. 0
10. 0	6. 0
20. 0	10. 0
30. 0	12. 0
50. 0	15. 0
100. 0	25. 0

TABLE 3.—MAINTENANCE TOLERANCES FOR APOTHECARIES AND TROY WEIGHTS

Nominal value	Maintenance tolerance	
Grains	*Grains*	*Milligrams*
1	0.01	0.6
2	.02	1.3
3	.03	2.0
5	.03	2.0
10	.04	2.5
20	.06	4.0
Scruples		
1	0.06	4.0
2	.10	6.5
Drams		
0.5	0.07	4.5
1.0	.10	6.5
2.0	.20	13.0
3.0	.30	20.0
4.0	.40	25.0
5.0	.50	30.0
6.0	.60	40.0
Pennyweights		
1	0.06	4.0
2	.10	6.5
3	.15	10.0
4	.20	13.0
5	.30	20.0
10	.40	25.0
Ounces		
1	0.4	25.0
2	.6	40.0
3	1.0	65.0
4	1.5	100.0
5	1.6	105.0
6	1.8	115.0
7	1.9	125.0
8	2.0	130.0
9	2.1	135.0
10	2.2	145.0
11	2.4	155.0
12	2.5	160.0

LIQUID-MEASURING DEVICES

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1.—This code applies to devices used for the measurement of liquids, including liquid fuels and lubricants. This code **does not** apply to the following devices:

(a) Meters mounted on vehicle tanks (for which see Code for Vehicle-Tank Meters).

(b) Devices used for dispensing liquefied petroleum gases (for which see Code for Liquefied Petroleum Gas Liquid-Measuring Devices).

(c) Devices used for dispensing other liquids that do not remain in a liquid state at atmospheric pressures and temperatures.

(d) Water meters.

(e) Devices used solely for dispensing a product in connection with operations in which the amount dispensed does not affect customer charges.

S. SPECIFICATIONS. (Applicable with respect to the design of devices.)

S.1. DESIGN OF INDICATING AND RECORDING ELEMENTS AND OF RECORDED REPRESENTATIONS.

S.1.1. PRIMARY ELEMENTS.

S.1.1.1. GENERAL.—A liquid-measuring device shall be equipped with a primary indicating element and may also be equipped with a primary recording element.

S.1.1.2. UNITS.—A liquid-measuring device shall indicate, and record if the device is equipped to record, its deliveries in terms of gallons, quarts, pints, or binary-submultiple or decimal subdivisions of the gallon.

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) one pint on retail devices, and

(b) one gallon on wholesale devices.

S.1.1.4. ADVANCEMENT OF INDICATING AND RECORDING ELEMENTS. — Primary indicating and recording elements shall be susceptible of 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.1.2. GRADUATIONS.

S.1.2.1. LENGTH.—Graduations shall be so varied in length that they may be conveniently read.

S.1.2.2. WIDTH.—In any series of graduations, the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations, and the width of main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Graduations shall in no case be less than 0.008 inch in width.

S.1.2.3. CLEAR INTERVAL BETWEEN GRADUATIONS.—The clear interval shall be not less than 0.04 inch. If the graduations are not parallel, the measurement shall be made

(a) along the line of relative movement between the graduations and 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 with which it is associated and at least throughout that portion of its length that is associated with the graduations.

S.1.3.2. LENGTH.—The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case the distance between the end of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 0.04 inch.

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 widest graduation, and

(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 0.06 inch.

S.1.3.5. PARALLAX.—Parallax effects shall be reduced to the practicable minimum.

S.1.4. FOR RETAIL DEVICES ONLY, EXCEPT SLOW-FLOW METERS.

S.1.4.1. INDICATION OF DELIVERY.—A retail liquid-fuel device shall be constructed to show automatically its initial zero condition and the amounts delivered up to the nominal capacity of the device.

S.1.4.2. RETURN TO ZERO.—The primary indicating elements, and primary recording elements if the device is equipped to record, shall be readily returnable to a definite zero indication. Means shall be provided to prevent the return of primary indicating elements, and of primary recording elements if the device is so equipped, beyond their correct zero position.

S.1.4.3. DISPLAY OF UNIT PRICE AND PRODUCT IDENTITY.—In a device of the computing type or of the coin-operated type, means shall be provided for displaying on each face of the device the unit price at which the device is set to compute or to deliver, as the case may be, and there shall be conspicuously displayed on each side of the device the identity of the product that is being dispensed. If a device is so designed as to dispense more than one grade, brand, blend, or mixture of product, means also shall be provided for displaying on each face of the device the identity of the grade, brand, blend, or mixture being dispensed.

S.1.4.4. PRINTED TICKETS.—Any printed ticket issued by a device of the computing type on which there is printed the total computed price shall have printed clearly thereon also the total volume of the delivery in terms of gallons and the appropriate fraction of the gallon and the price per gallon. (See G–S.5.5.2.)

S.1.4.5. MONEY-VALUE COMPUTATIONS.—Money-value computations on a retail device shall be of the full-computing type in which the money value at a single unit price, or at each of a series of unit prices, shall be computed for every delivery within either the range of measurement of the device **or** the range of the computing elements, **whichever is less.** Value graduations shall be supplied and shall be accurately positioned. The value of each graduated interval shall be 1 cent.

S.1.4.6. TRAVEL OF INDICATOR ON LUBRICANT DEVICES.—On a lubricant device, if the most sensitive element of the indicating system utilizes an indicator and graduations, the relative movement of these parts corresponding to a delivery of 1 pint shall be not less than 1 inch.

S.1.5. FOR WHOLESALE DEVICES ONLY.

S.1.5.1. TRAVEL OF INDICATOR.—A wholesale device shall be readily operable to deliver accurately any quantity from 50 gallons to the capacity of the device. If the most sensitive element of the indicating system utilizes an indicator and graduations, the relative movement of these parts corresponding to a delivery of 1 gallon shall be not less than 0.20 inch.

S.2. DESIGN OF MEASURING ELEMENTS.

S.2.1. VAPOR ELIMINATION.—A liquid-measuring device or metering system shall be equipped with an effective vapor eliminator or other effective means to prevent the passage of vapor and air through the meter.

S.2.2. PROVISION FOR SEALING.—Adequate provision shall be made for applying security seals in such a manner that no adjustment may be made of

(a) any measurement element, and

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

The adjusting mechanism shall be readily accessible for purposes of affixing a security seal. [1965]

S.2.3. DIRECTIONAL FLOW VALVES.—Valves intended to prevent reversal of flow shall be automatic in operation.

S.2.4. STOP MECHANISM.—If stops or other stroke-limiting elements are subject to direct pressure or impact, the security of their positions shall be accomplished by positive, nonfrictional engagement of parts, and they shall be adjustable to provide for deliveries within prescribed tolerances. If two or more stops or other elements may selectively be brought into operation to permit deliveries of predetermined amounts, the position for the proper setting of each such element shall be accurately defined, inadvertent displacement from position shall be obstructed, and the delivery for which the device is set at any time shall be conspicuously indicated.

S.2.5. FOR RETAIL DEVICES ONLY.

S.2.5.1. ZERO-SET-BACK INTERLOCK.—A retail motor-fuel device of the meter type shall be so constructed that, after a particular delivery cycle has been completed by movement of the starting lever to its shutoff position, or to what would appear to be its normal shutoff position from some reasonable "customer" position, an effective automatic interlock will prevent a subsequent delivery being started until the indicating elements have been returned to their correct zero positions.

S.2.6. FOR LUBRICANT DEVICES ONLY.

S.2.6.1. EXHAUSTION OF SUPPLY.—On a lubricant device other than one of the meter type, means shall be provided for making the device inoperable or for giving a conspicuous and distinct warning when the level of the supply of lubricant becomes so low as to endanger the accuracy of measurement.

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 or the discharge line therefrom.

S.3.2. PUMP-DISCHARGE UNIT.—If a pump-discharge unit is equipped with a flexible discharge hose, this shall be of the wet-hose type.

S.3.3. GRAVITY-DISCHARGE UNIT.—On a gravity-discharge unit, the discharge hose or equivalent pipe shall be of the dry-hose type with no shutoff valve at its outlet end; however, the discharge line may have a shutoff valve at or near the outlet end, provided the line will drain to the same level under all anticipated conditions of product discharge. A dry hose shall be of such stiffness and only of such length as to facilitate its drainage. The inlet end of the hose or of an equivalent outlet pipe shall be of such height as to provide for proper drainage. There shall be incorporated an automatic vacuum breaker or equivalent means to prevent siphoning and to insure the rapid and complete drainage.

S.3.4. DISCHARGE HOSE.—A discharge hose shall be adequately reinforced.

S.3.5. DISCHARGE VALVE.—A discharge valve may be installed in the discharge line only if the device is of the wet-hose type. Any other shutoff valve on the discharge side of the meter shall be of the automatic or semi-automatic predetermined-stop type or shall be operable only

(a) by means of a tool (but not a pin) entirely separate from the device, or

(b) by mutilation of a security seal with which the valve is sealed open.

S.3.6. ANTIDRAIN VALVE.—In a wet-hose, pressure-type device, an effective antidrain valve shall be incorporated in the discharge valve or immediately adjacent thereto.

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. AIR PRESSURES.—If a device is operable by air pressure, the air-pressure gage shall show, by special graduations or otherwise, the maximum and minimum working pressures recommended by the manufacturer.

S.4.3. FOR WHOLESALE DEVICES ONLY.

S.4.3.1. DISCHARGE RATES.—A wholesale device shall be marked to show its designed maximum and minimum discharge rates. However, such minimum discharge rate shall not exceed 20 percent of such maximum discharge rate.

N. NOTES. (Applicable with respect to the testing of devices.)

N.1. TEST LIQUID.—A liquid-measuring device shall be tested with the liquid to be commercially measured or with a liquid of the same general physical characteristics.

N.2. EVAPORATION AND VOLUME CHANGE.—Care shall be exercised to reduce to a minimum, evaporation losses and volume changes resulting from changes in temperature of the test liquid.

N.3. TEST DRAFTS.

N.3.1. FOR RETAIL PISTON-TYPE AND VISIBLE-TYPE DEVICES.—Test drafts shall include the full capacity delivery and each intermediate delivery for which the device is designed.

N.3.2. FOR SLOW-FLOW METERS.—Test drafts shall be equal to at least four times the minimum volume that can be measured by the device and indicated through either a visible indication or an audible signal.

N.3.3. FOR LUBRICANT DEVICES.—Tests shall include a draft of 1 quart, and may include drafts of 1 pint, 4 quarts, and 6 quarts.

787-784 O—65——6

N.3.4. FOR OTHER RETAIL DEVICES.—Tests shall include drafts of 1 or more amounts, including drafts of at least 5 gallons.

N.3.5. FOR WHOLESALE DEVICES.—Test drafts should be equal to at least the amount delivered by the device in one minute at its maximum discharge rate, and shall in no case be less than 50 gallons.

N.4. TESTING PROCEDURES.

N.4.1. NORMAL TESTS.—The "normal" test of a device shall be made at the maximum discharge rate that may be anticipated under the conditions of installation.

N.4.2. SPECIAL TESTS.—"Special" tests, to develop the operating characteristics of a liquid-measuring device and any special elements and accessories attached to or associated with the device, shall be made as circumstances require. Any test except as set forth in N.4.1. shall be considered a special test.

N.4.2.1. FOR SLOW-FLOW METERS.—A "special" test of a slow-flow meter shall be made at a flow rate at least as small as twice the minimum flow rate, and not smaller than the minimum flow rate, to which the meter is subjected, according to the particular installation.

N.4.2.2. FOR RETAIL MOTOR-FUEL DEVICES.—A "special" test of a retail motor-fuel device shall be made at a minimum discharge rate of

(a) 5 gallons per minute, **or**

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

N.4.2.3. FOR OTHER RETAIL DEVICES.—"Special" tests of other retail devices shall be made at a minimum discharge rate of

(a) 50 percent of the maximum discharge rate developed under the conditions of installation, **or**

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

N.4.2.4. FOR WHOLESALE DEVICES.—"Special" tests of a wholesale device shall be made as follows:

(a) At a minimum discharge rate of 20 percent of the marked maximum discharge rate **or** the minimum discharge rate marked on the device, **whichever is less.**

(b) To develop the operating characteristics of any special elements and accessories attached to or associated with the device.

N.4.3. ELAPSED-TIME TESTS.

N.4.3.1. DURATION.—The duration of an elapsed-time test on a liquid-measuring device shall in no case exceed 24 hours.

N.4.3.2. TEMPERATURE ADJUSTMENT.—In an elapsed-time test, the observed error on the delivery made after the device has stood unused shall be "adjusted," if necessary, by allowing for the unavoidable volume change of the liquid in the device resulting from changes in temperature occurring during the period of nonuse of the device. In the case of motor fuels, this temperature-volume change may be computed at 0.6 percent per 10 °F and 1.1 percent per 10 °C change of temperature.

T. TOLERANCES. (Applicable with respect to the performance of devices.)

T.1. APPLICATION.

T.1.1. TO UNDERREGISTRATION AND TO OVERREGISTRATION.—The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration.

T.2. TOLERANCE VALUES.

T.2.1. ON RETAIL DEVICES EXCEPT SLOW-FLOW METERS.—Maintenance tolerances and acceptance tolerances, except on elapsed-time tests, shall be as shown in table 1.

T.2.2. ON SLOW-FLOW METERS.—Maintenance tolerances and acceptance tolerances shall be as shown in table 2.

T.2.3. ON WHOLESALE DEVICES.—Maintenance tolerances and acceptance tolerances, except on elapsed-time tests, shall be as shown in table 3.

TABLE 1.—TOLERANCES FOR RETAIL DEVICES, EXCEPT SLOW-FLOW METERS AND EXCEPT ON ELAPSED-TIME TESTS

Indication	Maintenance tolerance (On normal and on special tests)	Acceptance tolerance (On normal and on special tests)
Gallons	*Cubic inches*	*Cubic inches*
½ or less	2	1
1	3	1½
2	4	2
3	5	2½
4	6	3
5	7	3½
Over 5	Add 1 cubic inch per indicated gallon	Add ½ cubic inch per indicated gallon

T.2.4. ON ELAPSED-TIME TESTS.—Maintenance tolerances on elapsed-time tests of liquid-measuring devices shall be as follows:

(a) For a retail device, 2 cubic inches on a test extending over a period of 1 hour or less, plus an additional ½ cubic inch for each hour or fractional part thereof beyond the first hour, but in no case more than 6 cubic inches.

(b) For a wholesale device, 5 cubic inches per hour.

Acceptance tolerances shall be one-half the maintenance tolerances. (The error to which these tolerances are applied is the leakage error.)

TABLE 2.—TOLERANCES FOR SLOW-FLOW METERS

Indication	On normal tests				On special tests	
	Maintenance tolerances		Acceptance tolerances		Maintenance and acceptance tolerances	
	Percent	(*Minims*)	*Percent*	(*Minims*)	*Percent*	(*Minims*)
1 gill	1. 0	(20)	0. 75	(15)	1. 25	(25)
0.05 gallon	1. 0	(30)	. 75	(25)	1. 25	(40)
½ pint	1. 0	(40)	. 75	(30)	1. 25	(50)
0.10 gallon	1. 0	(60)	. 75	(45)	1. 25	(75)
1 pint	1. 0	(75)	. 75	(60)	1. 25	(95)
0.20 gallon	1. 0	(120)	. 75	(90)	1. 25	(155)
		(*Fl. drams*)		(*Fl. drams*)		(*Fl. drams*)
1 quart	1. 0	(2½)	0. 75	(2)	1. 25	(3)
½ gallon	0. 75	(4)	. 60	(3)	1. 0	(5)
1 gallon and over	. 75	(8 per gallon)	. 60	(6 per gallon)	1. 0	(10 per gallon)

TABLE 3.—MAINTENANCE AND ACCEPTANCE TOLERANCES ON WHOLESALE DEVICES, EXCEPT ON ELAPSED-TIME TESTS

Indication	On normal tests		On special tests
	Maintenance tolerance	Acceptance tolerance	Maintenance and acceptance tolerances
Gallons 50 Over 50	*Cubic inches* 50 Add ½ cubic inch per indicated gallon	*Cubic inches* 25 Add ¼ cubic inch per indicated gallon	*Cubic inches* 50 Add 1 cubic inch per indicated gallon

UR. USER REQUIREMENTS. (Applicable with respect to the selection, installation, and use of devices.)

UR.1. SELECTION REQUIREMENTS.

UR.1.1. LENGTH OF DISCHARGE HOSE.—The length of the discharge hose on a retail motor-fuel device shall not exceed 15 feet, measured from the outside of the housing of the device to the inlet 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. (On a hose that is coiled or otherwise retained or connected inside the housing, the measurement shall be made with the hose fully extended.) Unnecessarily remote location of a device shall not be accepted as justification for an abnormally long hose.

UR.2. INSTALLATION REQUIREMENTS.

UR.2.1. PLUMB AND LEVEL CONDITION.—A device installed in a fixed location shall be installed plumb and level, and the installation shall be sufficiently strong and rigid to maintain this condition.

UR.2.2. 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.2.3. SUCTION HEAD.—A piston-type device shall be so installed that the total effective suction head will not be great enough to cause vaporization of the liquid being dispensed under the highest temperature and lowest barometric pressure likely to occur.

UR.3. USE REQUIREMENTS.

UR.3.1. RETURN OF INDICATING ELEMENT TO ZERO.—On any device used in making individual retail deliveries to individual consumers, the primary indicating element, and the primary recording element if the device is equipped to record, shall be returned to zero before each such delivery.

UR.3.2. UNIT PRICE AND PRODUCT IDENTITY.—On a retail device of the computing type or of the coin-operated type, there shall be displayed on each face of the device the unit price at which the device is set to compute or to deliver, as the case may be, and there shall be conspicuously displayed on each side of the device the identity of the product that is being dispensed. If a device is so designed as to dispense more than one grade, brand, blend, or mixture of product, there shall also be displayed on each face of the device, at any time the device is in service, the identity of the grade, brand, blend, or mixture which the device is set to dispense.

DEFINITIONS OF TERMS

LIQUID-MEASURING DEVICES

The terms defined here have a special and technical meaning when used in the Code for Liquid-Measuring Devices. Whenever a defined term is used in the LMD Code, it has the particular meaning given here.

device, liquid-measuring. See liquid-measuring device.

device, liquid fuel. See liquid-fuel device.

device, lubricant. See lubricant device.

device, motor-fuel. See motor-fuel device.

device, retail. See retail device.

device, wholesale. See wholesale device.

dry hose. A discharge hose intended to be completely drained at the end of each delivery of liquid. (See dry-hose type.)

dry-hose type. A type of device in which it is intended that the discharge hose be completely drained following the mechanical operations involved in each delivery. (See dry hose.)

elapsed-time test. One to determine the leakage error that results solely from nonuse of a liquid-measuring device.

fuel, liquid. See liquid fuel.

fuel, motor. See motor fuel.

gravity type. A type of device designed for discharge by gravity.

leakage error. On an elapsed-time test of a liquid-measuring device, the difference between the error on a normal delivery of a given nominal amount and the temperature-corrected error on a delivery of the same nominal amount made after the device has stood unused.

liquid fuel. Any liquid used for fuel purposes, that is, as a fuel, including motor fuel.

liquid-fuel device. A device designed for the measurement and delivery of liquid fuels.

liquid-measuring device. A mechanism or machine designed to measure and deliver liquid by definite volume. Means may or may not be provided to indicate automatically, for one of a series of unit prices, the total money value of the liquid measured, or to make deliveries corresponding to specific money values at a definite unit price.

liquid, test. See test liquid.

lubricant device. A device designed for the measurement and delivery of liquid lubricants, including, but not limited to, heavy gear lubricants and automatic-transmission fluids (automotive).

meter, slow-flow. See slow-flow meter.

motor fuel. Liquid used as fuel for internal combustion engines.

motor-fuel device. A device designed for the measurement and delivery of liquids used as fuel for internal-combustion engines.

pressure type. A type of device designed for operation with the liquid under pressure artificially produced.

retail device. A device designed for single deliveries of less than 100 gallons and, in addition, any device designed or used for retail deliveries of motor fuels to individual highway vehicles.

slow-flow meter. A retail device designed for the measurement, at very slow rates (less than 10 gallons per hour), of liquid fuels at individual domestic installations.

test, elapsed-time. See elapsed-time test.

test liquid. The liquid used during the test of a device.

visible type. A type of device in which the measurement takes place in a visible glass measuring chamber.

wet hose. A discharge hose intended to be full of liquid at all times.

wet-hose type. A type of device designed to be operated with the discharge hose full of liquid at all times.

wholesale device. Any device other than a retail device. (See retail device.)

VEHICLE-TANK METERS

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1.—This code applies to meters mounted on vehicle tanks. The code **does not** apply to the following devices:

(a) Devices used for dispensing liquefied petroleum gases (for which see Code for Liquefied Petroleum Gas Liquid-Measuring Devices), or other liquids that do not remain in a liquid state at atmospheric pressures and temperatures.

(b) Devices used solely for dispensing a product in connection with operations in which the amount dispensed does not affect customer charges.

(c) Vehicle tanks used as measures (for which see Code for Vehicle Tanks Used as Measures).

S. SPECIFICATIONS. (Applicable with respect to the design of devices.)

S.1. DESIGN OF INDICATING AND RECORDING ELEMENTS AND OF RECORDED REPRESENTATIONS.

S.1.1. PRIMARY ELEMENTS.

S.1.1.1. GENERAL.—A meter shall be equipped with a primary indicating element and may also be equipped with a primary recording element.

S.1.1.2. UNITS.—A meter shall indicate, and record if the meter is equipped to record, its deliveries in terms of gallons. Fractional parts of the gallon shall be in terms of either decimal or binary subdivisions.

S.1.1.3. VALUE OF SMALLEST UNIT.—The value of the smallest unit of indicated delivery, and recorded delivery if the meter is equipped to record, shall not exceed the equivalent of

(a) one pint on meters used for retail deliveries of liquid fuel for domestic use, and

(b) one gallon on other meters.

S.1.1.4. ADVANCEMENT OF INDICATING AND RECORDING ELEMENTS.—Primary indicating and recording elements shall be susceptible of advancement only by the mechanical operation of the meter. However, a meter may be cleared by advancing its elements to zero, but only if

(a) the advancing movement, once started, cannot be stopped until zero is reached, or

(b) in the case of indicating elements only, such elements are automatically obscured until the elements reach the correct zero position.

S.1.1.5. RETURN TO ZERO.—Primary indicating elements shall be readily returnable to a definite zero indication. Means shall be provided to prevent the return of primary indicating elements, and of primary recording elements if these are returnable to zero, beyond their correct zero position.

S.1.2. GRADUATIONS.

S.1.2.1. LENGTH.—Graduations shall be so varied in length that they may be conveniently read.

S.1.2.2. WIDTH.—In any series of graduations, the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations, and the width of main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Graduations shall in no case be less than 0.008 inch in width.

S.1.2.3. CLEAR INTERVAL BETWEEN GRADUATIONS.—The clear interval shall be not less than 0.04 inch. If the graduations are not parallel, the measurement shall be made

(a) along the line of relative movement between the graduations and 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 with which it is associated and at least throughout that portion of its length that is associated with the graduation.

S.1.3.2. LENGTH.—The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case the distance between the end of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 0.04 inch.

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 widest graduation, and
(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 0.06 inch.

S.1.3.5. PARALLAX.—Parallax effects shall be reduced to the practicable minimum.

S.1.3.6. TRAVEL OF INDICATOR.—If the most sensitive element of the primary indicating element utilizes an indicator and graduations, the relative movement of these parts corresponding to the smallest indicated value shall be not less than 0.20 inch.

S.1.4. COMPUTING-TYPE DEVICES.

S.1.4.1. DISPLAY OF UNIT PRICE.—In a device of the computing type, means shall be provided for displaying on the outside of the device, and in close proximity to the display of the total computed price, the price per gallon at which the device is set to compute.

S.1.4.2. PRINTED TICKET.—Any printed ticket issued by a device of the computing type on which there is printed the total computed price shall have printed clearly thereon also the total volume of the delivery in terms of gallons and the appropriate fraction of the gallon and the price per gallon. (See G–S.5.5.2.)

S.1.4.3. MONEY-VALUE COMPUTATIONS.—Money-value computations shall be of the full-computing type in which the money value at a single unit price, or at each of a series of unit prices, shall be computed for every delivery within either the range of measurement of the device **or** the range of the computing elements, **whichever is less.** Value graduations shall be supplied and shall be accurately positioned. The value of each graduated interval shall be 1 cent.

S.2. DESIGN OF MEASURING ELEMENTS.

S.2.1. VAPOR ELIMINATION.—A metering system shall be equipped with an effective vapor eliminator or other effective means to prevent the passage of vapor and air through the meter.

S.2.2. PROVISION FOR SEALING.—Adequate provision shall be made for applying security seals in such a manner that no adjustment may be made of

(a) any measurement element, and

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

The adjusting mechanism shall be readily accessible for purposes of affixing a security seal. [1965]

S.2.3. DIRECTIONAL FLOW VALVES.—Valves intended to prevent reversal of flow shall be automatic in operation. However, on equipment used exclusively for fueling aircraft, such valves may be manual in operation.

S.3. DESIGN OF DISCHARGE LINES AND DISCHARGE LINE VALVES.

S.3.1. DIVERSION OF MEASURED LIQUID.—Except on equipment used exclusively for fueling aircraft, 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 installed if means is 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.

S.3.2. PUMP-DISCHARGE UNIT.—On a pump-discharge unit, the discharge hose shall be of the wet-hose type with a shutoff valve at its outlet end. However, a pump-discharge unit may be equipped also with a dry hose without a shutoff valve at its outlet end, but only if

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

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

S.3.4. DISCHARGE HOSE.—A discharge hose shall be adequately reinforced.

S.3.5. DISCHARGE VALVE.—A discharge valve may be installed in the discharge line only if the device is of the wet-hose type, in which case such valve shall be at the discharge end of the line. Any other shutoff valve on the discharge side of the meter shall be of the automatic or semiautomatic predetermined-stop type or shall be operable only.

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

S.3.6. ANTIDRAIN VALVE.—In a wet-hose, pressure-type device, an effective antidrain valve shall be incorporated in the discharge valve or immediately adjacent thereto. The valve shall function so as to prevent the drainage of the discharge hose when a valve adjacent to the meter is closed. However, a device used exclusively for fueling and defueling aircraft may be of the pressure type without an antidrain valve.

S.4. MARKING REQUIREMENTS.

S.4.1. LIMITATION OF USE.—If a meter is intended to measure accurately only liquids having particular properties, or to measure accurately only under specific installation or operating conditions, or to measure accurately only when used in conjunction with specific accessory equipment, these limitations shall be clearly and permanently stated on the meter.

S.4.2. DISCHARGE RATES.—A meter shall be marked to show its designed maximum and minimum discharge rates. However, such minimum discharge rate shall not exceed 20 percent of such maximum discharge rate.

N. NOTES. (Applicable with respect to the testing of devices.)

N.1. TEST LIQUID.—A meter shall be tested with the liquid to be commercially measured or with a liquid of the same general physical characteristics.

N.2. EVAPORATION AND VOLUME CHANGE.—Care shall be exercised to reduce to a minimum, evaporation losses and volume changes resulting from changes in temperature of the test liquid.

N.3. TEST DRAFTS.—Test drafts should be equal to at least the amount delivered by the device in one minute at its maximum discharge rate, and shall in no case be less than 50 gallons.

N.4. TESTING PROCEDURES.

N.4.1. NORMAL TESTS.—The "normal" test of a meter shall be made at the maximum discharge rate that may be anticipated under the conditions of the installation.

N.4.2. SPECIAL TESTS.—"Special" tests, to develop the operating characteristics of a metering system and any special elements and accessories attached to or associated with the meter, shall be made as circumstances require. Any test except as set forth in N.4.1. shall be considered a special test. Special tests of a meter shall be made as follows:

(a) At a minimum discharge rate of 20 percent of the marked maximum discharge rate **or** the minimum discharge rate marked on the meter, **whichever is less.**

(b) To develop operating characteristics of the metering system during a split-compartment delivery.

T. TOLERANCES. (Applicable with respect to the performance of devices.)

T.1. APPLICATION.

T.1.1. TO UNDERREGISTRATION AND TO OVERREGISTRATION.—The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration.

T.2. TOLERANCE VALUES.—Maintenance and acceptance tolerances shall be as shown in table 1.

TABLE 1.—MAINTENANCE AND ACCEPTANCE TOLERANCES ON VEHICLE-TANK METERS

Indication	On normal tests		On special tests
	Maintenance tolerance	Acceptance tolerance	Maintenance and acceptance tolerances
Gallons	*Cubic inches*	*Cubic inches*	*Cubic inches*
50	50	25	50
Over 50	Add ½ cubic inch per indicated gallon	Add ¼ cubic inch per indicated gallon.	Add 1 cubic inch per indicated gallon

UR. USER REQUIREMENTS. (Applicable with respect to the installation and use of devices.)

UR.1. INSTALLATION REQUIREMENTS.

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

UR.1.2. UNIT PRICE.—There shall be displayed on the face of a device of the computing type the unit price at which the device is set to compute.

UR.2. USE REQUIREMENTS.

UR. 2.1. RETURN OF INDICATING AND RECORDING ELEMENTS TO ZERO.—The primary indicating elements (visual), and the primary recording elements when these are returnable to zero, shall be returned to zero before each delivery.

UR.3. PRINTED TICKET.—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.

LIQUEFIED PETROLEUM GAS LIQUID-MEASURING DEVICES

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1.—This code applies to devices used for the measurement of liquefied petroleum gas in the liquid state, whether such devices are installed in a permanent location or mounted on a vehicle. 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.

S. SPECIFICATIONS. Applicable with respect to the design of devices.)

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.

S.1.1.2. UNITS.—A device shall indicate, and record if the device is equipped to record, its deliveries in terms of gallons, quarts, pints, or binary-submultiple or decimal subdivisions of the gallon.

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) one pint on retail devices, and

(b) one gallon on wholesale devices.

S.1.1.4. ADVANCEMENT OF INDICATING AND RECORDING ELEMENTS.—Primary indicating and recording elements shall be susceptible of 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.1.2. GRADUATIONS.

S.1.2.1. LENGTH.—Graduations shall be so varied in length that they may be conveniently read.

S.1.2.2. WIDTH.—In any series of graduations, the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations, and the width of main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Graduations shall in no case be less than 0.008 inch in width.

S.1.2.3. CLEAR INTERVAL BETWEEN GRADUATIONS.—The clear interval shall be not less than 0.04 inch. If the graduations are not parallel, the measurement shall be made

(a) along the line of relative movement between the graduations and 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 with which it is associated and at least throughout that portion of its length that is associated with the graduations.

S.1.3.2. LENGTH.—The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case the distance between the end of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 0.04 inch.

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 widest graduation, and

(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 0.06 inch.

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 be constructed to show automatically *its initial zero condition* [1957] and the amounts delivered up to the nominal capacity of the device.

S.1.4.2. RETURN TO ZERO.—Primary indicating elements shall be readily returnable to a definite zero indication. Primary recording elements on a retail motor-fuel device, if the device is equipped to record, shall be readily returnable to a definite zero indication. Means shall be provided to prevent the return of primary indicating elements, and of primary recording elements if these are returnable to zero, beyond their correct zero position.

S.1.4.3. DISPLAY OF UNIT PRICE AND PRODUCT IDENTITY.—In a device of the computing type, means shall be provided for displaying on each face of the device the unit price at which the device is set to compute or to deliver, as the case may be, and there shall be conspicuously displayed on each side of the device the identity of the product that is being dispensed. If a device is so designed as to dispense more than one grade, brand, blend, or mixture of product, means also shall be provided for displaying on each face of the device the identity of the grade, brand, blend, or mixture being dispensed.

S.1.4.4. PRINTED TICKET.—Any printed ticket issued by a device of the computing type on which there is printed the total computed price shall have printed clearly thereon also the total volume of the delivery in terms of gallons and the appropriate fraction of the gallon and the price per gallon. (See G–S.5.5.2.)

S.1.4.5. MONEY-VALUE COMPUTATIONS.—Money-value computations on a retail device shall be of the full-computing type in which the money value at a single unit price, or at each of a series of unit prices, shall be computed for every delivery within either the range of measurement of the device **or** the range of the computing elements, **whichever is less.** Value graduations shall be supplied and shall be accurately positioned. The value of each graduated interval shall be 1 cent.

S.1.5. FOR WHOLESALE DEVICES ONLY.

S.1.5.1. TRAVEL OF INDICATOR.—A wholesale device shall be readily operable to deliver accurately any quantity from 50 gallons to the capacity of the device. If the most sensitive element of the indicating system utilizes an indicator and graduations, the relative movement of these parts corresponding to a delivery of 1 gallon shall be not less than 0.20 inch.

S.2. DESIGN OF MEASURING ELEMENTS.

S.2.1. VAPOR ELIMINATION.—A device shall be equipped with an effective vapor eliminator or other effective means to prevent the passage of vapor through the meter.

S.2.2. PROVISION FOR SEALING.—Adequate provision shall be made for applying security seals in such a manner that no adjustment may be made of

(a) any measurement element, and

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

The adjusting mechanism shall be readily accessible for purposes of affixing a security seal. [1965]

S.2.3. DIRECTIONAL FLOW VALVES.—Valves intended to prevent reversal of flow shall be automatic in operation.

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 passage through the meter.

S.2.5. THEROMETER WELL.—*Means shall be provided for inserting, for test purposes, a mercury-in-glass thermometer either*

(*a*) *in the liquid chamber of the meter, or*

(*b*) *in the meter inlet or discharge line and immediately adjacent to the meter.* [1957]

S.2.6. 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 60 °F.

S.2.6.1. PROVISION FOR DEACTIVATING.—Provision shall be made to facilitate the deactivation of the automatic temperature-compensating mechanism from the metering system so that the meter may indicate, and record if it is equipped to record, in terms of the uncompensated volume.

S.2.6.2. 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.2.7. FOR RETAIL DEVICES ONLY.

S.2.7.1. ZERO-SET-BACK INTERLOCK.—A retail motor-fuel device of the meter type shall be so constructed that, after a particular delivery cycle has been completed by movement of the starting lever to its shutoff position, or to what would appear to be its normal shutoff position from some reasonable "customer" position, an effective automatic interlock will prevent a subsequent delivery being started until the indicating elements have been returned to their correct zero positions.

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, except that 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.* [1957]

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) 5 gallons per minute for motor-fuel devices, or

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

S.4.3. 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 60 °F.

N. NOTES. (Applicable with respect to the testing of devices.)

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.

N.3. TEST DRAFTS.—Test drafts should be equal to at least the amount delivered by the device in one minute at its maximum discharge rate, and shall in no case be less than 10 gallons for a retail motor-fuel device and 50 gallons for any other device.

N.4. TESTING PROCEDURES.

N.4.1. NORMAL TESTS.—The "normal" test of a device shall be made at the maximum discharge rate that may be anticipated under the conditions of installation. If the device is equipped with an automatic temperature compensator, this test should be conducted with the compensator disconnected.

N.4.1.1. AUTOMATIC TEMPERATURE COMPENSATION.—If a device is equipped with an automatic temperature compensator, the compensator shall be tested by comparing the volume indicated or recorded by the device with the compensator connected and operating, with the actual delivered volume corrected to 60 °F.

N.4.2. SPECIAL TESTS.—"Special"tests, to develop the operating characteristics of a device and any special elements and accessories attached to or associated with the device, shall be made as circumstances require. Any test except as set forth in N.4.1. shall be considered a special test.

N.4.2.1 FOR MOTOR-FUEL DEVICES.—A motor-fuel device shall be so tested at a minimum discharge rate of

(a) 5 gallons 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

(a) 50 percent of the maximum discharge rate developed under the conditions of installations, **or**

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

N.4.2.3. FOR WHOLESALE DEVICES.—A wholesale device shall be so tested at a minimum discharge rate of

(a) 10 gallons per minute for a device with a rated maximum discharge less than 50 gallons per minute,

(b) 20 percent of the marked maximum discharge rate for a device with a rated maximum discharge of 50 gallons per minute or more, **or**

(c) the minimum discharge rate marked on the device, **whichever is least.**

N.5. TEMPERATURE CORRECTION.—Corrections 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 test measure.

T. TOLERANCES. (Applicable with respect to the performance of devices.)

T.1. APPLICATION.

T.1.1. TO UNDERREGISTRATION AND TO OVERREGISTRATION.—The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration, whether or not a device is equipped with an automatic temperature compensator.

T.2. TOLERANCE VALUES.

T.2.1. ON NORMAL TESTS.—The maintenance tolerance on "normal" tests shall be 4 cubic inches per indicated gallon on underregistration and 2 cubic inches per indicated gallon on overregistration. The acceptance tolerance on "normal" tests shall be 2 cubic inches per indicated gallon on underregistration and 1 cubic inch per indicated gallon on overregistration.

T.2.2. ON SPECIAL TESTS.—The maintenance and acceptance tolerances shall be 4 cubic inches per indicated gallon on underregistration and 2 cubic inches per indicated gallon on overregistration.

UR. USER REQUIREMENTS. (Applicable with respect to the installation and use of devices.)

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 motor-fuel device shall not exceed 15 feet, 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.

UR.2. USE REQUIREMENTS.

UR.2.1. RETURN OF INDICATING AND RECORDING ELEMENTS TO ZERO.—The primary indicating elements (visual), and the primary recording elements when these are returnable to zero, shall be returned to zero 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. (See also UR.2.1.)

UR.2.3. VAPOR-RETURN LINE.—During any metered delivery of liquefied petroleum gas from a supplier's tank to a receiving container, there shall be no vapor-return line from the receiving container to the supplier's tank

(a) in the case of any receiving container to which normal deliveries can be made without the use of such vapor-return line, or

(b) in the case of any new receiving container when the ambient temperature is below 90 °F.

UR.2.4. AUTOMATIC TEMPERATURE COMPENSATOR.—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.

DEFINITIONS OF TERMS

LIQUEFIED PETROLEUM GAS LIQUID-MEASURING DEVICES

The terms defined here have a special and technical meaning when used in the Code for Liquefied Petroleum Gas Liquid-Measuring Devices. Whenever a defined term is used in the LP Gas Code, it has the particular meaning given here.

liquefied petroleum gas. A petroleum product composed predominantly of any of the following hydrocarbons, or mixtures thereof: propane, propylene, butanes (normal butane or isobutane), and butylenes.

liquefied petroleum gas liquid-measuring device. A system including a mechanism or machine of the meter type designed to measure and deliver liquefied petroleum gas in the liquid state by definite volume, whether installed in a permanent location or mounted on a vehicle. Means may or may not be provided to indicate automatically, for one of a series of unit prices, the total money value of the liquid measured.

motor-fuel device. A stationary device used for retail deliveries of liquefied petroleum gas as motor fuel to the fuel tanks of individual highway vehicles.

retail device. A device used for single deliveries of liquefied petroleum gas for domestic use and, in addition, any motor-fuel device.

wholesale device. Any device other than a retail device.

LIQUID MEASURES

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1.—This code applies to liquid measures; that is, to rigid measures of capacity designed for general and repeated use in the measurement of liquids. The code **does not** apply to test measures or other volumetric standards.

S. SPECIFICATIONS. (Applicable with respect to the design of liquid measures.)

S.1. UNITS.—The capacity of a liquid measure shall be 1 gill, ½ liquid pint, 1 liquid pint, 1 liquid quart, ½ gallon, 1 gallon, 1¼ gallons, 1½ gallons, or a multiple of 1 gallon, and the measure shall not be subdivided. However, 3-pint and 5-pint brick molds and 2½-gallon (10-quart) cans shall be permitted when used exclusively for ice cream.

S.2. MATERIAL.—Measures shall be made of metal, glass, earthenware, enameled ware, composition, or similar and suitable material. If made of metal, the thickness of the metal shall be not less than the appropriate value given in table 1.

TABLE 1.—MINIMUM THICKNESSES OF METAL FOR LIQUID MEASURES

Nominal capacity	Minimum thickness	
	For iron or steel, plated or unplated	For copper or aluminum
	Inch	*Inch*
1 pint or less	0. 010	0. 020
1 quart, ½ gallon, 1 gallon	. 014	. 028
Over 1 gallon	. 016	. 032

S.3. CAPACITY POINT.—The capacity of a measure shall be determined to a definite edge, or to the lowest portion of a plate, bar, or wire, at or near the top of the measure, and shall not include the capacity or any lip or rim that may be provided.

S.4. REINFORCING RINGS.—Reinforcing rings, if used, shall be attached to the outside of the measure and shall show no divisions or lines on the inside surface of the measure.

S.5. DISCHARGE.—A measure equipped with a discharge faucet or valve shall be susceptible of complete discharge through the faucet or valve when the measure is standing on a level surface.

S.6. MARKING REQUIREMENTS.—A measure shall be marked on its side with a statement of its capacity. If the capacity is stated in terms of the pint or quart, the word "Liquid" or the abbreviation "Liq" shall be included.

T. TOLERANCES. (Applicable with respect to the accuracy of liquid measures.)

T.1.—Maintenance tolerances in excess and in deficiency shall be as shown in table 2. Acceptance tolerances shall be one-half the maintenance tolerances.

TABLE 2.—MAINTENANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR LIQUID MEASURES

Nominal capacity	Tolerance			
	In excess		In deficiency	
	Fluid drams	*Cubic inches*	*Fluid drams*	*Cubic inches*
½ pint or less	2	0. 4	1. 0	0. 2
1 pint	3	0. 7	1. 5	0. 3
1 quart	4	0. 9	2. 0	0. 5
½ gallon	6	1. 4	3. 0	0. 7
	Fluid ounces			
1 and 1¼ gallons	1. 0	1. 8	4. 0	0. 9
1½ gallons	1. 5	2. 7	6. 0	1. 4
			Fluid ounces	
2 gallons	2	3. 5	1	1. 8
3 and 4 gallons	4	7. 0	2	3. 6
5 gallons	6	11. 0	3	5. 4
10 gallons	10	18. 0	5	9. 0

VEHICLE TANKS USED AS MEASURES

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1.—This code applies to vehicle tanks when these are used as commercial measures. The code **does not** apply to the following devices:

(a) Devices used solely for dispensing a product in connection with operations in which the amount dispensed does not affect customer charges.

(b) Meters mounted on vehicle tanks (for which see Code for Vehicle-Tank Meters).

S. SPECIFICATIONS. (Applicable with respect to the design of devices.)

S.1. DESIGN OF COMPARTMENTS.

S.1.1. COMPARTMENT DISTORTION.—The shell and bulkheads of a vehicle tank shall be so constructed that under any condition of liquid lading they will not become distorted sufficiently to cause a change in the capacity of any compartment (as determined by volumetric test) equal to more than ½ pint per 200 gallons, or fraction thereof, of the nominal compartment capacity, or to more than 1 pint, whichever is greater. (This specification prescribes a limit on permissible distortion only, and is not be construed as setting up a secondary tolerance on compartment capacities to be added to the values given in tolerance paragraph T.2.)

S.1.2. VENTING.—Effective venting of a compartment shall be provided to permit air to escape, during filling operations, from all areas designed to be filled with liquid and to permit the influx of air to the compartment during the discharge of liquid therefrom. Venting shall prevent any formation of air pockets.

S.1.3. COMPLETENESS OF DELIVERY.—A tank shall be so constructed that, when it is standing on a level surface, complete delivery can be made from any compartment through its delivery faucet or valve whether other compartments are full or empty, and whether or not the delivery is through a manifold.

S.1.4. FILL OR INSPECTION OPENING.—The fill or inspection opening of a compartment shall be of such size and location that it can readily be determined by visual inspection that the compartment has been properly filled or completely emptied, *and shall be so positioned with respect to the ends of the compartment that the indicator may be positioned as required. In no case shall the opening, if circular, have a diameter of less than 7⅝ inches, or, if other than circular, have an effective area of less than 45 square inches.* [1960]

S.1.5. DOME FLANGE AND BAFFLE PLATES.—Any dome flange extending into a compartment shall be provided with sufficient perforations or openings flush with the compartment shell to prevent any trapping of air. All baffle plates in a compartment shall be so cut away at top and bottom, and elsewhere as necessary, as to facilitate loading and unloading.

S.1.6. COMPARTMENT AND PIPING CAPACITIES AND EMERGENCY VALVE.—If a compartment is equipped with an emergency (or safety) valve, this shall be positioned at the lowest point of outlet from the compartment, and the compartment capacity or capacities shall be construed as excluding the capacity of the piping leading therefrom. However, the capacity of the piping leading from such a compartment shall be separately determined and reported, and may be separately marked as specified in S.4.

S.1.7. EXPANSION SPACE.—When a compartment is filled to the level of the highest indicator in the compartment, there shall remain an expansion space of at least 0.75 percent of the nominal compartment capacity as defined by that indicator.

S.2. DESIGN OF COMPARTMENT INDICATORS.

S.2.1. GENERAL.—An indicator shall be so designed that it will distinctly and unmistakably define a capacity point of its compartment when liquid is in contact with the lowest portion of the indicator.

S.2.2. NUMBER OF INDICATORS.—In no case shall a compartment be provided with more than three indicators.

S.2.3. IDENTIFICATION OF MULTIPLE INDICATORS.—If a compartment is provided with multiple indicators, each such indicator shall be conspicuously marked with an identifying letter or number.

S.2.4. POSITION.—An indicator shall be positioned as nearly as practicable

(a) *midway between the sides of its compartment*, and

(b) midway between the ends of its compartment.

An indicator shall be adjacent to but shall not extend into that section of the compartment defined by a vertical projection of the fill opening. In no case shall an indicator be offset from a position midway between the ends of the compartment by more than 10 percent of the compartment length. [1960]

S.2.5. PERMANENT INDICATORS.—Any indicator that is not intended to remain adjustable shall be securely welded in position.

S.2.6. ADJUSTABLE INDICATORS.—Adequate provision shall be made for conveniently affixing a security seal or seals

(a) to any indicator intended to remain adjustable, so that no adjustment of the indicator can be made without mutilating or destroying the seal, and

(b) to any removable part to which an indicator may be attached, so that the part cannot be removed without mutilating or destroying the seal.

S.2.7. SENSITIVENESS.—The position of any indicator in its compartment shall be such that at the level of the indicator a change of 0.04 inch in the height of the liquid surface will represent a volume change of not more than the value of the tolerance for the nominal compartment capacity as defined by that indicator.

S.3. DESIGN OF COMPARTMENT DISCHARGE MANIFOLD.—*When two or more compartments discharge through a common manifold or other single outlet, effective means shall be provided to insure*

(*a*) *that liquid can flow through the delivery line leading from only one compartment at one time and cannot flow from one compartment into another compartment, or*

(*b*) *that all compartments will discharge simultaneously. If the discharge valves from two or more compartments are automatically so controlled that they can only be operated together, thus effectively connecting these compartments each to the other, such compartments shall, for purposes of this paragraph, be construed to be one compartment.* [1960]

S.4. MARKING OF COMPARTMENTS.

S.4.1. COMPARTMENT IDENTIFICATION.—Each compartment of a multiple-compartment tank shall be conspicuously identified by a letter or number marked on the dome or immediately below the fill opening. Such letters or numbers shall be in regular sequence from front to rear, and the delivery faucets or valves shall be marked to correspond with their respective compartments.

S.4.2. COMPARTMENT CAPACITY, SINGLE INDICATOR.—A compartment provided with a single indicator shall be clearly, permanently, and conspicuously marked with a statement of its capacity as defined by its indicator.

S.4.3. COMPARTMENT CAPACITY, MULTIPLE INDICATORS.—A compartment provided with two or three indicators shall be clearly, permanently, and conspicuously marked with a statement identifying

(a) each indicator by a letter or number, and, immediately adjacent thereto,

(b) the capacity of the compartment as defined by the particular indicator.

N. NOTES. (Applicable with respect to the testing of devices.)

N.1. TEST LIQUID.—Water or light fuel oil shall be used as the test liquid for a vehicle-tank compartment.

N.2. EVAPORATION AND VOLUME CHANGE.—Care shall be exercised to reduce to a minimum, evaporation losses and volume changes resulting from changes in temperature of the test liquid.

N.3. TO DELIVER.—A vehicle-tank compartment shall be gaged "to deliver." If the compartment is gaged by measuring the test liquid into the tank, the inside tank walls shall first be thoroughly wetted.

N.4. GAGING OF COMPARTMENTS.—When a compartment is gaged to determine the proper position for an indicator or to determine what a capacity marking should be, whether on a new vehicle tank or following repairs or modifications that might affect compartment capacities, tolerances are not applicable, and the indicator shall be set and the compartment capacity shall be marked as accurately as practicable.

N.5. ADJUSTMENT AND REMARKING.—When a compartment is found upon test to have an error in excess of the applicable tolerance, the capacity of the compartment shall be adjusted to agree with its marked capacity, or its marked capacity shall be changed to agree with its capacity as determined by the test.

T. TOLERANCES. (Applicable with respect to the accuracy of devices.)

T.1. APPLICATION.

T.1.1. TO EXCESS AND TO DEFICIENCY.—The tolerances hereinafter prescribed shall be applied to errors in excess and in deficiency.

T.2. TOLERANCE VALUES.—Maintenance and acceptance tolerances shall be as shown in table 1.

TABLE 1.—MAINTENANCE AND ACCEPTANCE TOLERANCES ON VEHICLE-TANK COMPARTMENTS

Nominal capacity of compartment	Maintenance and acceptance tolerance	
Gallons	*Expressed in quarts*	*Expressed in gallons*
200 or less	2	0. 5
201 to 400, incl	3	0. 75
401 to 600, incl	4	1. 0
601 to 800, incl	5	1. 25
801 to 1,000, incl	6	1. 50
Over 1,000	Add 1 quart per 200 gallons or fraction thereof.	Add 0.25 gallon per 200 gallons or fraction thereof.

UR. USER REQUIREMENTS. (Applicable with respect to the use of devices.)

UR.1. CONDITIONS OF USE.

UR.1.1. FILLING.—A vehicle shall stand upon a level surface during the filling of a compartment.

UR.1.2. DELIVERING.—During a delivery, a vehicle shall be so positioned as to assure complete emptying of a compartment.

FARM MILK TANKS

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1.—This code applies to farm milk tanks on the premises of producers when these are used, or are to be used, for the commercial measurement of milk. This code **does not** apply to tanks mounted on highway vehicles.

S. SPECIFICATIONS. (Applicable with respect to the design of devices.)

S.1. COMPONENTS.—A farm milk tank, whether stationary or portable, shall be considered suitable for commercial use only when it comprises

(a) a vessel, whether or not it is equipped with means for cooling its contents,

(b) means for reading the level of liquid in the tank, such as a removable gage rod or surface gage, and

(c) a chart for converting level-of-liquid readings to gallons.

Each compartment of a subdivided tank shall, for the purposes of this code, be construed to be a farm milk tank.

S.2. DESIGN OF TANK.

S.2.1. LEVEL.—A farm milk tank shall be designed to be in normal operating position when it is in level. The tank shall be so constructed that it will maintain its condition of level under all normal conditions of lading.

S.2.2. PORTABLE TANK.—A portable tank shall be of the center-reading type; that is, it shall be so designed that the gage rod or surface gage, when properly positioned for use, will be approximately in the vertical axis of the tank, centrally positioned with respect to the tank walls.

S.2.3. LEVEL-INDICATING MEANS.—A tank shall be permanently equipped with sensitive means by which the level of the tank can be determined.

S.2.3.1. ON A STATIONARY TANK.—On a stationary tank such means shall be a two-way or circular level, a plumb bob, two-way leveling lugs, or the like; or the top edge or edges of the tank shall be so constructed throughout as to provide an accurate reference for level determinations.

S.2.3.2. ON A PORTABLE TANK.—On a portable tank such means shall be either a two-way or a circular level.

S.2.3.3. ON A TANK OF 500 GALLONS OR GREATER.—On a tank with a nominal capacity of greater than 500 gallons, two level-indicating means shall be provided, in opposite positions on the tank.

S.3. DESIGN OF INDICATING MEANS.

S.3.1. GAGE-ROD BRACKET OR SUPPORTS.—If a tank is designed for use with a gage rod, a substantial and rigid gage-rod bracket or other suitable supporting elements for positioning the gage rod shall be provided. A gage rod and its bracket or other supporting elements shall be so constructed that, whenever the rod is placed in engagement with the bracket or supports and released, the rod will automatically seat itself at a fixed height and in a vertical position. When a gage rod is properly seated on its bracket or supports, there shall be a clearance of at least 3 inches between the graduated face of the rod and any tank wall or other surface that it faces.

S.3.2. GAGE ROD.—When properly seated in position, a rod shall not touch the bottom of the tank unless this is required by the design of the supporting elements. The rod shall be graduated throughout an interval corresponding to the gallonage range within which readings of liquid level are to be made. The graduated face of the rod shall have a dull finish.

S.3.3. SURFACE-GAGE BRACKET OR SUPPORTS.—If a tank is designed for use with a surface gage, a substantial and rigid surface-gage bracket or other suitable supporting elements for positioning the surface gage shall be provided. A surface gage and its bracket or other supporting elements shall be so constructed that, whenever the gage assembly is placed in engagement with the bracket or supports, the indicator, if not permanently mounted on the tank, will automatically seat itself in correct operating position, and the graduated element will be vertically positioned and will be securely held at any height to which it may be manually set.

S.3.4. SURFACE GAGE.—When properly engaged with its bracket and set to its lowest position, a surface gage shall not touch the bottom of the tank. The gage shall be graduated throughout an interval corresponding to the gallonage range within which readings of liquid level are to be made.

S.3.5. GRADUATIONS.

S.3.5.1. SPACING AND WIDTH OF GRADUATIONS.—On a gage rod or surface gage, the spacing of the graduations, center to center, shall be not more than 0.0625 ($1/16$) inch and not less than 0.03125 ($1/32$) inch. The graduations shall be not less than 0.005 inch in width, and the clear interval between adjacent edges of successive graduations shall be not less than 0.015625 ($1/64$) inch.

S.3.5.2. VALUES OF GRADUATIONS.—On a gage rod or surface gage, the graduations may be designated in inches and fractions thereof, or may be identified in a numerical series without reference to inches or fractions thereof. In either of these cases there shall be provided for each such rod or gage and each tank with which it is associated, a gallonage chart showing values in terms of gallons of liquid in the tank, corresponding to each graduation on the rod or gage. If a rod or gage is associated with but one tank, in lieu of linear or numerical-series graduations and gallonage chart, values in terms of gallons of liquid in the tank may be shown directly on the rod or gage.

S.3.5.3. VALUE OF GRADUATED INTERVAL.—The value of a graduated interval on a gage rod or surface gage (exclusive of the interval from the bottom of the tank to the lowest graduation) shall not exceed

(a) $1/2$ gallon for a tank of a nominal capacity of 250 gallons or less,

(b) 1 gallon for a tank of a nominal capacity of 251 to 500 gallons, inclusive, and

(c) 2 gallons for a tank of a nominal capacity of more than 500 gallons.

S.4. DESIGN OF GALLONAGE CHART.

S.4.1. GENERAL.—A gallonage chart shall show gallonage values only. All letters and figures on the chart shall be distinct and easily readable, the chart shall be substantially constructed, and the face of the chart shall be so protected that its lettering and figures will not tend easily to become obliterated or illegible.

S.4.2. FOR A TANK OF 250 GALLONS OR LESS.—The gallonage chart for a tank of nominal capacity of 250 gallons or less shall show values at least to the nearest ¼ gallon.

S.4.3. FOR A TANK OF 251 TO 500 GALLONS.—The gallonage chart for a tank of nominal capacity of 251 to 500 gallons, inclusive, shall show values at least to the nearest ½ gallon.

S.4.4. FOR A TANK OF GREATER THAN 500 GALLONS.—The gallonage chart for a tank of nominal capacity of greater than 500 gallons shall show values at least to the nearest gallon.

S.5. GAGING.

S.5.1. LEVEL.—A farm milk tank shall be in level, as shown by the level-indicating means, during the original gaging operation.

S.5.2. TO DELIVER.—A farm milk tank shall be originally gaged "to deliver." If the tank is gaged by measuring the test liquid into the tank, the inside tank walls shall first be thoroughly wetted and the tank then shall be drained for 30 seconds after the main drainage flow has ceased.

S.5.3. PREPARATION OF GALLONAGE CHART.—When a tank is gaged for the purposes of preparing a gallonage chart, tolerances are not applicable, and the chart shall be prepared as accurately as practicable.

S.6. IDENTIFICATION.—A tank and any gage rod or surface gage and gallonage chart associated therewith shall be mutually identified, as by a common serial number, in a prominent and permanent manner.

N. NOTES. (Applicable with respect to the testing of farm milk tanks.)

N.1. TEST LIQUID.—Water shall be used as the test liquid for a farm milk tank.

N.2. EVAPORATION AND VOLUME CHANGE.—Care shall be exercised to reduce to a minimum, evaporation losses and volume changes resulting from changes in temperature of the test liquid.

N.3. TO DELIVER.—A farm milk tank shall be tested "to deliver." If the tank is gaged by measuring the test liquid into the tank, the inside tank walls shall first be thoroughly wetted and the tank then shall be drained for 30 seconds after the main drainage flow has ceased.

N.4. LEVEL.—A farm milk tank shall be in level, as shown by the level-indicating means, during gaging and testing.

T. TOLERANCES. (Applicable with respect to the accuracy of farm milk tanks.)

T.1. APPLICATION.—The tolerances hereinafter prescribed shall be applied equally to errors in excess and errors in deficiency.

T.2. MINIMUM TOLERANCE VALUES.—On a particular tank, the maintenance and acceptance tolerances applied shall be not smaller than the smallest volume corresponding to a graduated interval at any point on the gage rod or surface gage.

T.3. BASIC TOLERANCE VALUES.—Basic maintenance and acceptance tolerances shall be as shown in table 1. (The error at any liquid level of a farm milk tank is the difference between the gallonage shown for that level on the gallonage chart and the corresponding gallonage determined by test. The tolerance is applied according to the volume of test liquid in the tank at each test draft, regardless of the nominal capacity of the tank.)

TABLE 1.—BASIC MAINTENANCE AND ACCEPTANCE TOLERANCES FOR FARM MILK TANKS

Test draft	Tolerance in excess and in deficiency
	Gallons
250 or less	½
251 to 500, incl	1
501 to 1,000, incl	2
1,001 to 1,500, incl	3
1,501 to 2,000, incl	4
Over 2,000	5

UR. USER REQUIREMENTS. (Applicable with respect to installation, maintenance, and use of farm milk tanks.)

UR.1. INSTALLATION.—A stationary tank shall be rigidly installed in level without the use of removable blocks or shims under the legs. If such tank is not mounted permanently in position, the correct position on the floor for each leg shall be clearly and permanently defined.

UR.2. LEVEL CONDITION.

UR.2.1. STATIONARY TANK.—A stationary farm milk tank shall be maintained in level.

UR.2.2. PORTABLE TANK.—On a portable tank, measurement readings shall be made only when the tank is approximately level; that is, when it is not out of level by more than 5 percent or approximately 3 degrees in any direction.

UR.3. STORAGE OF GAGE ROD.—Between periods of actual use for measuring, a gage rod shall be stored at room temperature and shall not be placed inside a farm milk tank.

DEFINITIONS OF TERMS

FARM MILK TANKS

The terms defined here have a special and technical meaning when used in the Code for Farm Milk Tanks. Whenever a defined term is used in the Farm Milk Tank Code, it has the particular meaning given here.

center-reading tank. One so designed that the gage rod or surface gage, when properly positioned for use, will be approximately in the vertical axis of the tank, centrally positioned with respect to the tank walls.

farm milk tank. A unit for measuring milk or other fluid dairy product, comprising a combination of (1) a stationary or portable tank, whether or not equipped with means for cooling its contents, (2) means for reading the level of liquid in the tank, such as a removable gage rod or a surface gage, and (3) a chart for converting level-of-liquid readings to gallons; or such a unit in which readings are made on gage rod or surface gage directly in terms of gallons. Each compartment of a subdivided tank shall, for purposes of this code, be construed to be a "farm milk tank."

gage rod. A graduated, "dip-stick" type of measuring rod designed to be partially immersed in the liquid and to be read at the point where the liquid surface crosses the rod.

surface gage. A combination of (1) a stationary indicator and (2) a movable, graduated element designed to be brought into contact with the surface of the liquid from above.

MEASURE-CONTAINERS

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1.—This code applies to the following measure-containers;

(a) Retail measure-containers intended to be used only once to determine at the time of retail sale, and from bulk supply, the quantity of commodity on the basis of liquid measure. The retail measure-container serves as the container for the delivery of the commodity.

(b) Prepackaged measure-containers intended to be used only once to determine in advance of sale the quantity of a commodity (such as ice cream, iced milk, sherbet, sour cream, or yoghurt) on the basis of liquid measure. The prepackaged measure-container serves as the container for the delivery of the commodity, in either a wholesale or a retail marketing unit.

This code **does not** apply to rigid containers used for milk, cream, or other fluid dairy products, which are covered by the Code for Milk Bottles.

S. SPECIFICATIONS. (Applicable with respect to the design of measure-containers.)

S.1. UNITS.

S.1.1. FOR RETAIL MEASURE-CONTAINERS.—The capacity of a retail container shall be 1 gill (or ¼ liquid pint or 4 fluid ounces), ½ liquid pint, 1 liquid pint, 1 liquid quart, ½ gallon, 1 gallon, or a multiple of 1 gallon, and the container shall not be subdivided.

S1.2. FOR PREPACKAGED MEASURE-CONTAINERS.—The capacity of a prepackaged measure-container shall be ½ liquid pint, 1 liquid pint, 1 liquid quart, ½ gallon, 1 gallon, 2½ gallons, 3½ gallons, or a multiple of 1 gallon. However, any capacity less than ½ liquid pint shall be permitted.

S.2. CAPACITY POINT.—The capacity of a measure-container shall be sharply defined by

(a) the top edge,

(b) a line near the top edge, or

(c) the lowest portion of a shoulder, cap seat, lid seat, or indentation near the top edge of the container.

S.3. SHAPE.—A measure-container shall be designed as some suitable geometrical shape, and its capacity shall be determined without distortion from its normal assembled shape.

S.4. MARKING.

S.4.1. CAPACITY POINT.—If the capacity point of a measure-container is defined by a line, the container shall be marked conspicuously on its side with a suitable statement clearly identifying this line as the capacity point.

S.4.2. CAPACITY STATEMENT.—A measure-container shall be clearly and conspicuously marked with a statement of its capacity in terms of one of the units prescribed in S.1.1. or S.1.2. However, a prepackaged measure-container of less than ½ pint shall be marked in terms of fluid ounces.

S.4.2.1. LOCATION ON A CONTAINER WITH AN ATTACHED CLOSURE.—On a container with an attached closure, the capacity statement shall be located either on the side of the container or on that portion of the top fold that will be exposed to view when the container is closed.

S.4.2.2. LOCATION ON A CONTAINER WITH A REMOVABLE LID OR COVER.—On a container with a removable lid or cover, the capacity statement shall be located either on the side of the container or on both the bottom of the container and the top of the lid or cover.

N. NOTES. (Applicable with respect to the testing of measure-containers.)

N.1. TEST LIQUID.—Water shall be used as the test liquid for a measure-container.

N.2. PREPARATION OF CONTAINER FOR TEST.

N.2.1. GENERAL.—Before an actual test is begun, a measure-container shall, if necessary, be so restrained that it will maintain its normal assembled shape and that its sides will not bulge when it is filled with water.

N.2.2. RESTRAINING FORM FOR TEST.

N.2.2.1. FOR RECTANGULAR CONTAINER OF ONE QUART OR LESS.—Bulging of the sides of a rectangular measure-container of one-quart capacity or less may be controlled by holding against each side of the container, with a cord, rubber bands, or tape, a metal plate or a piece of heavy cardboard slightly smaller than the side of the container.

N.2.2.2. FOR RECTANGULAR PREPACKAGED MEASURE-CONTAINER OF ONE-HALF GALLON OR GREATER.—A rectangular prepackaged measure-container of one-half-gallon capacity or greater shall be supported during a test by a rigid restraining form. This form shall restrain not less than the entire area of the central two-thirds of each side of the container, measured from bottom to top. The inside width dimension of any side panel of the restraining form shall be 1/16 inch greater than the corresponding outside dimension of the container. (The outside width dimension of any side panel of the container shall be established by adding to the inner side center-of-score to center-of-score dimension two thicknesses of the board used, and the sum thus obtained shall be rounded off to the nearest 1/64 inch.)

T. TOLERANCES. (Applicable with respect to the accuracy of measure-containers.)

T.1.—Acceptance tolerances in excess and in deficiency shall be as shown in table 1.

TABLE 1.—ACCEPTANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR MEASURE-CONTAINERS

Nominal capacity	Tolerance			
	In excess		In deficiency	
	Fluid drams	*Cubic inches*	*Fluid drams*	*Cubic inches*
½ pint or less	3	0. 6	1. 5	0. 3
1 pint	4	1. 0	2. 0	0. 5
1 quart	6	1. 4	3. 0	0. 7
½ gallon	9	2. 0	4. 5	1. 0
1 gallon	12	2. 8	6. 0	1. 4
Over 1 gallon	Add 12 fluid drams per gallon.	Add 2.8 cubic inches per gallon.	Add 6.0 fluid drams per gallon.	Add 1.4 cubic inches per gallon.

UR. USER REQUIREMENTS. (Applicable with respect to the use of measure-containers.)

UR.1. LIMITATION OF USE.—The use of a measure-container of rectangular cross section of a capacity of ½ gallon or over shall be limited to the packaging, in advance of sale, of ice cream, sherbet, or other similar frozen desserts.

MILK BOTTLES

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1.—This code applies to any container that is used for the measurement and delivery of milk and other fluid dairy products at retail.

S. SPECIFICATIONS. (Applicable with respect to the design of milk bottles.)

S.1. UNITS.—The capacity of a milk bottle shall be 1 gill, ½ liquid pint, 10 fluid ounces, 1 liquid pint, 1 liquid quart, ½ gallon, 1 gallon, or 2 gallons.

S.2. MATERIAL.—A milk bottle shall be sufficiently transparent that the level of milk easily can be seen under normal lighting conditions without removing the cap or lid, and shall be made of such material that the volumetric capacity of the bottle will not be altered by customary filling and handling operations.

S.3. CAPACITY POINT.—The capacity point of a milk bottle shall relate to the plane of its sealing surface as follows:

(a) On "cap-seat" bottles, the plane established by the under side of the bottle cap (corresponding to the plane of the cap seat).

(b) On "crown-cap" bottles, the plane established by the under side of the crown cap or other cover (corresponding to the top edge of the bottle).

(c) On a bottle designed for optional or multiple types of closures, the plane established by the lowest sealing surface.

S.3.1. POSITION.—The capacity point of a milk bottle shall be

(a) ¼ inch below the plane of the sealing surface on a bottle with an inside diameter of 2 inches or less, measured immediately below that plane, and

(b) ⅛ inch below the plane of the sealing surface on a bottle with an inside diameter of greater than 2 inches, measured immediately below that plane.

S.4. MARKING REQUIREMENTS.—A milk bottle shall be permanently marked with a statement of its capacity. The capacity statement shall not be on the bottom of the bottle.

N. NOTES. (Applicable with respect to the testing of milk bottles.)

N.1. TO CONTAIN.—A milk bottle shall be tested "to contain."

N.2. TEST LIQUID.—Water shall be used as the test liquid for milk bottles.

N.3. TEMPERATURE CONTROL.—The test of a milk bottle shall be conducted with the ambient temperature, the temperature of the bottle, and the temperature of the test liquid at 68 °F±5 °F.

N.4. SAMPLE SELECTION.—For the test to determine the average error in a lot or delivery of milk bottles, not less than 25 bottles of the same capacity, pattern, make, and ownership shall be selected at random so as properly to be representative of the total lot or delivery.

T. TOLERANCES. (Applicable with respect to the accuracy of milk bottles.)

T.1. TOLERANCE ON AVERAGE CAPACITY.—Maintenance and acceptance tolerances in excess and in deficiency on the average capacity of milk bottles tested shall be as shown in table 1.

TABLE 1.—MAINTENANCE AND ACCEPTANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, ON AVERAGE CAPACITY OF MILK BOTTLES

Nominal capacity	Tolerance on average capacity	
	Fluid drams	*Cubic inches*
10 fluid ounces or less	0. 50	0. 12
1 pint	. 75	. 17
1 quart	1. 00	. 23
½ gallon	1. 50	. 35
1 gallon	2. 50	. 60
2 gallons	4. 50	1. 00

T.2. TOLERANCE ON INDIVIDUAL BOTTLE.—Maintenance and acceptance tolerances in excess and in deficiency on an individual milk bottle shall be four times the appropriate value shown in table 1.

T.3. TOLERANCE REQUIREMENTS.—A lot or delivery of milk bottles shall be considered as failing to meet tolerance requirements when

(a) the average error of the sample of 25 or more bottles is greater than the appropriate tolerance value (see T.1.), or

(b) the error in 20 percent or more of the individual bottles in the sample is greater than the appropriate tolerance on individual bottles (see T.2.).

LUBRICATING-OIL BOTTLES

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1.—This code applies to any rigid (inflexible) container used for the measurement of lubricating oil for direct delivery to the crankcase of a motor vehicle, whether or not the bottle is sealed with a cap or some other device.

S. SPECIFICATIONS. (Applicable with respect to the design of lubricating-oil bottles.)

S.1. UNITS.—The capacity of a lubricating-oil bottle shall be 1 liquid pint, 1 liquid quart, ½ gallon, or 1 gallon, when the temperature of the bottle is 20° C (68°F), and the bottle shall not be subdivided.

S.2. MATERIAL.—Bottles shall be made of clear, uncolored glass.

S.3. CAPACITY POINT.—The capacity point shall be defined by a permanent, clearly defined graduation not more than 0.1 inch in width, extending at least halfway around the bottle, and the words "Fill to line" or a similar and suitable statement clearly referring to this graduation shall be permanently marked on the bottle. An auxiliary, undesignated graduation less prominent than the capacity graduation may be placed above the capacity graduation to serve as a guide in filling the bottle with an excess measure of oil.

S.4. HEADSPACE.—The capacity of that portion of the bottle above the capacity graduation shall be not less than 3 cubic inches.

S.5. CLEARANCE ABOVE CAPACITY GRADUATION.—When any opaque top or spout that is provided is screwed firmly in place or is otherwise securely attached, the lower edge of such top or spout shall be at least ¼ inch above the capacity graduation.

S.6. DRAINAGE.—A bottle, and any top or spout that is provided, shall be so constructed as to permit free and unobstructed drainage of the contents of the bottle.

S.7. MARKING REQUIREMENTS.—A bottle shall be permanently marked on its side with a statement of its capacity. (See also S.3.)

N. NOTES. (Applicable with respect to the testing of lubricating-oil bottles.)

N.1. TO DELIVER.—A lubricating-oil bottle shall be tested "to deliver" with a 10-second drain period.

N.2. TEST LIQUID.—Water shall be used as the test liquid for lubricating-oil bottles.

N.3. TEMPERATURE CONTROL.—During the test of a lubricating-oil bottle, appropriate precautions shall be exercised to reduce to the practicable minimum any detrimental temperature effects.

N.4. LEVEL OF TEST LIQUID.—During the test of a lubricating-oil bottle, the top of the meniscus of the water shall be brought into coincidence with the bottom of the capacity graduation.

T. TOLERANCES. (Applicable with respect to the accuracy of lubricating-oil bottles.)

T.1.—Maintenance and acceptance tolerances in excess shall be as shown in table 1. There shall be no tolerance in deficiency.

TABLE 1.—MAINTENANCE AND ACCEPTANCE TOLERANCES, IN EXCESS ONLY, FOR LUBRICATING-OIL BOTTLES

Nominal capacity	Tolerance	
	Fluid drams	*Cubic inches*
1 pint	6	1. 4
1 quart	8	1. 8
½ gallon	12	2. 7
1 gallon	20	4. 5

UR. USER REQUIREMENTS. (Applicable with respect to the use of lubricating-oil bottles.)

UR.1. DRAINAGE.—Lubricating-oil bottles shall be permitted to drain into the oil-fill pipe for such period of time as is necessary to provide for the complete delivery.

GRADUATES

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1.—This code applies to subdivided glass measures of capacity, either cylindrical or conical in shape.

S. SPECIFICATIONS. (Applicable with respect to the design of graduates.)

S.1. UNITS.—*Nominal capacities, graduation ranges, values of graduated intervals, and numbered graduations applicable to single-scale graduates and to the appropriate portions of double-scale graduates shall be as shown in table 1.* [1956]

TABLE 1.—DESIGN DETAILS FOR GRADUATES

Nominal capacity	To be graduated between—	Value of graduated intervals	To be numbered at each even—
Minims	*Minims*	*Minims*	*Minims*
60	15 and 60	5	[a] 10
120	30 and 120	10	[b] 20
Fluid drams	*Fluid drams*	*Fluid drams*	*Fluid drams*
4	1 and 4	½	1
8	2 and 8	1	2
Fluid ounces	*Fluid ounces*	*Fluid ounces*	*Fluid ounces*
2	½ and 2	¼	½
4	1 and 4	½	1
8	2 and 8	½	1
16	4 and 16	1	2
32	8 and 32	2	4
Milliliters	*Milliliters*	*Milliliters*	*Milliliters*
5	1 and 5	½	1
10	2 and 10	1	2
25	5 and 25	5	5
50	10 and 50	5	10
100	20 and 100	10	20
250	50 and 250	25	50
500	100 and 500	25	50
1, 000	200 and 1,000	50	100

[a] And, in addition, at the first or 15-minim graduation.
[b] And, in addition, at the first or 30-minim graduation.

S.2. INITIAL INTERVAL.—*A graduate shall have an initial interval that is not subdivided, equal to not less than one-fifth and not more than one-fourth of the capacity of the graduate.* [1956]

S.3. SHAPE.—A graduate of a capacity of more than 4 fluid drams (15 milliliters) may be of either the cylindrical or conical type. *A graduate of a capacity of 4 fluid drams (15 milliliters) or less shall be of the single-scale cylindrical type.* [1956]

S.4. MATERIAL.—A graduate shall be made of good-quality, thoroughly annealed, clear, transparent glass, free from bubbles and streaks that might affect the accuracy of measurement. The glass shall be uniform in thickness and shall not be excessively thick.

S.5. DIMENSIONAL PROPORTIONS.

S.5.1. ON A CONICAL GRADUATE.—The inside measurement from the bottom of a conical graduate to the capacity graduation shall be not less than two times the inside diameter at the capacity graduation. The inside measurement from the bottom of the graduate to the point representing one-fourth of the capacity shall be not less than the inside diameter at that point.

S.5.2. ON A CYLINDRICAL GRADUATE.—The inside measurement from the bottom of a cylindrical graduate to the capacity graduation shall be not less than five times the inside diameter at the capacity graduation.

S.6. BASE.—The base of the graduate shall be perpendicular to the vertical axis of the graduate. The diameter of the base shall be of such size that the empty graduate will remain standing on an inclined surface of 25 percent, or approximately 15 degrees, from the horizontal.

S.7. DESIGN OF GRADUATIONS.

S.7.1. GENERAL.—Graduations shall be perpendicular to the axis of the graduate and parallel to each other. Graduations shall be etched or engraved and shall be not wider than 0.015 inch (0.38 millimeter). No graduation shall extend less than one-fourth the distance around the graduate.

S.7.2. ON A SINGLE-SCALE GRADUATE.—*On a single-scale graduate, the main graduations shall completely encircle the graduate and subordinate graduations shall extend at least one-half the distance around the graduate.* [1956]

S.7.3. ON A DOUBLE-SCALE OR A DUPLEX GRADUATE.—On a double-scale or duplex graduate, there shall be a clear space between the ends of the main graduations on the two scales, and this space shall be approximately 90 degrees from the lip of the graduate and shall conform to the requirements of table 2.

TABLE 2.—CLEAR SPACE BETWEEN ENDS OF MAIN GRADUATIONS ON DOUBLE-SCALE GRADUATES

Inside diameter of graduate at the graduations	Clear space between ends of main graduations
Inches	*Inch*
Less than 1.5	⅛ to ¼
1.5 to 3, incl	¼ to ½
Over 3	⅜ to ⅝

S.8. BASIS OF GRADUATION.—*A graduate shall be graduated "to deliver" when the temperature of the graduate is 20 °C (68 °F), and shall be marked accordingly in a permanent and conspicuous manner.* [1956]

S.9. MARKING REQUIREMENTS.—Each main graduation shall be marked to show its value. Intermediate graduations shall not be marked. Value figures shall be uniformly positioned either directly upon or immediately above the graduations to which they refer. Figures placed upon graduations shall be set in from the ends of the graduations a sufficient distance to allow the ends of the graduations to be used in making a setting.

N. NOTES. (Applicable with respect to the testing of graduates.)

N.1. TEST LIQUID.—Water shall be used as the test liquid for graduates.

N.2. TEMPERATURE CONTROL.—During the test of a graduate, appropriate precautions shall be exercised to reduce to the practicable minimum any detrimental temperature effects.

T. TOLERANCES. (Applicable with respect to the accuracy of graduates.)

T.1.—Maintenance and acceptance tolerances in excess and in deficiency shall be as shown in table 3 for graduates that are graduated "to contain" or "to deliver." (The tolerance to be applied at any graduation is determined by the inside diameter of the graduate at the graduation in question.)

TABLE 3.—MAINTENANCE AND ACCEPTANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR GRADUATES

Inside diameter of graduate	Tolerance	Inside diameter of graduate	Tolerance
Inches	*Fluid drams Minims*	*Millimeters*	*Milliliters*
½ or less	2	15 or less	0. 1
9/16 to ¾, incl	3	16 to 20, incl	0. 2
13/16 to 1, incl	6	21 to 25, incl	0. 4
1 1/16 to 1¼ incl	10	26 to 30, incl	0. 6
1 5/16 to 1½, incl	15	31 to 35, incl	0. 8
1 9/16 to 1¾, incl	20	36 to 40, incl	1. 1
1 13/16 to 2, incl	30	41 to 45, incl	1. 4
2 1/16 to 2¼, incl	40	46 to 50, incl	1. 8
2 5/16 to 2½, incl	50	51 to 55, incl	2. 2
2 9/16 to 2¾, incl	1 and 5	56 to 60, incl	2. 8
2 13/16 to 3, incl	1 and 20	61 to 65, incl	3. 4
3 1/16 to 3¼, incl	1 and 35	66 to 70, incl	4. 1
3 5/16 to 3½, incl	1 and 50	71 to 75, incl	4. 8
3 9/16 to 3¾, incl	2 and 10	76 to 80, incl	5. 6
3 13/16 to 4, incl	2 and 30	81 to 85, incl	6. 4
		86 to 90, incl	7. 2
		91 to 95, incl	8. 1
		96 to 100, incl	9. 0

LINEAR MEASURES

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1.—This code applies to any linear measure or measure of length, whether flexible or inflexible, permanently installed or portable.

S. SPECIFICATIONS. (Applicable with respect to the design of linear measures.)

S.1. UNITS.—A linear measure may be in total length, and the total length may be subdivided in any or all of the following:

(a) Inches and binary submultiples of the inch.
(b) Feet.
(c) Yards and multiples of yards.

A 1-yard measure may be graduated, in addition, to show ⅓-yard and ⅔-yard subdivisions. A flexible tape may be graduated in tenths feet, hundredths feet, or both tenths and hundredths. (Any other subdivisions are allowable only on measures for special purposes and when required for such purposes.)

S.2. MATERIAL.

S.2.1. FLEXIBLE TAPE.—*A flexible tape shall be made of metal.* [1959]

S.2.2. END MEASURE.—If an end measure is made of material softer than brass, the ends of the measure shall be protected by brass (or other metal at least equally hard) securely attached.

S.3. FINISH.—Measures shall be smoothly finished.

S.4. DESIGN.

S.4.1. RIGID MEASURE.—A rigid measure shall be straight.

S.4.2. FOLDING MEASURE.—A folding measure shall open to a definite stop, and when so opened shall be straight.

S.5. GRADUATIONS.

S.5.1. GENERAL.—Graduations shall be perpendicular to the edge of the measure.

S.5.2. WIDTH.—The width of the graduations on any measure shall not exceed one-fourth the width of the smallest graduated interval on the measure, and shall in no case be wider than 0.03 inch.

T. TOLERANCES. (Applicable with respect to the accuracy of linear measures.)

T.1. FOR MEASURES EXCEPT METAL TAPES.—Maintenance tolerances in excess and in deficiency for measures except metal tapes shall be as shown in table 1. Acceptance tolerances shall be one-half the maintenance tolerances.

TABLE 1.—MAINTENANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR LINEAR MEASURES EXCEPT METAL TAPES

Nominal interval from zero	Tolerance
Feet	*Inch*
½ or less	1/64
1	1/32
2	1/16
3	3/32
4	1/8
5	5/32
6	3/16

T.2. FOR METAL TAPES.—Maintenance and acceptance tolerances in excess and in deficiency for metal tapes shall be as shown in table 2, tapes of 25 feet and over being at a tension of 10 pounds, tapes of less than 25 feet being at a tension of 5 pounds, and all tapes being supported throughout on a horizontal flat surface.

TABLE 2.—MAINTENANCE AND ACCEPTANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR METAL TAPES

Nominal interval from zero	Tolerance
Feet	*Inch*
6 or less	1/32
7 to 30, incl	1/16
31 to 55, incl	1/8
56 to 80, incl	3/16
81 to 100, incl	1/4

FABRIC-MEASURING DEVICES

(See also General Code Requirements)

A. Application. (Pertaining to the application of code requirements.)

A.1.—This code applies only to mechanisms and machines designed to indicate automatically (with or without value-computing capabilities) the length of fabric passed through the measuring elements.

S. SPECIFICATIONS. (Applicable with respect to the design of fabric-measuring devices.)

S.1. UNITS.—A fabric-measuring device shall indicate lengths in terms of ⅛ yards, ¼ yards, ½ yards, and yards. In addition, lengths may be indicated in terms of any or all of the following subdivisions: ⅓ yards, 1/16 yards, feet, and inches.

S.2. DESIGN OF INDICATING ELEMENTS.

S.2.1. GRADUATIONS.

S.2.1.1. LENGTH.—Graduations shall be so varied in length that they may be conveniently read.

S.2.1.2. WIDTH.—In any series of graduations, the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations, and the width of main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Graduations shall in no case be less than 0.008 inch in width.

S.2.1.3. CLEAR INTERVAL BETWEEN GRADUATIONS.—The clear interval between graduations shall be at least 11/16 inch for ⅛-yard graduations, and ⅛ inch for 1-inch graduations.

S.2.2. INDICATOR.

S.2.2.1. SYMMETRY.—The index of an indicator shall be symmetrical with respect to the graduations with which it is associated and at least throughout that portion of its length that is associated with the graduations.

S.2.2.2. LENGTH.—The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case the distance between the end of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 0.04 inch.

S.2.2.3. WIDTH.—The index of an indicator shall not be wider than the narrowest graduations with which it is used, and shall in no case exceed 0.015 inch.

S.2.2.4. CLEARANCE.—The clearance between the index of an indicator and the graduations shall in no case be more than 0.06 inch.

S.2.2.5. PARALLAX.—Parallax effects shall be reduced to the practicable minimum.

S.2.3. MONEY-VALUE COMPUTATIONS.

S.2.3.1. FULL-COMPUTING TYPE.—In this type, the money value at each of a series of unit prices shall be computed automatically for every length within the range of measurement of the fabric-measuring device. Value graduations shall be provided and shall be accurately positioned. The value of each graduated interval shall be 1 cent at all prices per yard of 30 cents and less, and shall not exceed 2 cents at higher prices per yard. Five-cent intervals may be represented in the 2-cent range by special graduations, but these shall not be positioned in the clear intervals between graduations of the regular series.

S.2.3.2. LIMITED-COMPUTING TYPE.—In this type, the money value at each of a series of unit prices shall be computed automatically only for lengths corresponding to a definite series of length graduations. There shall be no value graduations. At no position that the chart can assume shall two value figures at the same price per yard be completely and clearly exposed to view at one time. Money values shown shall be mathematically accurate, except that a fraction of less than ½ cent shall be dropped and the next higher cent shall be shown in the case of a fraction of ½ cent or more. One of the following requirements shall be met:

(a) There shall be a money-value computation for each length graduation within the range of measurement of the device.

(b) No money-value computation shall be exposed to view except at such times as the device shows a length indication for which a corresponding series of value indications is computed.

(c) Each column or row of money-value computations shall be marked to show the length to which the computations correspond, the device shall be marked to show the character and limitations of the computations, and there shall be computations corresponding to at least ⅛ yard throughout the range of measurement of the device.

S.2.4. RETURN TO ZERO.—Primary indicating elements shall be readily returnable to a definite zero indication. Means shall be provided to prevent the return of the indicating elements beyond their correct zero position.

S.3. MARKING REQUIREMENTS.—If a device will not accurately measure all fabrics, it shall be marked to indicate clearly its limitations.

S.4. DESIGN ACCURACY.—Indications of length and money value shall be accurate whether the values of the indications are being increased or decreased.

N. NOTES. (Applicable with respect to the testing of fabric-measuring devices.)

N.1. TESTING MEDIUM.—A fabric-measuring device shall be tested with a suitable testing tape approximately 3 inches wide and with a graduated length of at least 12 yards, made from such material and having such surface finish as to provide dimensional stability and reduce slippage to the practicable minimum.

T. TOLERANCES. (Applicable with respect to the performance of fabric-measuring devices.)

T.1. TOLERANCE VALUES.—Maintenance and acceptance tolerances shall be as shown in table 1.

TABLE 1.—MAINTENANCE AND ACCEPTANCE TOLERANCES FOR FABRIC-MEASURING DEVICES

Indication of device	Maintenance tolerance		Acceptance tolerance	
	On under-registration	On over-registration	On under-registration	On over-registration
Yards	*Inches*	*Inches*	*Inches*	*Inches*
2 or less	3/8	1/4	1/4	1/8
3	3/8	5/16	1/4	5/32
4	1/2	5/16	1/4	5/32
5	5/8	3/8	5/16	3/16
6	3/4	3/8	3/8	3/16
7 and 8	1	1/2	1/2	1/4
9	1 1/4	5/8	5/8	5/16
10 and 11	1 1/2	3/4	3/4	3/8
12 and 13	1 3/4	7/8	7/8	7/16
14 and 15	2	1	1	1/2
Over 15	Add 1/8 inch per indicated yard	Add 1/16 inch per indicated yard	Add 1/16 inch per indicated yard	Add 1/32 inch per indicated yard

UR. USER REQUIREMENTS. (Applicable with respect to the installation and use of fabric-measuring devices.)

UR.1. INSTALLATION REQUIREMENTS.

UR.1.1. INSTALLATION.—A fabric-measuring device shall be securely supported and firmly fixed in position.

UR.2. USE REQUIREMENTS.

UR.2.1. LIMITATION OF USE.—A fabric-measuring device shall be used to measure only those fabrics that it was designed to measure, and in no case shall it be used to measure a fabric that a marking on the device indicates should not be measured.

CORDAGE-MEASURING DEVICES

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1.—This code applies to mechanisms and machines designed to indicate automatically the length of cordage, rope, wire, cable, or similar flexible material passed through the measuring elements.

S. SPECIFICATIONS. (Applicable with respect to the design of cordage-measuring devices.)

S.1. UNITS.—A cordage-measuring device shall indicate lengths in terms of feet.

S.2. DESIGN OF INDICATING ELEMENTS.

S.2.1. GRADUATIONS.

S.2.1.1. LENGTH.—Graduations shall be so varied in length that they may be conveniently read.

S.2.1.2. WIDTH.—In any series of graduations, the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations, and the width of main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Graduations shall in no case be less than 0.008 inch, nor more than 0.04 inch, in width.

S.2.1.3. CLEAR INTERVAL BETWEEN GRADUATIONS.—The clear interval between graduations shall be at least as wide as the widest graduation, and in no case less than 0.03 inch.

S.2.2. INDICATOR.

S.2.2.1. SYMMETRY.—The index of an indicator shall be symmetrical with respect to the graduations with which it is associated and at least throughout that portion of its length that is associated with the graduations.

S.2.2.2. LENGTH.—The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case the distance between the end of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 0.04 inch.

S.2.2.3. WIDTH.—The index of an indicator shall not be wider than the narrowest graduations with which it is used, and shall in no case exceed 0.015 inch.

S.2.2.4. CLEARANCE.—The clearance between the index of an indicator and the graduations shall in no case be more than 0.06 inch.

S.2.2.5. PARALLAX.—Parallax effects shall be reduced to the practicable minimum.

S.2.3. RETURN TO ZERO.—Primary indicating elements shall be readily returnable to a definite zero indication. Means shall be provided to prevent the return of the indicating elements beyond their correct zero position.

S.3. DESIGN OF MEASURING ELEMENTS.

S.3.1. SENSITIVENESS.—If the most sensitive element of the indicating system utilizes an indicator and graduations, the relative movement of these parts corresponding to a measurement of 1 foot shall be not less than ¼ inch.

S.3.2. SLIPPAGE.—The measuring elements of a cordage-measuring device shall be so designed and constructed as to reduce to the practicable minimum any slippage of material being measured and any lost motion in the measuring mechanism.

S.4. MARKING REQUIREMENTS.

S.4.1. LIMITATION OF USE.—If a device will measure accurately only certain configurations, diameters, types, or varieties of materials, or with certain accessory equipment, its limitations shall be clearly and permanently stated on the device.

S.4.2. OPERATING INSTRUCTIONS.—Any necessary operating instructions shall be clearly stated on the device.

S.4.3. INDICATIONS.—Indicating elements shall be identified by suitable words or legends so that the values of the indications will be unmistakable.

S.5. DESIGN ACCURACY.—Indications of length shall be accurate whether the values of the indications are being increased or decreased.

N. NOTES. (Applicable with respect to the testing of cordage-measuring devices.)

N.1. TESTING MEDIUM.—A cordage-measuring device shall be tested with a steel tape not less than ½ inch in width and 50 feet in length. The tape shall have a smooth surface or intaglio figures and graduations (i.e., the figures and graduations shall not be raised.)

T. TOLERANCES. (Applicable with respect to the performance of cordage-measuring devices.)

T.1. TOLERANCE VALUES.—Maintenance and acceptance tolerances shall be as shown in table 1.

TABLE 1.—MAINTENANCE AND ACCEPTANCE FOR CORDAGE-MEASURING DEVICES

Indication of device	Maintenance tolerance		Acceptance tolerance	
	On under-registration	On over-registration	On under-registration	On over-registration
Feet	*Inches*	*Inches*	*Inches*	*Inches*
0 to 20, incl	2	1	1	½
21 to 30, incl	3	1½	1½	¾
31 to 40, incl	4	2	2	1
41 to 50, incl	5	2½	2½	1¼
Over 50	Add 2 inches per indicated 50 feet	Add 1 inch per indicated 50 feet	Add 1 inch per indicated 50 feet	Add ½ inch per indicated 50 feet

UR. USER REQUIREMENTS. (Applicable with respect to the installation and use of cordage-measuring devices.)

UR.1. INSTALLATION REQUIREMENTS.

UR.1.1. INSTALLATION.—A cordage-measuring device shall be securely supported and firmly fixed in position.

UR.2. USE REQUIREMENTS.

UR.2.1. LIMITATION OF USE.—A cordage-measuring device shall be used to measure only those materials that it was designed to measure, and in no case shall it be used to measure a material that a marking on the device indicates should not be measured.

TAXIMETERS

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1.—This code applies to taximeters; that is, to devices that automatically calculate at a predetermined rate or rates and indicate the charge for hire of a vehicle.

A.2.—This code *does not* apply to odometers on vehicles that are rented on a mileage basis (for which see Code for Odometers).

S. SPECIFICATIONS. (Applicable with respect to the design of taximeters.)

S.1. DESIGN OF INDICATING ELEMENTS.

S.1.1. GENERAL.—A taximeter shall be equipped with a primary indicating element.

S.1.2. ADVANCEMENT OF INDICATING ELEMENTS.—Except when a taximeter is being cleared, the primary indicating elements shall be susceptible of advancement only by the rotation of the vehicle wheel or wheels.

S.1.3. VISIBILITY OF INDICATIONS.—Except when a taximeter is being cleared, indications of fare and extras shall be visible at all times.

S.1.4. ACTUATION OF FARE-INDICATING MECHANISM.—When a taximeter designed to calculate fares upon the basis of a combination of mileage traveled and time elapsed is operative with respect to fare indication, the fare-indicating mechanism shall be actuated by the mileage mechanism whenever the vehicle is in motion at such a speed that the rate of mileage revenue equals or exceeds the time rate, and may be actuated by the time mechanism whenever the vehicle speed is less than this and when the vehicle is not in motion. Means shall be provided for the vehicle operator to render the time mechanism either operative or inoperative with respect to the fare-indicating mechanism.

S.1.5. OPERATING CONDITION.

S.1.5.1. GENERAL.—Whenever the indicating elements of a taximeter are set to indicate a charge for the hire of the vehicle, the character of the fare indication shall be clearly shown on the taximeter face. When a taximeter is cleared, the indication "Not Registering," "Vacant," or an equivalent expression shall be shown.

S.1.5.2. SINGLE-TARIFF TAXIMETER.—Whenever a single-tariff taximeter is set so as to register charges, the indication "Registering," "Hired," or an equivalent expression shall be shown.

S.1.5.3. MULTIPLE-TARIFF TAXIMETER.—Whenever a multiple-tariff taximeter is set so as to register charges, the basis for the particular tariff for which it is set shall be shown. The indication "Registering," "Hired," or an equivalent expression may be shown for the lowest tariff. For any tariff rate higher than the lowest, there shall be shown the type of tariff that actually is being charged ("3 or more persons," for example).

S.1.5.4. TIME NOT RECORDING.—While a taximeter is set for fare registration but with the time mechanism inoperative with respect thereto, the indication "Time Not Recording" or an equivalent expression shall appear. This indication may replace the indication specified for a single-tariff taximeter and for the lowest rate on a multiple-tariff taximeter, but shall be in addition to the indication specified for the higher rates on a multiple-tariff taximeter.

S.1.6. FARE IDENTIFICATION.—Fare indications shall be identified by the word "Fare" or by an equivalent expression. Values shall be defined by suitable words or monetary signs.

S.1.7. EXTRAS.—If an extras mechanism is provided, extras shall be indicated as a separate item and shall not be included in the fare indication. They shall be identified by the word "Extras" or by an equivalent expression. Values shall be defined by suitable words or monetary signs.

S.1.7. NONUSE OF EXTRAS.—If and when taximeter extras are prohibited by legal authority or are discontinued by a vehicle operator, with respect to all taximeters involved the extras mechanisms shall be rendered inoperable or the extras indications shall be effectively obscured by permanent means.

S.1.8. PROTECTION OF INDICATIONS.—Indications of fare and extras shall be displayed through and entirely protected by glass or other suitable transparent material securely attached to the housing or the taximeter.

S.2. BASIS OF FARE CALCULATIONS.—A taximeter shall calculate fares only upon the basis of

(a) mileage traveled,
(b) time elapsed, or
(c) a combination of mileage traveled and time elapsed.

S.3. STATEMENT OF RATES.—The mileage and time rates for which a taximeter is adjusted, and the schedule of extras when an extras mechanism is provided, shall be conspicuously displayed inside the vehicle. The words "Rate," "Rates," or "Rates of Fare" shall precede the rate statement. The rate statement shall be fully informative, self-explanatory, and readily understandable by the ordinary passenger, and shall either be of a permanent character or be protected by glass or other suitable transparent material.

S.4. DESIGN OF OPERATING CONTROL.

S.4.1. MEANS OF CONTROL.—A control lever-arm, knob, handle, or other convenient and effective means shall be provided to set the taximeter mechanism for the desired operating condition and to "clear" the taximeter.

S.4.2. POSITIONS OF CONTROL.—The several positions of the control lever shall be mechanically defined, and displacement from any one of these positions shall be sufficiently obstructed that the accidental or inadvertent changing of the operating condition of the taximeter is improbable. Possible movement of this control to an operating position immediately following its movement to the cleared position shall automatically be delayed enough to permit the taximeter mechanism to come to complete rest in the cleared condition.

S.4.3. FLAG.—If the control for the operating condition is a lever-arm and flag, the flag shall be at its highest position when the taximeter is cleared, and in this position the whole of the flag shall be above the level of the taximeter housing.

S.4.4. CONTROL FOR EXTRAS MECHANISM.—The knob, handle, or other means provided to actuate the extras mechanism shall be inoperable whenever the taximeter is cleared.

S.5. INTERFERENCE.—The construction of a taximeter shall be such that there will be no interference between the time and the mileage portions of the mechanism at any speed of operation corresponding to a vehicle speed faster than the speed at which the basic rate of mileage revenue equals the basic waiting-time rate. Specifically, the registration of a taximeter in the "hired" condition shall agree with its performance in the "time not recording" condition within 1 percent.

S.6. PROVISION FOR SECURITY SEALS.—Adequate provision shall be made for affixing lead-and-wire seals to a taximeter and to other parts required for service operation of a complete installation on a vehicle, so that no adjustments, alterations, or replacements affecting in any way the accuracy or indications of the device or the assembly can be made without mutilating the seal or seals. The sealing means shall be such that it is not necessary to disassemble or remove any part of the device or of the vehicle to apply or inspect the seals.

N. NOTES. (Applicable with respect to the testing of taximeters.)

N.1. MILEAGE TESTS.

N.1.1. TEST METHODS.—To determine compliance with mileage tolerances, a mileage test of a taximeter shall be conducted utilizing one or more of the following test methods:

(a) **ROAD TEST.**—A road test consists of driving the vehicle over a precisely measured road course.

(b) **FIFTH-WHEEL TEST.**—A fifth-wheel test consists of driving the vehicle over any reasonable road course and determining the distance actually traveled through the use of a mechanism known as a "fifth wheel" that is attached to the vehicle and that independently measures and indicates the distance.

(c) **SIMULATED-ROAD TEST.**—A simulated-road test involves the use of a special device which provides drums to support the rear wheels of the vehicle and allows the vehicle engine to rotate the drums through the wheels of the vehicle. The distance actually traveled is measured and indicated by the special device.

N.1.2. TEST PROCEDURES.—The mileage test of a taximeter, whether a road test, a simulated-road test, or a fifth-wheel test, shall include at least duplicate runs of sufficient length to cover at least the third money drop **or** one mile, **whichever is greater,** and shall be at a speed approximating the average speed traveled by the vehicle in normal commercial service.

N.1.3. TEST CONDITIONS.

N.1.3.1. VEHICLE LADING.—During the mileage test of a taximeter, the vehicle shall carry two persons.

N.1.3.2. TIRE PRESSURE.—At the beginning of each test run, the tires on the vehicle under test shall be adjusted to 28 pounds per square inch at stabilized tire temperatures.

N.2. TIME TEST.—If a taximeter is equipped with a mechanism through which charges are made for time intervals, this mechanism shall be tested at least through the first 5 time intervals.

N.3. INTERFERENCE TEST.—If a taximeter is equipped with a mechanism through which charges are made for time intervals, a test shall be conducted to determine whether there is interference between the time and mileage mechanisms. During the interference test, the vehicle is operated at a speed of 2 or 3 miles per hour faster than the speed at which the basic mileage-revenue rate equals the basic waiting-time rate.

T. TOLERANCES. (Applicable with respect to the performance of taximeters.)

T.1. TOLERANCE VALUES.

T.1.1. ON MILEAGE TESTS.—Maintenance and acceptance tolerances for taximeters shall be as follows:

(a) **ON OVERREGISTRATION:** 1 percent of the interval under test.

(b) **ON UNDERREGISTRATION:** 4 percent of the interval under test, with an added tolerance of 100 feet whenever the initial interval is included in the interval under test.

T.1.2. ON TIME TESTS.

T.1.2.1. ON INDIVIDUAL TIME INTERVALS.—Maintenance and acceptance tolerances on individual time intervals shall be as follows:

(a) **ON OVERREGISTRATION:** 3 seconds per minute (5 percent).

(b) **ON UNDERREGISTRATION:** 9 seconds per minute (15 percent) on the initial interval, and 6 seconds per minute (10 percent) on other intervals.

T.1.2.2. ON AVERAGE TIME INTERVAL COMPUTED AFTER EXCLUDING THE INITIAL INTERVAL.—Maintenance and acceptance tolerances on the average time interval excluding the initial interval shall be as follows:

(a) **ON OVERREGISTRATION:** No tolerance.

(b) **ON UNDERREGISTRATION:** 3 seconds per minute (5 percent).

UR. USER REQUIREMENTS. (Applicable with respect to the maintenance of taximeters.)

UR.1. INFLATION OF VEHICLE TIRES.—The pressure in the tires on the wheels that actuate the taximeter shall be maintained at not less than the normal operating pressure recommended by the manufacturer of the vehicle.

UR.2. POSITION AND ILLUMINATION OF TAXIMETER.—When mounted upon a vehicle, a taximeter shall be so placed that its face can be seen by a passenger seated upon the rear seat of the vehicle. Adequate lighting facilities shall be provided for so illuminating the face of the taximeter that the indications thereof may be conveniently read by the passenger, and the face of the taximeter shall be so illuminated whenever the taximeter is in operation and artificial illumination is necessary for the convenient reading of its indications.

UR.3. REINSPECTION.—Whenever a taximeter has been damaged, or repairs that might in any way affect the accuracy of its indications have been made, or any of the official security seals have been mutilated, such device shall not thereafter be used until it has been officially examined and reapproved.

DEFINITIONS OF TERMS

TAXIMETERS

The terms defined here have a special and technical meaning when used in the Taximeter Code. Whenever a defined term is used in the Taximeter Code, it has the particular meaning given here.

cleared. A taximeter is "cleared" when it is inoperative with respect to all fare indication, when no indication of fare or extras is shown, and when all parts are in those positions in which they are designed to be when the vehicle on which the taximeter is installed is not engaged by a passenger.

extras. Charges to be paid by a passenger in addition to the fare, including any charge at a flat rate for the transportation of passengers in excess of a stated number and any charge for the transportation of baggage.

face. That side of a taximeter upon which passenger charges are indicated.

fare. That portion of the charge for the hire of a vehicle that is automatically calculated by a taximeter through the operation of the mileage or time mechanism.

fifth-wheel test. A mileage test similar to a road test except that the distance traveled by the vehicle under test is determined by a mechanism known as a "fifth wheel" that is attached to the vehicle and that independently measures and indicates the distance.

flag. A plate at the end of the lever arm or similar part by which the operating condition of a taximeter is controlled.

initial mileage or time interval. The interval corresponding to the initial money drop.

money drop. An increment of fare indication. The "initial money drop" is the first increment of fare indication following the flag pull.

multiple-tariff taximeter. One that may be set to calculate fares at any one of two or more rates.

road test. A mileage test, over a measured course, of a complete taximeter assembly when installed on a vehicle, the mechanism being actuated as a result of vehicle travel.

simulated road test. A mileage test similar to a road test except that the vehicle wheel or wheels that actuate the mechanism rest in a cradle formed by rollers, one of which is a mileage-measuring element. The vehicle remains at rest during this test.

single-tariff taximeter. One that calculates fares at a single rate only.

taximeter. A device that automatically calculates, at a predetermined rate or rates, and indicates, the charge for hire of a vehicle.

ODOMETERS

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1.—This code applies to odometers that are used or are to be used to determine the charges for rent or hire of a passenger vehicle. (When official examinations are undertaken on odometers whose readings form the basis for the payment of fees or taxes to, or the preparation of reports for, governmental agencies, and in similar cases, the requirements of this code shall be applied insofar as they are applicable and appropriate to the conditions of such special uses.)

A.2.—This code **does not** apply to odometers on cargo vehicles (trucks) or to taximeters (for which see Code for Taximeters).

S. SPECIFICATIONS. (Applicable with respect to the design of odometers.)

S.1. DESIGN OF INDICATING ELEMENTS.

S.1.1. GENERAL.—The primary indicating element of an odometer may be

(a) the mileage-traveled portion of the "speedometer" assembly of a motor vehicle,

(b) a special cable-driven mileage-indicating device, or

(c) a hub odometer attached to the hub of a wheel on a motor vehicle.

S.1.2. UNITS.—An odometer shall indicate in terms of miles.

S.1.3. VALUE OF MINIMUM INDICATION.—The value of the minimum interval of mileage on an odometer shall be one-tenth mile.

S.1.4. ADVANCEMENT OF INDICATING ELEMENTS.—The most sensitive indicating element of an odometer shall advance continuously; all other elements shall advance intermittently. Except when the indications are being returned to zero, the indications of an installed odometer shall be susceptible of advancement only by the rotation of the vehicle wheel or wheels.

S.1.5. READABILITY.—Mileage figures and their background shall be of sharply contrasting colors. The colors of all figures except those indicating tenth miles shall be uniform, and the color of the tenth-mile figures shall be different from the color of the other figures. Except during the period of advance of an indicator to the next higher indication, only one figure on each drum or dial shall be exposed to view. Any protective covering intended to be transparent shall be in such condition that it can be made transparent by ordinary cleaning of its exposed surface.

N. NOTES. (Applicable with respect to the testing of odometers.)

N.1. MILEAGE TESTS.

N.1.1. TEST METHODS.—To determine compliance with mileage tolerances, a mileage test of an odometer shall be conducted utilizing one or more of the following test methods:

(a) **ROAD TEST.**—A road test consists of driving the vehicle over a precisely measured road course.

(b) **FIFTH-WHEEL TEST.**—A fifth-wheel test consists of driving the vehicle over any reasonable road course and determining the distance actually traveled through the use of a mechanism known as a "fifth wheel" that is attached to the vehicle and that independently measures and indicates the distance.

N.1.2. TESTING PROCEDURES.—The mileage test of an odometer, whether a road test or a fifth-wheel test, shall be preceded by a run of at least 5 miles for the purpose of stabilizing tire temperatures, and shall include at least 2 runs of at least 2 miles in length at a speed of approximately 45 miles per hour.

N.1.3. TEST CONDITIONS.

N.1.3.1. VEHICLE LADING.—During the mileage test of an odometer, the vehicle shall carry two persons.

N.1.3.2. TIRE PRESSURE.—At the beginning of each test run, the tires on the vehicle under test shall be adjusted to 28 pounds per square inch (gage) at stabilized tire temperatures.

T. TOLERANCES. (Applicable with respect to the performance of odometers.)

T.1. TO UNDERREGISTRATION AND TO OVERREGISTRATION.—The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration.

T.2. TOLERANCE VALUES.—Maintenance and acceptance tolerances on odometers shall be 3.75 percent of the interval under test (±396 feet on a 2-mile test run).

UR. USER REQUIREMENTS. (Applicable with respect to the maintenance of odometers.)

UR.1. INFLATION OF VEHICLE TIRES.—The pressure in the tires on the wheels that actuate the odometer shall be maintained at not less than the normal operating pressure recommended by the manufacturer of the vehicle.

DEFINITIONS OF TERMS
ODOMETERS

The terms defined here have a special and technical meaning when used in the Odometer Code. Whenever a defined term is used in the Odometer Code, it has the particular meaning given here.

fifth-wheel test. A mileage test similar to a road test except that the distance traveled by the vehicle under test is determined by a mechanism known as a "fifth wheel" that is attached to the vehicle and that independently measures and indicates the distance.

odometer. A device that automatically indicates the total mileage traveled by a vehicle. For the purpose of this code, this definition includes hub odometers, cable-driven odometers, and the mileage-indicating, or odometer, portions of "speedometer" assemblies for automotive vehicles.

road test. A mileage test, over a measured course, of an odometer assembly when installed on a vehicle, the mechanism being actuated as a result of vehicle travel.

DRY MEASURES[9]

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1.—This code applies to rigid measures of capacity designed for **general and repeated use** in the measurement of solids, including capacities of ½ bushel or more. This code **does not** apply to "standard containers" used for the measurement of fruits and vegetables and as shipping containers therefor.

S. SPECIFICATIONS. (Applicable with respect to the design of dry measures.)

S.1. UNITS.—The capacity of a measure shall be 1 bushel, a multiple of the bushel, or a binary submultiple of the bushel, and the measure shall not be subdivided or double-ended.

S.2. MATERIAL.—A dry measure shall be made of any suitable material that will retain its shape during normal usage.

S.3. SHAPE.—A measure, other than a basket, of a capacity of ½ bushel or less, shall be cylindrical or conical in shape. The top diameter shall in no case be less than the appropriate minimum diameter shown in table 1. The bottom of a measure, other than a basket, shall be perpendicular to the axis of the measure and shall be flat, except that a metal bottom may be slightly corrugated. The bottom of a measure shall not be adjustable or moveable.

S.3.1. CONICAL DRY MEASURES.—If conical, the top diameter shall exceed the bottom diameter by not more than 10 percent of the bottom diameter.

[9] This code should not be promulgated in any jurisdiction in which the use of dry measures is prohibited by law.

TABLE 1.—MINIMUM TOP DIAMETERS FOR DRY MEASURES OTHER THAN BASKETS

Nominal capacity	Minimum top diameter
	Inches
1 pint	4
1 quart	5⅜
2 quarts	6⅝
½ peck	8½
1 peck	10⅞
½ bushel	13¾

S.4. CAPACITY POINT.—The capacity of a measure shall be determined by the top edge of the measure.

S.5. TOP REINFORCEMENT.—The top edge of a measure shall be reinforced. On a wooden measure other than a basket, of a capacity of 1 quart or more, this reinforcement shall be in the form of a firmly attached metal band.

S.6. MARKING REQUIREMENTS.—A measure shall be conspicuously marked on its side with a statement of its capacity. If the capacity is stated in terms of the pint or quart, the word "Dry" shall be included. The capacity statement shall be in letters of the following dimensions:

(a) At least ½ inch high and ¼ inch wide on a measure of any capacity between ¼ pint and 1 peck.

(b) At least 1 inch high and ½ inch wide on a measure of a capacity of ½ bushel or more.

(c) On a measure of a capacity of ⅛ pint or less, the statement shall be as prominent as practicable, considering the size and design of such measure.

N. NOTES. (Applicable with respect to the testing of dry measures.)

N.1. TESTING MEDIUM.

N.1.1. WATERTIGHT DRY MEASURES.—Water shall be used as the testing medium for watertight dry measures.

N.1.2. NONWATERTIGHT DRY MEASURES.—Rape seed shall be used as the testing medium for nonwatertight dry measures.

T. TOLERANCES. (Applicable with respect to the accuracy of dry measures.)

T.1.—Maintenance tolerances in excess and in deficiency shall be as shown in table 2. Acceptance tolerances shall be one-half the maintenance tolerances.

TABLE 2.—MAINTENANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR DRY MEASURES

Nominal capacity	Tolerance	
	In excess	In deficiency
	Cubic inches	*Cubic inches*
1/32 pint or less	0. 1	0. 05
1/16 pint	. 15	. 1
1/8 pint	. 25	. 15
1/4 pint	. 5	. 3
1/2 pint	1. 0	. 5
1 pint	2. 0	1. 0
1 quart	3. 0	1. 5
2 quarts	5. 0	2. 5
1/2 peck	10. 0	5. 0
1 peck	16. 0	8. 0
1/2 bushel	30. 0	15. 0
1 bushel	50. 0	25. 0

BERRY BASKETS AND BOXES

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1.—This code applies to baskets and boxes for berries and small fruits in capacities of 1 dry quart and less.

S. SPECIFICATIONS. (Applicable with respect to the design of berry baskets and boxes.)

S.1. UNITS.—The capacity of a berry basket or box shall be ½ dry pint, 1 dry pint, or 1 dry quart.

S.2. MATERIAL.—A berry basket or box shall be made of any suitable material that will retain its shape during normal filling, storage, and handling.

S.3. CAPACITY POINT.—The capacity of a berry basket or box shall be determined by its top edges.

N. NOTES. (Applicable with respect to the testing of berry baskets and boxes.)

N.1. METHOD OF TEST.—A berry basket or box may be tested either volumetrically, using rape seed as the testing medium, or geometrically through accurate inside dimension measurement and calculation.

T. TOLERANCES. (Applicable with respect to the accuracy of berry baskets and boxes.)

T.1.—Acceptance tolerances in excess and in deficiency shall be as shown in table 1.

TABLE 1.—ACCEPTANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR BERRY BASKETS AND BOXES

Nominal capacity	Tolerance	
	In excess	In deficiency
	Cubic inches	*Cubic inches*
½ pint	1	0. 5
1 pint	2	1. 0
1 quart	3	1. 5

Appendix I.—GENERAL TABLES OF WEIGHTS AND MEASURES

Part 1. TABLES OF UNITED STATES CUSTOMARY WEIGHTS AND MEASURES

LINEAR MEASURE

12 inches (in.)	=1 foot (ft)
3 feet	=1 yard (yd)=36 inches
5½ yards	=1 rod (rd), pole, or perch=16½ feet
40 rods	=1 furlong (fur.)=220 yards=660 feet
8 furlongs	=1 statute mile (mi)=1 760 yards=5 280 feet
3 miles	=1 league=5 280 yards=15 840 feet

* * * * * *

6 076.115 49 feet (1 852 meters)=1 international nautical mile.

The international nautical mile was adopted for use in the United States effective July 1, 1954. The value expressed in feet became effective July 1, 1959.

AREA MEASURE [1]

144 square inches (sq in.)	=1 square foot (sq ft)
9 square feet	=1 square yard (sq yd)= 1 296 square inches
30¼ square yards	=1 square rod (sq rd)=272¼ square feet
160 square rods	=1 acre=4 840 square yards=43 560 square feet
640 acres	=1 square mile (sq mi)
1 mile square	=1 section [of land]
6 miles square	=1 township=36 sections=36 square miles

CUBIC MEASURE [2]

1 728 cubic inches (cu in.)	=1 cubic foot (cu ft)
27 cubic feet	=1 cubic yard (cu yd)

GUNTER'S OR SURVEYORS CHAIN MEASURE

7.92 inches (in.)	=1 link (li)
100 links	=1 chain (ch)=4 rods=66 feet
80 chains	=1 statute mile (mi)=320 rods=5 280 feet

[1] Squares of units are sometimes abbreviated by using the superior figure 2. For example, ft^2 means square foot or feet.

[2] Cubes of units are sometimes abbreviated by using the superior figure 3. For example, ft^3 means cubic foot or feet.

LIQUID MEASURE [3]

4 gills (gi) = 1 pint (pt) [= 28.875 cubic inches]
2 pints = 1 quart (qt) [= 57.75 cubic inches]
4 quarts = 1 gallon (gal) [= 231 cubic inches] = 8 pints = 32 gills

APOTHECARIES FLUID MEASURE

60 minims (min or ♏) = 1 fluid dram (fl dr or f ℥) [= 0.225 6 cubic inch]
8 fluid drams = 1 fluid ounce (fl oz or f ℥) [= 1.804 7 cubic inches]
16 fluid ounces = 1 pint (pt or O) [= 28.875 cubic inches] = 128 fluid drams
2 pints = 1 quart (qt) [= 57.75 cubic inches] = 32 fluid ounces = 256 fluid drams
4 quarts = 1 gallon (gal) [= 231 cubic inches] = 128 fluid ounces = 1 024 fluid drams

DRY MEASURE [4]

2 pints (pt) = 1 quart (qt) [= 67.200 6 cubic inches]
8 quarts = 1 peck (pk) [= 537.605 cubic inches] = 16 pints
4 pecks = 1 bushel (bu) [= 2 150.42 cubic inches] = 32 quarts

AVOIRDUPOIS WEIGHT [5]

[The "grain" is the same in avoirdupois. troy, and apothecaries weight.]

$27^{11}/_{32}$ grains = 1 dram (dr)
16 drams = 1 ounce (oz) = 437½ grains
16 ounces = 1 pound (lb) = 256 drams = 7 000 grains
100 pounds = 1 hundredweight (cwt) [6]
20 hundredweights = 1 ton (tn) = 2 000 pounds [6]

In "gross" or "long" measure, the following values are recognized:

112 pounds = 1 gross or long hundredweight [6]
20 gross or long hundredweights = 1 gross or long ton = 2 240 pounds [6]

---

[3] When necessary to distinguish the *liquid* pint or quart from the *dry* pint or quart, the word "liquid" or the abbreviation "liq" should be used in combination with the name or abbreviation of the name of the *liquid* unit.

[4] When necessary to distinguish the *dry* pint or quart from the *liquid* pint or quart, the word "dry" should be used in combination with the name or abbreviation of the name of the *dry* unit.

[5] When necessary to distinguish the *avoirdupois* dram from the *apothecaries* dram or to distinguish the *avoirdupois* dram or ounce from the *fluid* dram or ounce, or to distinguish the *avoirdupois* ounce or pound from the *troy* or *apothecaries* ounce or pound, the word "avoirdupois" or the abbreviation "avdp" should be used in combination with the name or abbreviation of the *avoirdupois* unit.

[6] When the terms "hundredweight" and "ton" are used unmodified, they are commonly understood to mean the 100-pound hundredweight and the 2 000-pound ton, respectively; these units may be designated "net" or "short" when necessary to distinguish them from the corresponding units in *gross* or *long* measure.

TROY WEIGHT

[The "grain" is the same in avoirdupois, troy, and apothecaries weight.]

24 grains =1 pennyweight (dwt)
20 pennyweights=1 ounce troy (oz t)=480 grains
12 ounces, troy =1 pound troy (lb t)=240 pennyweights=5 760 grains

APOTHECARIES WEIGHT

[The "grain" is the same in avoirdupois, troy, and apothecaries weight.]

20 grains =1 scruple (s ap or ℈)
3 scruples =1 dram apothecaries (dr ap or ʒ)=60 grains
8 drams, apothecaries =1 ounce apothecaries (oz ap or ℥)=24 scruples=480 grains
12 ounces, apothecaries=1 pound apothecaries (lb ap or lb)=96 drams apothecaries=288 scruples=5 760 grains

Part 2. NOTES ON BRITISH WEIGHTS AND MEASURES TABLES

In Great Britain, the yard, the avoirdupois pound, the apothecaries pound, and the troy ounce are now identical for science and industry with the units of the same name in the United States, and are essentially identical for commercial purposes. The use of the troy pound is illegal in Great Britain. The tables of British linear measure, troy weight, and apothecaries weight are the same as the corresponding United States tables, except for the British spelling "drachm" in the table of apothecaries weight. The table of British avoirdupois weight is the same as the United States table up to 1 pound; above that point the table reads:

14 pounds =1 stone
2 stones =1 quarter=28 pounds
4 quarters =1 hundredweight=112 pounds
20 hundredweight=1 ton=2 240 pounds

The present British gallon and bushel, known as the "Imperial gallon" and "Imperial bushel" are, respectively, about 20 percent and 3 percent larger than the United States gallon and bushel. The Imperial gallon is defined as the volume of 10 avoirdupois pounds of water under specified conditions, and the Imperial bushel is defined as 8 Imperial gallons. Also, the subdivision of the Imperial gallon as presented in the table of British apothecaries measure differs in two important respects from the corresponding United States subdivision in that the Imperial gallon is divided into 160 fluid ounces (whereas the United States gallon is divided into 128 fluid ounces), and a "fluid scruple" is included. The full table of British measures of capacity (which are used alike for liquid and for dry commodities) is as follows:

4 gills	=1 pint
2 pints	=1 quart
4 quarts	=1 gallon
2 gallons	=1 peck
8 gallons [4 pecks]	=1 bushel
8 bushels	=1 quarter

The full table of British apothecaries measure is as follows:

20 minims	=1 fluid scruple
3 fluid scruples	=1 fluid drachm=60 minims
8 fluid drachms	=1 fluid ounce
20 fluid ounces	=1 pint
8 pints	=1 gallon=160 fluid ounces

Part 3. TABLES OF METRIC WEIGHTS AND MEASURES

LINEAR MEASURE

10 millimeters (mm)	=1 centimeter (cm)
10 centimeters	=1 decimeter (dm)=100 millimeters
10 decimeters	=1 meter (m)=1 000 millimeters
10 meters	=1 dekameter (dam)
10 dekameters	=1 hectometer (hm)=100 meters
10 hectometers	=1 kilometer (km)=1 000 meters

AREA MEASURE

100 square millimeters (mm^2)	=1 square centimeter (cm^2)
10 000 square centimeters	=1 square meter (m^2)=1 000 000 square millimeters
100 square meters	=1 are (a)
100 ares	=1 hectare (ha)=10 000 square meters
100 hectares	=1 square kilometer (km^2)=1 000 000 square meters

VOLUME MEASURE

10 milliliters (ml)	=1 centiliter (cl)
10 centiliters	=1 deciliter (dl)=100 milliliters
10 deciliters	=1 liter (l)=1 000 milliliters
10 liters	=1 dekaliter (dal)
10 dekaliters	=1 hectoliter (hl)=100 liters
10 hectoliters	=1 kiloliter (kl)=1 000 liters

CUBIC MEASURE

1 000 cubic millimeters (mm^3) = 1 cubic centimeter (cm^3)
1 000 cubic centimeters = 1 cubic decimeter (dm^3) = 1 000 000 cubic millimeters
1 000 cubic decimeters = 1 cubic meter (m^3) = 1 stere = 1 000 000 cubic centimeters = 1 000 000 000 cubic millimeters

WEIGHT

10 milligrams (mg) = 1 centigram (cg)
10 centigrams = 1 decigram (dg) = 100 milligrams
10 decigrams = 1 gram (g) = 1 000 milligrams
10 grams = 1 dekagram (dag)
10 dekagrams = 1 hectogram (hg) = 100 grams
10 hectograms = 1 kilogram (kg) = 1 000 grams
1 000 kilograms = 1 metric ton (t)

NOTE.—In the metric system of weights and measures, designations of multiples and subdivisions of any unit may be arrived at by combining with the name of the unit the prefixes, *deka*, *hecto*, *kilo*, *mega*, *giga*, and *tera* meaning, respectively, 10, 100, 1 000, 1 000 000, and 1 000 000 000, and *deci*, *centi*, *milli*, *micro*, *nano*, *pico*, *femto* and *atto*, meaning, respectively, one-tenth, one-hundredth, one-thousandth, one-millionth, one-billionth, one-trillionth, one-quadrillionth, and one-quintillionth. In some of the foregoing metric tables, some such multiples and subdivisions have not been included for the reason that these have little, if any, currency in actual usage.

A special case is found in the term "micron" (abbreviated as μ [the Greek letter mu]), a coined word meaning one-millionth of a meter (equivalent to one-thousandth of a millimeter); a millimicron (abbreviated as mμ) is one-thousandth of a micron (equivalent to one-millionth of a millimeter), and a micromicron (abbreviated as $\mu\mu$) is one-millionth of a micron (equivalent to one-thousandth of a millimicron or to 0.000 000 001 millimeter.)

Part 4. TABLES OF INTERRELATION OF UNITS OF MEASUREMENT

[Exact equivalents are indicated by bold face type]

UNITS OF LENGTH

Unit	Inches	Links [a]	Feet
1 inch =	**1**	0.126 262 6	0.083 333 33
1 link =	**7.92**	**1**	**0.66**
1 foot =	**12**	1.515 152	**1**
1 yard =	**36**	4.545 45	**3**
1 rod =	**198**	**25**	**16.5**
1 chain =	**792**	**100**	**66**
1 mile =	**63 360**	**8 000**	**5 280**
1 centimeter =	0.393 700 8	0.049 709 70	0.032 808 40
1 meter =	39.370 08	4.970 970	3.280 840

Unit	Yards	Rods	Chains [a]
1 inch =	0.027 777 78	0.005 050 505	0.001 262 626
1 link =	**0.22**	**0.04**	**0.01**
1 foot =	0.333 333 3	0.060 606 06	0.015 151 52
1 yard =	**1**	0.181 818 2	0.045 454 55
1 rod =	**5.5**	**1**	**0.25**
1 chain =	**22**	**4**	**1**
1 mile =	**1 760**	**320**	**80**
1 centimeter =	0.010 936 13	0.001 988 388	0.000 497 097 0
1 meter =	1.093 613	0.198 838 8	0.049 709 70

Unit	Miles	Centimeters	Meters
1 inch =	0.000 015 782 83	**2.54**	**0.025 4**
1 link =	**0.000 125**	**20.116 8**	**0.201 168**
1 foot =	0.000 189 393 9	**30.48**	**0.304 8**
1 yard =	0.000 568 181 8	**91.44**	**0.914 4**
1 rod =	**0.003 125**	**502.92**	**5.029 2**
1 chain =	**0.012 5**	**2 011.68**	**20.116 8**
1 mile =	**1**	**160 934.4**	**1 609.344**
1 centimeter =	0.000 006 213 712	**1**	**0.01**
1 meter =	0.000 621 371 2	**100**	**1**

[a] Gunter's or Surveyors.

UNITS OF AREA

Unit	Square inches	Square links	Square feet
1 square inch =	**1**	0.015 942 25	0.006 944 444
1 square link =	**62.726 4**	**1**	**0.435 6**
1 square foot =	**144**	2.295 684	**1**
1 square yard =	**1 296**	20.661 16	**9**
1 square rod =	**39 204**	**625**	**272.25**
1 square chain =	**627 264**	**10 000**	**4 356**
1 acre =	**6 272 640**	**100 000**	**43 560**
1 square mile =	**4 014 489 600**	**64 000 000**	**27 878 400**
1 square centimeter =	0.155 000 3	0.002 471 054	0.001 076 391
1 square meter =	1 550.003	24.710 54	10.763 91
1 hectare =	15 500 031	247 105.4	107 639.1

UNITS OF AREA—Continued

Unit		Square yards	Square rods	Square chains [a]
1 square inch	=	0.000 771 604 9	0.000 025 507 60	0.000 001 594 225
1 square link	=	0.048 4	0.000 6	0.000 1
1 square foot	=	0.111 111 1	0.003 673 095	0.000 229 568 4
1 square yard	=	1	0.033 057 85	0.002 066 116
1 square rod	=	30.25	1	0.062 5
1 square chain	=	484	16	1
1 acre	=	4 840	160	10
1 square mile	=	3 097 600	102 400	6 400
1 square centimeter	=	0.000 119 599 0	0.000 003 953 686	0.000 000 247 105 4
1 square meter	=	1.195 990	0.039 536 86	0.002 471 054
1 hectare	=	11 959.90	395.368 6	24.710 54

Unit		Acres	Square miles	Square centimeters
1 square inch	=	0.000 000 159 422 5	0.000 000 000 249 097 7	6.451 6
1 square link	=	0.000 01	0.000 000 015 625	404.685 642 24
1 square foot	=	0.000 022 956 84	0.000 000 035 870 06	929.030 4
1 square yard	=	0.000 206 611 6	0.000 000 322 830 6	8 361.273 6
1 square rod	=	0.006 25	0.000 009 765 625	252 928.526 4
1 square chain	=	0.1	0.000 156 25	4 046 856.422 4
1 acre	=	1	0.001 562 5	40 468 564.224
1 square mile	=	640	1	25 899 881 103.36
1 square centimeter	=	0.000 000 024 710 54	0.000 000 000 038 610 22	1
1 square meter	=	0.000 247 105 4	0.000 000 386 102 2	10 000
1 hectare	=	2.471 054	0.003 861 022	100 000 000

Unit		Square meters	Hectares
1 square inch	=	0.000 645 16	0.000 000 064 516
1 square link	=	0.040 468 564 224	0.000 004 046 856 422 4
1 square foot	=	0.092 903 04	0.000 009 290 304
1 square yard	=	0.836 127 36	0.000 083 612 736
1 square rod	=	25.292 852 64	0.002 529 285 264
1 square chain	=	404.685 642 24	0.040 468 564 224
1 acre	=	4 046.856 422 4	0.404 685 642 24
1 square mile	=	2 589 988.110 336	258.998 811 033 6
1 square centimeter	=	0.000 1	0.000 000 01
1 square meter	=	1	0.000 1
1 hectare	=	10 000	1

[a] Gunter's or Surveyors.

UNITS OF VOLUME

Unit	Cubic inches	Cubic feet	Cubic yards
1 cubic inch =	1	0.000 578 703 7	0.000 021 433 47
1 cubic foot =	1 728	1	0.037 037 04
1 cubic yard =	46 656	27	1
1 cubic centimeter =	0.061 023 74	0.000 035 314 67	0.000 001 307 951
1 cubic decimeter =	61.023 74	0.035 314 67	0.001 307 951
1 cubic meter =	61 023.74	35.314 67	1.307 951

Unit	Cubic centimeters	Cubic decimeters	Cubic meters
1 cubic inch =	16.387 064	0.016 387 064	0.000 016 387 064
1 cubic foot =	28 316.846 592	28.316 846 592	0.028 316 846 592
1 cubic yard =	764 554.857 984	764.554 857 984	0.764 554 857 984
1 cubic centimeter =	1	0.001	0.000 001
1 cubic decimeter =	1 000	1	0.001
1 cubic meter =	1 000 000	1 000	1

UNITS OF CAPACITY—LIQUID MEASURE [7]

Unit	Minims	Fluid drams	Fluid ounces	Gills
1 minim =	1	0.016 666 67	0.002 083 333	0.000 520 833 3
1 fluid dram =	60	1	0.125	0.031 25
1 fluid ounce =	480	8	1	0.25
1 gill =	1920	32	4	1
1 liquid pint =	7680	128	16	4
1 liquid quart =	15 360	256	32	8
1 gallon =	61 440	1024	128	32
1 cubic inch =	265.974 0	4.432 900	0.554 112 6	0.138 528 1
1 cubic foot =	459 603.1	7660.052	957.506 5	239.376 6
1 milliliter =	16.230 73	0.270 512 18	0.033 814 02	0.008 453 506
1 liter =	16 230.73	270.512 18	33.814 02	8.453 506

[7] See footnote at end of table.

Units	Liquid pints	Liquid quarts	Gallons	Milliliters
1 minim =	0.000 130 208 3	0.000 065 104 17	0.000 016 276 04	0.061 611 52
1 fluid dram =	0.007 812 5	0.003 906 25	0.000 976 562 5	3.696 691
1 fluid ounce =	0.062 5	0.031 25	0.007 812 5	29.573 53
1 gill =	0.25	0.125	0.031 25	118.294 118 25
1 liquid pint =	1	0.5	0.125	473.176 473
1 liquid quart =	2	1	0.25	946.352 946
1 gallon =	8	4	1	3 785.411 784
1 cubic inch =	0.034 632 03	0.017 316 02	0.004 329 004	16.387 064
1 cubic foot =	59.844 16	29.922 08	7.480 519	28 316.846 592
1 milliliter =	0.002 113 376	0.001 056 688	0.000 264 172 05	1
1 liter =	2.113 376	1.056 688	0.264 172 05	1000

UNITS OF CAPACITY—LIQUID MEASURE [7]—Continued

Unit	Liters	Cubic inches	Cubic feet
1 minim =	0.000 061 611 52	0.003 759 766	0.000 002 175 790
1 fluid dram =	0.003 696 691	0.225 585 9	0.000 130 547 4
1 fluid ounce =	0.029 573 53	1.804 687 5	0.001 044 379
1 gill =	0.118 294 118 25	7.218 75	0.004 177 517
1 liquid pint =	0.473 176 473	28.875	0.016 710 07
1 liquid quart =	0.946 352 946	57.75	0.033 420 14
1 gallon =	3.785 411 784	231	0.133 680 6
1 cubic inch =	0.016 387 064	1	0.000 578 703 7
1 cubic foot =	28.316 846 592	1728	1
1 milliliter =	0.001	0.061 023 74	0.000 035 314 67
1 liter =	1	61.023 74	0.035 314 67

[7] See also table of equivalents between U.S. and British liquid measure units, p. 165.

UNITS OF CAPACITY—DRY MEASURE

Unit	Dry pints	Dry quarts	Pecks	Bushels
1 dry pint =	1	0.5	0.062 5	0.015 625
1 dry quart =	2	1	0.125	0.031 25
1 peck =	16	8	1	0.25
1 bushel =	64	32	4	1
1 cubic inch =	0.029 761 6	0.014 880 8	0.001 860 10	0.000 465 025
1 cubic foot =	51.428 09	25.714 05	3.214 256	0.803 563 95
1 liter =	1.816 166	0.908 083	0.113 510 37	0.028 377 59
1 dekaliter =	18.161 66	9.080 83	1.135 103 7	0.283 775 9

Unit	Liters	Dekaliters	Cubic inches	Cubic feet
1 dry pint =	0.550 610 47	0.055 061 047	33.600 312 5	0.019 444 63
1 dry quart =	1.101 220 9	0.110 122 09	67.200 625	0.038 889 25
1 peck =	8.809 767 5	0.880 976 75	537.605	0.311 114
1 bushel =	35.239 07	3.523 907	2150.42	1.244 456
1 cubic inch =	0.016 387 064	0.001 638 706 4	1	0.000 578 703 7
1 cubic foot =	28.316 846 592	2.831 684 659 2	1728	1
1 liter =	1	0.1	61.023 74	0.035 314 67
1 dekaliter =	10	1	610.237 4	0.353 146 7

UNITS OF MASS NOT GREATER THAN POUNDS AND KILOGRAMS

Unit	Grains	Apothecaries scruples	Pennyweights
1 grain =	1	0.05	0.041 666 67
1 apoth scruple =	20	1	0.833 333 3
1 pennyweight =	24	1.2	1
1 avdp dram =	27.343 75	1.367 187 5	1.139 323
1 apoth dram =	60	3	2.5
1 avdp ounce =	437.5	21.875	18.229 17
1 apoth or troy ounce =	480	24	20
1 apoth or troy pound =	5 760	288	240
1 avdp pound =	7 000	350	291.666 7
1 milligram =	0.015 432 36	0.000 771 617 9	0.000 643 014 9
1 gram =	15.432 36	0.771 617 9	0.643 014 9
1 kilogram =	15 432.36	771.617 9	643.014 9

UNITS OF MASS NOT GREATER THAN POUNDS AND KILOGRAMS—Continued

Unit		Avoirdupois drams	Apothecaries drams	Avoirdupois ounces
1 grain	=	0.036 571 43	0.016 666 67	0.002 285 714
1 apoth scruple	=	0.731 428 6	0.333 333 3	0.045 714 29
1 pennyweight	=	0.877 714 3	0.4	0.054 857 14
1 avdp dram	=	1	0.455 729 2	0.062 5
1 apoth dram	=	2.194 286	1	0.137 142 9
1 avdp ounce	=	16	7.291 667	1
1 apoth or troy ounce	=	17.554 29	8	1.097 143
1 apoth or troy pound	=	210.651 4	96	13.165 71
1 avdp pound	=	256	116.666 7	16
1 milligram	=	0.000 564 383 4	0.000 257 206 0	0.000 035 273 96
1 gram	=	0.564 383 4	0.257 206 0	0.035 273 96
1 kilogram	=	564.383 4	257.206 0	35.273 96

Unit		Apothecaries or troy ounces	Apothecaries or troy pounds	Avoirdupois pounds
1 grain	=	0.002 083 333	0.000 173 611 1	0.000 142 857 1
1 apoth scruple	=	0.041 666 67	0.003 472 222	0.002 857 143
1 pennyweight	=	0.05	0.004 166 667	0.003 428 571
1 avdp dram	=	0.056 966 15	0.004 747 179	0.003 906 25
1 apoth dram	=	0.125	0.010 416 67	0.008 571 429
1 avdp ounce	=	0.911 458 3	0.075 954 86	0.062 5
1 apoth or troy ounce	=	1	0.083 333 333	0.068 571 43
1 apoth or troy pound	=	12	1	0.822 857 1
1 avdp pound	=	14.583 33	1.215 278	1
1 milligram	=	0.000 032 150 75	0.000 002 679 229	0.000 002 204 623
1 gram	=	0.032 150 75	0.002 679 229	0.002 204 623
1 kilogram	=	32.150 75	2.679 229	2.204 623

Unit		Milligrams	Grams	Kilograms
1 grain	=	64.798 91	0.064 798 91	0.000 064 798 91
1 apoth scruple	=	1 295.978 2	1.295 978 2	0.001 295 978 2
1 penny-weight	=	1 555.173 84	1.555 173 84	0.001 555 173 84
1 avdp dram	=	1 771.845 195 312 5	1.771 845 195 312 5	0.001 771 845 195 312 5
1 apoth dram	=	3 887.934 6	3.887 934 6	0.003 887 934 6
1 avdp ounce	=	28 349.523 125	28.349 523 125	0.028 349 523 125
1 apoth or troy ounce	=	31 103.476 8	31.103 476 8	0.031 103 476 8
1 apoth or troy pound	=	373 241.721 6	373.241 721 6	0.373 241 721 6
1 advp pound	=	453 592.37	453.592 37	0.453 592 37
1 milligram	=	1	0.001	0.000 001
1 gram	=	1 000	1	0.001
1 kilogram	=	1 000 000	1 000	1

UNITS OF MASS NOT LESS THAN AVOIRDUPOIS OUNCES

Unit		Avoirdupois ounces	Avoirdupois pounds	Short hundredweights	Short tons
1 avoirdupois ounce	=	1	0.062 5	0.000 625	0.000 031 25
1 avoirdupois pound	=	16	1	0.01	0.000 5
1 short hundredweight	=	1 600	100	1	0.05
1 short ton	=	32 000	2 000	20	1
1 long ton	=	35 840	2 240	22.4	1.12
1 kilogram	=	35.273 96	2.204 623	0.022 046 23	0.001 102 311
1 metric ton	=	35 273.96	2 204.623	22.046 23	1.102 311

Unit		Long tons	Kilograms	Metric tons
1 avoirdupois ounce	=	0.000 027 901 79	0.028 349 523 125	0.000 028 349 523 125
1 avoirdupois pound	=	0.000 446 428 6	0.453 592 37	0.000 453 592 37
1 short hundredweight	=	0.044 642 86	45.359 237	0.045 359 237
1 short ton	=	0.892 857 1	907.184 74	0.907 184 74
1 long ton	=	1	1 016.046 908 8	1.016 046 908 8
1 kilogram	=	0.000 984 206 5	1	0.001
1 metric ton	=	0.984 206 5	1 000	1

Part 5. TABLES OF EQUIVALENTS

NOTES.—When the name of a unit is enclosed in brackets (thus, [1 hand] . . .), this indicates (1) that the unit is not in general current use in the United States, or (2) that the unit is believed to be based on "custom and usage" rather than on formal authoritative definition.

Equivalents involving decimals are, in most instances, rounded off to the third decimal place except where they are exact, in which cases these exact equivalents are so designated.

LENGTHS

1 angstrom (A)
- 0.1 millimicron (exactly).
- 0.000 1 micron (exactly).
- 0.000 000 1 millimeter (exactly).
- 0.000 000 003 937 inch.

1 cable's length
- 120 fathoms.
- 720 feet.
- 219.456 meters (exactly).

1 centimeter (cm) — 0.393 7 inch.

1 chain (ch) (Gunter's or surveyors)
- 66 feet.
- 20.116 8 meters (exactly).

[1 chain] (engineers)
- 100 feet.
- 30.48 meters (exactly).

1 decimeter (dm) — 3.937 inches.

1 dekameter (dam) — 32.808 feet.

1 fathom	6 feet. 1.828 8 meters (exactly).
1 foot (ft)	0.304 8 meter (exactly).
1 furlong (fur.)	10 chains (surveyors). 660 feet. 220 yards. ⅛ statute mile. 201.168 meters (exactly).
[1 hand]	4 inches.
1 inch (in.)	2.54 centimeters (exactly).
1 kilometer (km)	0.621 mile.
1 league (land)	3 statute miles. 4.828 kilometers.
1 link (li) (Gunter's or surveyors)	7.92 inches (exactly). 0.201 168 meter (exactly).
[1 link (li) engineers]	1 foot. 0.304 8 meter (exactly).
1 meter (m)	39.37 inches. 1.094 yards.
1 micron (μ [the Greek letter mu])	0.001 millimeter (exactly). 0.000 039 37 inch.
1 mil	0.001 inch (exactly). 0.025 4 millimeter (exactly).
1 mile (mi) (statute or land)	5 280 feet. 1.609 kilometers.
1 mile (mi) (nautical, international) [8]	1.852 kilometers (exactly). 1.151 statute miles. 0.999 U.S. nautical mile.
1 millimeter (mm)	0.039 37 inch.
1 millimicron (mμ [the English letter m in combination with the Greek letter mu])	0.001 micron (exactly). 0.000 000 039 37 inch.
1 point (typography)	0.013 837 inch (exactly).[9] 0.351 millimeter.
1 rod (rd), pole, or perch	16½ feet. 5½ yards. 5.029 2 meters (exactly).
1 yard (yd)	0.914 4 meter (exactly).

AREAS OR SURFACES

1 acre [10]	43 560 square feet. 4 840 square yards. 0.405 hectare.
1 are	119.599 square yards. 0.025 acre.
1 hectare	2.471 acres.

[8] See Table of Linear Measure, p. 163.
[9] This value is nearly 1/72 inch.
[10] A square 208.710+ ft on a side has an area of 1 acre.

[1 square (building)]	100 square feet.
1 square centimeter (cm^2)	0.155 square inch.
1 square decimeter (dm^2)	15.500 square inches.
1 square foot (sq ft)	929.030 square centimeters.
1 square inch (sq in.)	6.451 6 square centimeters (exactly).
1 square kilometer (km^2)	247.105 acres. 0.386 square mile.
1 square meter (m^2)	1.196 square yards. 10.764 square feet.
1 square mile (sq mi)	258.999 hectares.
1 square millimeter (mm^2)	0.002 square inch.
1 square rod (sq rd), sq pole, or sq perch.	25.293 square meters.
1 square yard (sq yd)	0.836 square meter.

CAPACITIES OR VOLUMES

1 barrel (bbl), liquid	31 to 42 gallons.[11]
1 barrel (bbl), standard, for fruits, vegetables, and other dry commodities except cranberries.	7056 cubic inches. 105 dry quarts. 3.281 bushels, struck measure.
1 barrel (bbl), standard, cranberry	5 826 cubic inches. $86\frac{4}{64}$ dry quarts. 2.709 bushels, struck measure.
1 bushel (bu) (U.S.) (struck measure)	2 150.42 cubic inches (exactly). 1.244 cubic feet. 0.969 British bushel. 35.238 liters. 9.309 gallons.[12]
[1 bushel, heaped (U.S.)]	2 747.715 cubic inches. 1.278 bushels, struck measure.[13]
[1 bushel (bu) (British Imperial) (struck measure)].	1.032 U.S. bushels, struck measure. 2 219.36 cubic inches.
1 cord (cd) (firewood)	128 cubic feet.
1 cubic centimeter (cm^3)	0.061 cubic inch.
1 cubic decimeter (dm^3)	61.024 cubic inches.
1 cubic foot (cu ft)	7.481 gallons. 28.316 cubic decimeters.
1 cubic inch (cu in.)	0.554 fluid ounce. 4.433 fluid drams. 16.387 cubic centimeters.
1 cubic meter (m^3)	1.308 cubic yards.
1 cubic yard (cu yd)	0.765 cubic meter.
1 cup, measuring	8 fluid ounces. ½ liquid pint.

[11] There are a variety of "barrels," established by law or usage. For example, Federal taxes on fermented liquors are based on a barrel of 31 gallons; many State laws fix the "barrel for liquids" as 31½ gallons; one State fixes a 36-gallon barrel for cistern measurement; Federal law recognizes a 40-gallon barrel for "proof spirits"; by custom, 42 gallons comprise a barrel of crude oil or petroleum products for statistical purposes, and this equivalent is recognized "for liquids" by four States.

[12] This is a mathematical equivalent, useful only in correlating units of liquid and dry measure.

[13] Frequently recognized as 1¼ bushels, struck measure.

1 dram, fluid (or liquid) (fl dr or ƒ℥) (U.S.)	⅛ fluid ounce. 0.226 cubic inch. 3.697 milliliters. 1.041 British fluid drachm.
[1 dram, fluid (fl dr) (British)]	0.961 U.S. fluid dram. 0.217 cubic inch. 3.552 milliliters.
1 dekaliter (dal)	2.642 gallons. 1.135 pecks.
1 gallon (gal) (U.S.)	231 cubic inches. 0.134 cubic foot. 3.785 liters. 0.833 British gallon. 128 U.S. fluid ounces. 0.107 U.S. struck bushel.[14]
[1 gallon (gal) (British Imperial)]	277.42 cubic inches. 1.201 U.S. gallons. 4.546 liters. 160 British fluid ounces.
1 gill (gi)	7.219 cubic inches. 4 fluid ounces. 0.118 liter.
1 hectoliter (hl)	26.418 gallons. 2.838 bushels.
1 hogshead (hhd), liquid	63 gallons (two 31½-gallon barrels). 238.474 liters.
1 liter	1.057 liquid quarts. 0.908 dry quart. 61.025 cubic inches.
1 milliliter (ml)	0.271 fluid dram. 16.231 minims. 0.061 cubic inch.
1 ounce, fluid (or liquid) (fl oz or ƒ℥) (U.S.)	1.805 cubic inches. 29.573 milliliters. 1.041 British fluid ounces.
[1 ounce, fluid (fl oz) (British)]	0.961 U.S. fluid ounce. 1.734 cubic inches. 28.412 milliliters.
1 peck (pk)	8.810 liters.
1 pint (pt), dry	33.600 cubic inches. 0.551 liter.
1 pint (pt), liquid	28.875 cubic inches (exactly). 0.473 liter.
1 quart (qt), dry (U.S.)	67.201 cubic inches. 1.101 liters. 0.969 British quart. 1.164 U.S. liquid quarts.[14]
1 quart (qt), liquid (U.S.)	57.75 cubic inches (exactly). 0.946 liter. 0.833 British quart. 0.859 U.S. dry quart.[14]

[14] This is a mathematical equivalent, useful only in correlating units of liquid and dry measure.

[1 quart (qt) (British)]	69.354 cubic inches. 1.032 U.S. dry quarts. 1.201 U.S. liquid quarts.
1 tablespoon	3 teaspoons.[15] 4 fluid drams. ½ fluid ounce.
1 teaspoon	⅓ tablespoon.[15] 1⅓ fluid drams.[15]

WEIGHTS OR MASSES

1 assay ton [16] (AT)	29.167 grams.
1 carat (c)	200 milligrams. 3.086 grains.
1 dram, apothecaries (dr ap or ℥)	60 grains. 3.888 grams.
1 dram, avoirdupois (dr avdp)	27 11/32 (=27. 344) grains. 1.772 grams.
gamma, *see* microgram	
1 grain	64.798 91 milligrams (exactly).
1 gram (g)	15.432 grains. 0.035 avoirdupois ounce.
1 hundredweight, gross or long [17] (gross cwt)	112 avoirdupois pounds. 50.802 kilograms.
1 hundredweight, net or short (cwt or net cwt)	100 avoirdupois pounds. 45.359 kilograms.
1 kilogram (kg)	2.205 avoirdupois pounds.
1 microgram (μ g [the Greek letter mu plus the letter g]) [18]	0.000 001 gram (exactly).
1 milligram (mg)	0.015 grain.
1 ounce, avoirdupois (oz avdp)	437.5 grains (exactly). 0.911 troy or apothecaries ounce. 28.350 grams.
1 ounce, troy or apothecaries (oz t, or oz ap, or ℥)	480 grains. 1.097 avoirdupois ounces. 31.103 grams.
1 pennyweight (dwt)	1.555 grams.
1 point	0.01 carat (exactly). 2 milligrams.
1 pound, avoirdupois (lb avdp)	7 000 grains. 1.215 troy or apothecaries pounds. 453.592 37 grams (exactly).
1 pound, troy or apothecaries (lb t or lb ap)	5 760 grains. 0.823 avoirdupois pounds. 373.242 grams.

---

[15] The equivalent "1 teaspoon=1⅓ fluid drams" has been found by the Bureau to correspond more closely with the actual capacities of "measuring" and silver teaspoons than the equivalent "1 teaspoon=1 fluid dram" which is given by a number of dictionaries.

[16] Used in assaying. The assay ton bears the same relation to the milligram that a ton of 2,000 pounds avoirdupois bears to the ounce troy; hence the weight in milligrams of precious metal obtained from one assay ton of ore gives directly the number of troy ounces to the net ton.

[17] The gross or long ton and hundredweight are used commercially in the United States to only a very limited extent, usually in restricted industrial fields. These units are the same as the British "ton" and "hundredweight."

[18] The Greek letter gamma (γ) is also used as a symbol for "microgram."

1 scruple (s ap or ℈)	20 grains. 1.296 grams.
[1 stone (British)]	14 avoirdupois pounds.
1 ton, gross or long [19] (gross tn)	2 240 avoirdupois pounds. 1.12 net tons (exactly). 1.016 metric tons.
1 ton, metric (t)	2 204. 623 avoirdupois pounds. 0.984 gross ton. 1.102 net tons.
1 ton, net or short (tn or net tn)	2 000 avoirdupois pounds. 0.893 gross ton. 0.907 metric ton.

[19] The gross or long ton and hundredweight are used commercially in the United States to only a very limited extent, usually in restricted industrial fields. These units are the same as the British "ton" and "hundredweight."

U.S. GOVERNMENT PRINTING OFFICE: 1965 O—787-784