

Western States Petroleum Association (Tanya DeRivi)

Please see attached.



WSPA

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September 14, 2026

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Electronically submitted at:
<https://carb.commentinput.com/?id=4sTAbd8UM>

Re: WSPA Comments on Proposed CaRFG Amendments for the Voluntary Sale of E15

The Western States Petroleum Association (WSPA) appreciates the opportunity to comment on the California Air Resources Board's (CARB) proposed amendments to the California Reformulated Gasoline (CaRFG) Regulations (Proposed CaRFG Amendments) to allow the sale of gasoline containing up to 15% ethanol (E15), consistent with Assembly Bill (AB) 30 (2025).¹ WSPA is a non-profit trade association representing companies that produce, refine, transport, and market petroleum, petroleum products, alternative fuels, natural gas, and other energy supplies in California and four other western states, and has actively participated in air quality planning issues for over 30 years.

WSPA appreciates CARB's explicit recognition that AB 30 allows for the *voluntary sale* of E15 in California, provided that specified conditions are met. This distinction is critical because many transportation vehicles are not certified for E15 use, and any mandate to sell E15 would impede efforts to reduce California's gasoline prices. WSPA recognizes that fuel suppliers and retailers will make individual economic decisions in response to increased consumer demand for E15 fuel.

As discussed in more detail below, WSPA urges CARB to revise the Proposed CaRFG Amendments to address the following critical issues:

- CARB should adopt more practical ethanol content cutoffs for gasoline containing up to 10% ethanol (E10) and gasoline containing up to 15% ethanol (E15) to minimize potential compliance challenges or inconsistencies with federal requirements;
- CARB should clarify the California Predictive Model certification requirements under Section 2265 of the Proposed CaRFG Amendments;
- CARB should further clarify the Phase 3 Standards table in Section 2262 of the Proposed CaRFG Amendments;
- CARB should update the definitions of "Imported Gasoline" and "Terminal;"
- CARB should retain the oxygen content compliance provisions in current Section 2262.5(d) of the CaRFG Regulations;
- CARB should update the referenced ASTM standards and test methods throughout the Proposed CaRFG Amendments where applicable;
- State agencies should coordinate in developing and issuing timely guidance on a Vapor Recovery Program to certify equipment needed to dispense E15; and
- CARB should ensure the Proposed CaRFG Amendments do not nullify potential U.S. Environmental Protection Agency (EPA) exemptions for "California gasoline."

WSPA looks forward to continuing to work with CARB throughout this rulemaking process. WSPA's detailed comments are provided below.

¹ See AB 30; available at: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202520260AB30.

1. CARB should adopt more practical E10 and E15 ethanol content cutoffs.

WSPA believes practical updates are needed to ensure E15 gasoline is not inadvertently produced by a producer or oxygenate blender intending to make E10. Currently, the maximum ethanol content for E10 is limited to a *very specific* 10.0%. Therefore, if the ethanol actually blended were even slightly higher than that percentage, the gasoline would be considered E15 under the Proposed CaRFG Amendments. This result is impractical for both blenders and oxygenate producers. The equipment typically used to measure the amount of ethanol blended has a margin of error of ± 0.3 volume percent.² Accordingly, CARB should consider the practical implementation challenges for ethanol blending facilities, which may inadvertently blend E15 because of equipment measuring capabilities.

To alleviate this issue, CARB should align the acceptable E10 maximum ethanol content and the acceptable E15 minimum ethanol content with AB 30's clearly stated ethanol blending range for E15 of 10.5% to 15%. This approach is more consistent with EPA's definitions of E10 and E15.³ Additionally, the "California Multimedia Evaluation of Gasoline Containing up to 15 percent Ethanol (E15)" indicates that gasoline blends containing between 10% and 15% ethanol have limited impact on public health or the environment.⁴

For example, Section 2265(a)(2)(A)(2) of the Proposed CaRFG Amendments, "Gasoline with up to 10 Percent Ethanol by Volume," should be modified to apply to "Gasoline with up to 10.5 Percent Ethanol by Volume." Additional provisions would require conforming updates, including, but not limited to, the definitions of E10 and E15 in Section 2260 of the Proposed CaRFG Amendments. These recommended modifications will help streamline production of these fuels and prevent inadvertent compliance issues.

2. CARB should clarify the California Predictive Model certification requirements under Section 2265 of the Proposed CaRFG Amendments.

As currently drafted, Section 2265(a)(2)(A)(3) of the Proposed CaRFG Amendments appears to address *blending* of E15 from a product certified as E10. WSPA believes this proposed new subsection does not fit structurally under Section 2265(a)(2)(A), which addresses evaluations of the candidate Predictive Model *alternative specifications*. WSPA members also differ in their understanding of the new language in Section 2265(a)(2)(A). WSPA therefore requests that CARB clarify the intended meaning of that language, engage in further conversation with industry pending issuance of such clarification, and update the Proposed CaRFG Amendments accordingly.

3. CARB should retain the oxygen content compliance provisions in current Section 2262.5(d).

The Proposed CaRFG Amendments would delete current Section 2262.5(d), which restricts the addition of oxygenates to California gasoline after it has been supplied from the production or import facility, and would renumber current Section 2262.5(e) as Section 2262.5(d). WSPA urges CARB to retain these provisions because they provide important controls over fuel composition and certification. CARB should also further revise Section 2262.5(d) to clarify precisely what activity CARB intends to allow or disallow through this rulemaking. WSPA recommends that CARB work with industry on practical solutions to address this issue, and update the Proposed CaRFG Amendments accordingly.

² See National Institute of Standards and Technology, "Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices," 3-119 (Table T.2.); available at: <https://nvlpubs.nist.gov/nistpubs/hb/2026/NIST.HB.44-2026.pdf>.

³ See, e.g., 40 C.F.R. 1090.80.

⁴ See CARB, "California Multimedia Evaluation of Gasoline Containing up to 15 percent Ethanol (E15): Staff Written Summary" 14 (Dec. 2025), available at: https://ww2.arb.ca.gov/sites/default/files/2025-12/E15_MMWG_Staff_Written_Summary_Final_12-11-2025.pdf.

4. CARB should further clarify the CaRFG Phase 3 Standards table in Section 2262.

CARB should clarify its proposed revisions to the table in Section 2262. WSPA believes revisions are required to flat limits, averaging limits, and cap limits for listed properties to enable the Proposed CaRFG Amendments' provisions related to E15. Accordingly, WSPA urges CARB to review the proposed oxygen-content flat and cap limit specifications for both E10 and E15 and provide an explanation as to why the flat limit is different from the larger cap value. WSPA asks CARB to explore whether it is technically more appropriate for the oxygen-content flat limit to be the same value as the higher adjusted cap limit window of 1.8 – 3.7 (for E10) and 3.8 – 6.0 (for E15). The current and proposed flat limits of 1.8 – 2.2 (for E10) and 2.3 – 3.5 (for E15) are set so low that they would likely prohibit various ethanol blends up to 15 volume percent.

5. CARB should update the definitions of “Imported gasoline” and “Terminal.”

CARB's proposed definition of “Imported gasoline” in Section 2260 should be updated for clarity and consistency with other defined terms (such as the definition of “California gasoline”). WSPA believes the proposed definition, which describes imported gasoline by reference to what does not fall within part of the “California gasoline” definition, is difficult to apply in practice. Accordingly, WSPA recommends the following definition:

“Imported California gasoline” means gasoline which was produced outside of California and is sold, intended for sale, or made available for sale as motor vehicle fuel in California.”

Additionally, CARB is proposing to define “Terminal” to mean “a facility to store, blend, and distribute gasoline.” WSPA requests that CARB explain why this new definition is needed and identify the specific gap, issue, or compliance concern that the definition is intended to address. Adding this definition may not be necessary and could create unintended ambiguity, including questions about whether a refinery that stores, blends, and distributes gasoline would be captured within the proposed “Terminal” definition.

6. CARB should update the ASTM International sampling and testing method references.

WSPA notes that CARB's Proposed CaRFG Amendments would retain several outdated ASTM specifications and methods. For example, Section 2262.9(a)(1)(B) would still reference an outdated ethanol ASTM specification (ASTM D4806-99). This reference should be replaced with the current specification, ASTM D4806-25. This ethanol specification reflects what is most commonly available in the transportation fuels market today and would improve consistency with existing fuel supply practices while avoiding potential sourcing complications.

CARB's proposal would remove obsolete CaRFG Phase 2 provisions, update Table 1 in Section 2263, and revise the test methods used to determine compliance with the gasoline standards in Section 2262. However, many of these specifications have been updated or withdrawn in recent years to reflect modern oxygenated fuels, whereas the Proposed CaRFG Amendments would continue to reference the versions in use when the Phase 3 requirements were created, as noted below:⁵

⁵ See latest ASTM International standards at: <https://www.astm.org/standards-and-solutions/standards-publications#standard-products>.

Citation	Gasoline Specification	CARB's Proposed Test Method	WSPA's Recommended Test Method
§ 2263 in Table 1	Reid Vapor Pressure	ASTM D 323-58 or 13 C.C.R. § 2297	No change.
§ 2263 in Table 1	Sulfur Content	ASTM D 5453-93 (1993)	ASTM D5453-25 , Standard Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence
§ 2263 in Table 1	Benzene Content	ASTM D 5580-02 (2007)	ASTM D5580-26 , Standard Test Method for Determination of Benzene, Toluene, Ethylbenzene, p/m-Xylene, o-Xylene, C9 and Heavier Aromatics, and Total Aromatics in Finished Gasoline by Gas Chromatography
§ 2263 in Table 1	Olefin Content	ASTM D 6550-10 (2010)	ASTM D6550-25 , Standard Test Method for Determination of Olefin Content of Gasolines by Supercritical-Fluid Chromatography
§ 2263 in Table 1	Oxygen Content	ASTM D 4815-09 (2009)	ASTM D4815-22 , Standard Test Method for Determination of MTBE, ETBE, TAME, DIPE, tertiary-Amyl Alcohol and C1 to C4 Alcohols in Gasoline by Gas Chromatography
§ 2263 in Table 1	T90 and T50	ASTM D 86-99ae1	ASTM D86-23ae2 , Standard Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure
§ 2263 in Table 1	Aromatic Hydrocarbon Content	ASTM D 5580-02 (2007)	ASTM D5580-26 , Standard Test Method for Determination of Benzene, Toluene, Ethylbenzene, p/m-Xylene, o-Xylene, C9 and Heavier Aromatics, and Total Aromatics in Finished Gasoline by Gas Chromatography
§ 2263 in Table 1	Ethanol Content	ASTM D 4815-09 (2009)	ASTM D4815-22 , Standard Test Method for Determination of MTBE, ETBE, TAME, DIPE, tertiary-Amyl Alcohol and C1 to C4 Alcohols in Gasoline by Gas Chromatography
§ 2263 in Table 1	MTBE Content	ASTM D 7754-11 (2011)	ASTM D7754-23 , Standard Test Method for Determination of Trace Oxygenates in Automotive Spark-Ignition Engine Fuel by Multidimensional Gas Chromatography
§ 2263 in Table 1	Oxygen from oxygenates (revised) in § 2262.6(b)(3) ⁶	ASTM D 7754-11 (2011)	ASTM D7754-23 , Standard Test Method for Determination of Trace Oxygenates in Automotive Spark-Ignition Engine Fuel by Multidimensional Gas Chromatography
§ 2262.9(a)(1)(B) and specification table included therein	Denatured Ethanol Specs (various)	Standards based on ASTM D4806-99 (same as current rule, no revisions proposed)	Update the text of Section 2262.9(a)(1)(B) to reference “Standards based on ASTM D 4806-25” and update the following table accordingly
§ 2253.4(c)	Lead	ASTM D3237-79 (same as current rule, no revisions proposed)	ASTM D3237-22 , Standard Test Method for Lead in Gasoline by Atomic Absorption Spectroscopy ASTM D3231-25
§ 2253.4(c)	Phosphorus	ASTM D3231-73 (same as current rule, no revisions proposed)	ASTM D3231-25 , Standard Test Method for Phosphorus in Gasoline

CARB should update the ASTM standards and test methods referenced throughout the Proposed CaRFG Amendments where applicable.

In addition, if the referee test method versions are updated, WSPA requests that CARB acknowledge that alternative test methods authorized through Executive Orders would remain valid despite referring to a historic version of the referee method.

⁶ See current § 2262.6(c)(4).

7. CARB should correct a cross-reference error in Section 2262.6(b)(2).

WSPA notes that there appears to be a drafting error with a cross-reference in Section 2262.6(b)(2) and recommends that CARB replace the cross-reference as follows:

“(2) Starting July 1, 2004, no person shall sell, offer for sale, supply or offer for supply California gasoline which contains a total of more than 0.06 weight percent oxygen collectively from all of the oxygenates identified in section (b)(3), other than oxygenates not prohibited by section (b)(1).”

8. CARB should provide vapor recovery equipment guidance.

CARB’s February 2026 guidance indicated that manufacturers should obtain E15-compatible equipment;⁷ however, there are still no CARB-certified E15 vapor recovery systems for use in California. WSPA recognizes that four other state agencies⁸ are involved in providing prior approvals before CARB can certify any such components, but there is still no timeframe for such coordination or for the anticipated completion of a Vapor Recovery Program to certify equipment needed to dispense E15. WSPA encourages CARB to continue to emphasize that these equipment constraints must be resolved before E15 is fully enabled and voluntarily sold within California.

9. CARB should ensure the Proposed CaRFG Amendments do not nullify federal “California gasoline” exemptions.

WSPA understands that CARB plans to submit the amended CaRFG Regulations, if approved, to EPA as a State Implementation Plan (SIP) revision. WSPA recognizes that CARB established a lower Reid vapor pressure (RVP) for California Reformulated Gasoline Blendstock for Oxygenate Blending (CARBOB) than for other EPA-regulated gasoline during the summer to help address California’s unique air quality challenges. However, WSPA strongly urges CARB to seek EPA guidance on any regulatory impacts, particularly in light of constraints related to the sale of E15 nationwide and requirements in title 40 of the Code of Federal Regulations (C.F.R.), Part 1090.⁹ Alignment must be maintained so as not to jeopardize the federal regulatory exemption and SIP compliance under current modeling assumptions. If not effectively managed, this would likely *deter* gasoline manufacturers from producing E15 despite any updates to California’s various state regulations. CARB’s CaRFG Amendments need to be part of California’s SIP to ensure they do not nullify the federal “California gasoline” exemption.

Additionally, fuel and fuel additive manufacturers involved in manufacturing E15 are required to meet various EPA registration and reporting requirements.¹⁰ For example, under 40 C.F.R. Part 79, a fuel manufacturer must be registered to produce E15 gasoline, while an ethanol manufacturer must be registered to produce ethanol specifically for use in E15. There are no exemptions from Part 79 for E10 or E15 fuels or fuel additives used in California. The fuel and fuel additive manufacturer must also adopt EPA-approved misfuelling mitigation plans and participate in an E15 compliance survey.¹¹ Such requirements should be part of California’s SIP to ensure federal alignment as appropriate.

WSPA appreciates the opportunity to provide these comments.

Sincerely,



Tanya DeRivi
Senior Director, California Climate and Fuels

⁷ See CARB “AB30 LEGISLATION PASSAGE AND STEPS TO OBTAIN E15 CERTIFICATION OF VAPOR RECOVERY COMPONENTS AND ECO NOZZLE/LOW-PERM HOSES,” (Feb. 24, 2026); available at: <https://ww2.arb.ca.gov/sites/default/files/2026-02/E15CertProcess.pdf>.

⁸ These include the State Water Resources Control Board, the California Office of Safety and Health Administration, the California Department of Food and Agriculture, and the Office of the State Fire Marshal.

⁹ See 40 C.F.R. Part 1090; available at: <https://www.ecfr.gov/current/title-40/chapter-I/subchapter-U/part-1090#part-1090>.

¹⁰ See <https://www.epa.gov/fuels-registration-reporting-and-compliance-help/e15-fuel-registration>.

¹¹ See *id.*; see also 40 C.F.R. § 1090.1420.


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AB-30 State Air Resources Board: gasoline specifications: ethanol blends. (2025-2026)

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Date Published: 10/03/2025 10:00 AM

Assembly Bill No. 30

CHAPTER 247

An act to add Section 43013.7 to the Health and Safety Code, relating to motor vehicle fuels, and declaring the urgency thereof, to take effect immediately.

[Approved by Governor October 02, 2025. Filed with Secretary of State
October 02, 2025.]

LEGISLATIVE COUNSEL'S DIGEST

AB 30, Alvarez. State Air Resources Board: gasoline specifications: ethanol blends.

Existing law requires the State Air Resources Board to adopt and implement motor vehicle fuel specifications for the control of air contaminants and sources of air pollution. Existing law prohibits the state board from adopting any regulation that establishes a specification for motor vehicle fuel unless that regulation, and a multimedia evaluation conducted by affected agencies and coordinated by the state board, are reviewed by the California Environmental Policy Council.

This bill would, notwithstanding that prohibition, authorize blends of gasoline containing 10.5% to 15% ethanol by volume to be sold in the state for use as a transportation fuel until (1) the California Environmental Policy Council completes its review of those blends and (2) the state board either adopts a regulation establishing a specification for those blends or posts an assessment on its internet website demonstrating that it is not possible for a regulation establishing a specification for those blends to meet specified requirements.

This bill would declare that it is to take effect immediately as an urgency statute.

Vote: 2/3 Appropriation: no Fiscal Committee: yes Local Program: no

THE PEOPLE OF THE STATE OF CALIFORNIA DO ENACT AS FOLLOWS:

SECTION 1. Section 43013.7 is added to the Health and Safety Code, to read:

43013.7. (a) Notwithstanding Section 43830.8, blends of gasoline containing 10.5 percent to 15 percent ethanol by volume may be sold in the state for use as a transportation fuel until both of the following occur:

(1) The California Environmental Policy Council completes its review and publicly posts its findings of the multimedia evaluation for blends of gasoline containing 10.5 percent to 15 percent ethanol by volume required pursuant to Section 43830.8.

(2) The state board does either of the following:

(A) Adopts a regulation establishing a specification for blends of gasoline containing 10.5 percent to 15 percent ethanol by volume.

(B) Posts an assessment on its internet website demonstrating that it is not possible for a proposed regulation establishing a specification for blends of gasoline containing 10.5 percent to 15 percent ethanol by volume to meet the requirements of subdivision (f) of Section 43830.8.

(b) This section shall not be construed to limit the authority of the state board to adopt and enforce transportation fuel specifications for other fuels, or for blends of gasoline containing 10.5 percent to 15 percent ethanol by volume after the state board takes action pursuant to subparagraph (A) or (B) of paragraph (2) of subdivision (a).

SEC. 2. This act is an urgency statute necessary for the immediate preservation of the public peace, health, or safety within the meaning of Article IV of the California Constitution and shall go into immediate effect. The facts constituting the necessity are:

In order to develop solutions to help reduce the price of gasoline in California as soon as possible, it is necessary that this act take effect immediately.



NIST OFFICE OF
WEIGHTS AND MEASURES



Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

as adopted by the 110th
National Council on
Weights and Measures

NIST Handbook **44**
2026



**NIST Handbook
NIST HB 44-2026**

Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

*as adopted by the
110th National Council on Weights and Measures*

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January 2026



U.S. Department of Commerce
Howard Lutnick, Secretary

National Institute of Standards and Technology
Craig Burkhardt, Acting Under Secretary of Commerce for Standards and Technology and Acting NIST Director

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This handbook conforms to the concept of primary use of SI (metric) measurements recommended in the Omnibus Trade and Competitiveness Act of 1988 by citing SI units before U.S. customary units where both units appear together and placing separate sections containing requirements in SI units before corresponding sections containing requirements in U.S. customary units. In some cases, however, trade practice is currently restricted to the use of U.S. customary units; therefore, some requirements in this handbook will continue to specify only U.S. customary units until a broad consensus is achieved on the permitted SI units.

In accord with NIST policy, the “meter” and “liter” spellings are used in this document. However, the “metre” and “litre” spellings are acceptable.

It should be noted that a space has been inserted instead of commas in all numerical values having four digits or more in this document. This follows a growing practice, originating in tabular work, to use spaces to separate large numbers into groups of three digits. This avoids conflict with the practice in many countries to use the comma as a decimal marker.

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Abstract

NIST Handbook 44 includes specifications, tolerances, and other technical requirements for weighing and measuring devices. These requirements are intended to encourage the design, installation, testing, and use of weighing and measuring devices that provide for accurate, repeatable measurements; facilitate clear and transparent transactions for buyer and seller; and do not facilitate fraud.

NIST Handbook 44 is adopted by many state, local, and some federal weights and measures authorities to apply to commercial weighing and measuring equipment and associated equipment and for use in applications for law enforcement and the collection of statistical information by government agencies.

NIST has a statutory responsibility for “cooperation with the states in securing uniformity of weights and measures laws and methods of inspection” and publishes this and other NIST Handbooks in partial fulfillment of this responsibility. NIST Handbook 44 was first published in 1949, having been preceded by similar handbooks of various designations and in several forms, beginning in 1918; the handbook is now typically published on an annual basis.

This 2026 edition includes amendments made through the Committee on Specifications and Tolerances of the National Council on Weights and Measures (NCWM) with technical guidance from the Office of Weights and Measures (OWM) of the National Institute of Standards and Technology (NIST) and input from weights and measures officials and industry representatives. These amendments were adopted by the NCWM at its 110th Annual Meeting in July 2025.

Keywords

devices; dry measures; electric vehicle fueling systems; grain analyzers; grain moisture meters; hydrogen gas-measuring devices; liquid-measuring devices; LPG and anhydrous ammonia liquid-measuring; mass flow meters; measure-containers; measuring; measuring systems; meters; multiple dimension measuring devices; odometers; scales; taximeters; timing devices; transportation network measuring systems; vehicle tanks; weighing; weighing systems.

Foreword

NIST Handbook 44 was first published in 1949, having been preceded by similar handbooks of various designations and in several forms, beginning in 1918.

NIST Handbook 44 is typically published in its entirety each year following the Annual Meeting of the National Council on Weights and Measures (NCWM) formerly the National Conference on Weights and Measures. This handbook includes amendments endorsed by the 110th National Council on Weights and Measures during its Annual Meetings in 2025.

This handbook conforms to the concept of primary use of SI (metric) measurements recommended in the Omnibus Trade and Competitiveness Act of 1988 by citing SI units before U.S. customary units where both units appear together and placing separate sections containing requirements in SI units before corresponding sections containing requirements in U.S. customary units. In some cases, however, trade practice is currently restricted to the use of U.S. customary units; therefore, some requirements in this handbook will continue to specify only U.S. customary units until a broad consensus is achieved on the permitted SI units.

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Main Table of Contents

	Page
Abstract	i
Foreword.....	ii
Author Contributions.....	ii
Acknowledgments.....	iii
2025 Amendments	vii
2025 Editorial Changes.....	ix
 Introduction.....	 1
 Section 1.	
1.10. General Code.....	1-1
 Section 2.	
2.20. Scales	2-3
2.21. Belt-Conveyor Scale Systems.....	2-65
2.22. Automatic Bulk Weighing Systems	2-83
2.23. Weights	2-93
2.24. Automatic Weighing Systems	2-101
2.25. Weigh-In-Motion Systems Used for Vehicle Enforcement Screening – Tentative Code	2-119
 Section 3.	
3.30. Liquid-Measuring Devices	3-3
3.31. Vehicle-Tank Meters	3-29
3.32. Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices	3-45
3.33. Hydrocarbon Gas Vapor-Measuring Devices	3-63
3.34. Cryogenic Liquid-Measuring Devices	3-75
3.35. Milk Meters	3-87
3.36. Water Meters	3-97
3.37. Mass Flow Meters	3-107
3.38. Carbon Dioxide Liquid-Measuring Devices	3-123
3.39. Hydrogen Gas-Measuring Devices	3-139
3.40. Electric Vehicle Fueling Systems	3-151
3.41. Non-Utility Electricity-Measuring Systems – Tentative Code	3-165
 Section 4.	
4.40. Vehicle Tanks Used as Measures	4-3
4.41. Liquid Measures	4-9
4.42. Farm Milk Tanks	4-13
4.43. Measure-Containers	4-21
4.44. Graduates	4-27
4.45. Dry Measures	4-33
4.46. Berry Baskets and Boxes	4-37
 Section 5.	
5.50. Fabric-Measuring Devices	5-3
5.51. Wire- and Cordage-Measuring Devices	5-9
5.52. Linear Measures	5-15
5.53. Odometers	5-19
5.54. Taximeters	5-25
5.55. Timing Devices	5-39
5.56.(a) Grain Moisture Meters	5-47
5.56.(b) Grain Moisture Meters	5-59

Main Table of Contents (continued)

	Page
5.57. Near-Infrared Grain Analyzers	5-69
5.58. Multiple Dimension Measuring Devices	5-79
5.59. Electronic Livestock, Meat, and Poultry Evaluation Systems and/or Devices	5-93
5.60. Transportation Network Measurement Systems – Tentative Code	5-97

Appendices

A. Fundamental Considerations Associated with the Enforcement of Handbook 44 Codes	A-1
B. Units and Systems of Measurement - Their Origin, Development, and Present Status.....	B-1
C. General Tables of Units of Measurement	C-1
D. Definitions.....	D-1

2025 Amendments

The following table lists the codes, paragraphs, and pages in which the 110th National Council on Weights and Measures adopted amendments. In the column headed “Action,” changes are noted as “added,” “amended,” “deleted,” or “renumbered.” Each code, section, or paragraph that has been changed will be noted as “Added 2025” or “Amended 2025.”

Section	Code	S&T Item No.	Paragraph	Action	Page
2.20.	Scales	SCL-25.4	S.1.2.2.2. Class III, III L, and IIII Scales	Amended	2-9
			S.1.2.2.2.2. Weight Classifiers	Amended	2-9
			Table S.6.3.b. Notes for Table S.6.3.a. Marking Requirements, Note 4. (b)	Amended	2-25
		SCL-25.2	Table S.6.3.a. Marking Requirements, Minimum Verification Scale Division ($e_{\min}$)	Amended	2-24
		SCL-25.5	T.N.2.4. Multi-Interval and Multiple Range (Variable Division-Value) Scales	Amended	2-44
2.24	Automatic Weighing Systems Code	AWS-24.1	N.1.5. Test Loads	Amended	2-111
			N.1.5.1. Initial Verification	Added	2-111
			Table N.1.5. Test Loads	Amended	2-111
			N.1.5.2. Subsequent Verification	Added	2-112
			N.2. Test Procedures -Weigh-Labelers	Amended	2-112
			N.2.1. Non-Automatic Tests	Amended	2-112
			N.2.1.3. Shift Test	Amended	2-112
			N.2.2.1. Tests Non-Automatic	Amended	2-112
			N.2.2.2. Automatic Tests	Amended	2-112
			N.3. Test Procedures -Automatic Checkweigher	Deleted	2-113
			Table N.3.2. Number of Sample Weights per Test for Automatic Checkweighers	Amended	2-113
Appendix D.	Definitions	SCL-25.4	weight classifier	Amended	D-38
		SCL-25.2	$e_{\min}$ (minimum verification scale division)	Amended	D-15
			$e_{\min}$ (minimum verification scale Interval)	Added	D-15

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2025 Editorial Changes

Section	Code	Paragraph	Action	Page
2.20.	Scales	S.1.11.1. Devices and Systems Adjusted Using a Removable Digital Storage Device.	Added a designation after the paragraph “(added 2019)” to identify the date it was added to the handbook.	2-14
		<i>Table 3. Parameters for Accuracy Classes</i>	Corrected footnote references for Class III and III L devices under the U.S. Customary Units section of the table. The footnote reference for Class III was changed to “4” from “5”. The footnote reference for Class III L was changed to “2” from “3”.	2-22
		<i>UR.2.10. Primary Indicating Elements Provided by the User.</i>	Changed the title font of UR.2.10. from upright roman type to italic type and corrected the reference to the sub-paragraph of S.1.1.1. from “(c)” to “(d)”.	2-54
2.23.	Weights	S.2.1. Surface.	Removed the second “or” in the second sentence of the paragraph to make the sentence grammatically correct and to read as: “A weight of more than 2 grams or 30 grains shall not have sharp edges, points, or corners.	2-95
3.31.	Vehicle-Tank Meters	Table 1. Accuracy Classes and Tolerances for Vehicle-Tank Meters Other Than Vehicle-Mounted Milk Meters	Reformatted the overregistration tolerance for Accuracy Class 1.5 Water to be consistent with the other cells in the table.	3-41
Appendix A: Fundamental Considerations	4. Inspection of Commercial Equipment	4.1. Inspection Versus Testing.	Added the word “the” between the words “of” and “value” in the second-to-last sentence to read: “The term testing may then be limited to those operations carried out to determine the accuracy of the value or performance of the equipment under examination by comparison with the actual physical standards of the official.”	A-6

Section	Code	Paragraph	Action	Page
Appendix C: General Tables of Units of Measurement	1. Tables of Metric Units of Measurement		Added terms and numbers to further describe the prefixes for multiples and subdivisions in the first paragraph of “1. Tables of Metric Units of Measurement”.	C-3
			Added four new SI prefixes. Two for forming multiples: ronna and quetta. Two for forming submultiples: ronto and quecto.	C-3
	Entire Appendix C.		Nonbreaking spaces inserted, following the SP 811 SI symbol writing style.	C-3
			Formatting updated following NIST SP 811 section 10.5.3 grouping digits style.	C-3

Introduction

A. Source

The specifications, tolerances, and other technical requirements in this handbook comprise all of those adopted by the National Council on Weights and Measures, Inc. (NCWM). Effective August 13, 2024, the National Conference on Weights and Measures (NCWM) changed its corporate name to the National Council on Weights and Measures (NCWM). Every effort has been made to incorporate this name change into the NIST Handbooks and other relevant publications. In some instances, the reference will remain as the National Conference on Weights and Measures, indicating that the change was not yet effective. For more information, please visit the **NCWM History** page (www.ncwm.com/history).

Contact NCWM at:

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Lincoln, NE 68516

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

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

(Amended 2015)

B. Purpose

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

C. Amendments

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

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

The policy is available on the NCWM website at www.ncwm.com. For information on the regional weights and measures associations, visit www.ncwm.com/meetings.

(Amended 2015)

D. System of Paragraph Designation

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

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

- G.** The letter G is a prefix and indicates that the requirement is part of the General Code.
- A. Application.** These paragraphs pertain to the application of the requirements of a code.
- S. Specification.** These paragraphs relate to the design of equipment. Specification paragraphs are directed particularly to manufacturers of devices.
- N. Note.** These paragraphs apply to the official testing of devices.
- T. Tolerance.** Tolerances are performance requirements. They fix the limit of allowable error or departure from true performance or value.

Sensitivity. The sensitivity requirements, applicable only to nonautomatic-indicating scales, are performance requirements and are lettered with a “T.”
- UR. User Requirement.** These paragraphs are directed particularly to the owner and operator of a device. User requirements apply to the selection, installation, use, and maintenance of devices.
- D. Definitions of Terms.** A definitions section appears in Appendix D to provide the definition of the terms having a special meaning.

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

S. Specifications

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

- S.1.1. Zero Indication.
 - S.1.1.1. Digital Indicating Elements.
 - S.1.1.2. No-Load Reference Value.
- S.1.2. Value of Scale Units.
 - S.1.2.1. Digital Indicating Scales.
- S.1.3. Graduations.
 - S.1.3.1. Length.
 - S.1.3.2. Width.
 - S.1.3.3. Clear Space Between Graduations.

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

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

E. Classification of Requirements

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

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

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

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

F. Using the Handbook

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

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

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

(Paragraph added 1996)

National Council on Weights and Measures / National Type Evaluation Program

Form 15: Proposal to Amend NIST Handbooks, Guidance Documents, NCWM Bylaws or NCWM Publication 14Email proposals in Microsoft Word format to info@ncwm.com by August 15.

Each regional association will hold hearings on proposals in the fall. See meeting dates at www.ncwm.com/meetings. If any region deems that the item has merit, the region will forward the item to NCWM for national consideration. For more information on the Form 15 process, visit www.ncwm.com/standards-dev.

GENERAL INFORMATION			
1. Proposal to:			
☐ Laws & Regulations ☐ Specifications & Tolerances ☐ Professional Development ☐ Board of Directors ☐ NTEP Committee			
2. Submitter's Name:		3. Date:	
4. Submitter's Organization:		5. Address:	
6. City:	7. State:	8. Zip Code:	9. Country:
10. Phone Number:	11. Fax Number:	12. Email Address:	
PROPOSAL INFORMATION			
13. Purpose: Concise statement as to the intent or purpose of this proposal, such as problem being fixed. (Do not include justification here.)			
14. Document to be Amended:			
☐ Handbook 44 ☐ Handbook 130 ☐ Handbook 133 ☐ NCWM Guidance Document ☐ NCWM Bylaws ☐ NTEP Administrative Policy			
15. Cite portion to be Amended: Submit a separate Form 15 for each code, model law or regulation to be amended.			
Section:			
Paragraph:			
16. Proposal: Use strikeout to show words to be deleted and <u>underline</u> to show new words. (Do not use track changes.)			
17. For Handbook 44 proposals, indicate one of the following:			
☐ Retroactive (Enforceable with respect to all devices) ☐ Nonretroactive (Enforceable on or after the effective date for devices a) manufactured within a state after the effective date, b) both new and used equipment brought into a state after the effective date, c) used in noncommercial applications which are placed into commercial use after the effective date, and d) undergoing type evaluation including devices that have been modified to the extent that a new NTEP Certificate of Conformance is required.)			
18. Justification: Include national importance, background on the issue, and reference to supporting data or documents.			
19. Possible Opposing Argument's: Demonstrate that you are aware and have considered possible opposition.			
20. Requested Action if Considered for NCWM Agenda:			
☐ Voting Item ☐ Developing Item ☐ Informational Item ☐ Other (Please Describe):			
21. List of Attachments:			

Submit Form via Email to: info@ncwm.com
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Revised: June 2023

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Table of Contents

	Page
Section 1.10. General Code	1-3
G-A. Application	1-3
G-A.1. Commercial and Law-Enforcement Equipment.	1-3
G-A.2. Code Application.	1-3
G-A.3. Special and Unclassified Equipment.	1-3
G-A.4. Metric Equipment.	1-3
G-A.5. Retroactive Requirements.	1-3
G-A.6. Nonretroactive Requirements.	1-4
G-A.7. Effective Enforcement Dates of Code Requirements.	1-4
G-S. Specifications.....	1-4
G-S.1. Identification.	1-4
G-S.1.1. <i>Location of Marking Information for Not-Built-For-Purpose, Software-Based</i> <i>Devices.</i>	1-6
G-S.1.2. Devices and Main Elements Remanufactured as of January 1, 2002.	1-6
G-S.2. Facilitation of Fraud.	1-6
G-S.3. Permanence.	1-6
G-S.4. Interchange or Reversal of Parts.	1-7
G-S.5. Indicating and Recording Elements.	1-7
G-S.5.1. General.	1-7
G-S.5.2. Graduations, Indications, and Recorded Representations.	1-7
G-S.5.3. Values of Graduated Intervals or Increments.	1-7
G-S.5.4. Repeatability of Indications.	1-8
G-S.5.5. Money Values, Mathematical Agreement.	1-8
G-S.5.6. Recorded Representations.	1-8
G-S.5.7. Magnified Graduations and Indications.	1-9
G-S.6. <i>Marking Operational Controls, Indications, and Features.</i>	1-9
G-S.7. Lettering.	1-9
G-S.8. <i>Provision for Sealing Electronic Adjustable Components.</i>	1-9
G-S.8.1. <i>Multiple Weighing or Measuring Elements that Share a Common Provision for</i> <i>Sealing.</i>	1-10
G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Device.	1-10
G-S.9. Metrologically Significant Software Updates.	1-10
G-N. Notes.....	1-10
G-N.1. Conflict of Laws and Regulations.	1-10
G-N.2. Testing With Nonassociated Equipment.	1-11
G-N.3. Test Methods.	1-11
G-T. Tolerances.....	1-11
G-T.1. Acceptance Tolerances.	1-11
G-T.2. Maintenance Tolerances.	1-11
G-T.3. Application.	1-11
G-T.4. For Intermediate Values.	1-11
G-T.5. Tolerances on Tests When Type 2 Transfer Standards Are Used.	1-11
G-UR. User Requirements.....	1-12
G-UR.1. Selection Requirements.	1-12
G-UR.1.1. Suitability of Equipment.	1-12

G-UR.1.2.	Environment	1-12
G-UR.1.3.	Liquid-Measuring Devices	1-12
G-UR.2.	Installation Requirements	1-12
G-UR.2.1.	Installation	1-12
G-UR.2.2.	Installation of Indicating or Recording Element	1-12
G-UR.2.3.	Accessibility for Inspection, Testing, and Sealing Purposes	1-12
G-UR.3.	Use Requirements	1-13
G-UR.3.1.	Method of Operation	1-13
G-UR.3.2.	Associated and Nonassociated Equipment	1-13
G-UR.3.3.	Position of Equipment	1-13
G-UR.3.4.	Responsibility, Money-Operated Devices	1-13
G-UR.4.	Maintenance Requirements	1-13
G-UR.4.1.	Maintenance of Equipment	1-13
G-UR.4.2.	Abnormal Performance	1-13
G-UR.4.3.	Use of Adjustments	1-13
G-UR.4.4.	Assistance in Testing Operations	1-14
G-UR.4.5.	Security Seal	1-14
G-UR.4.6.	Testing Devices at a Central Location	1-14

Section 1.10. General Code

G-A. Application

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

1. To commercial weighing and measuring equipment; that is:
 - (a) To weights and measures and weighing and measuring devices used or employed:
 - (1) in establishing the size, quantity, extent, area, composition (limited to meat and poultry), constituent values (limited to grain), or measurement of quantities, things, produce, or articles for distribution or consumption, purchased, offered, or submitted for sale, hire, or award;
 - (2) when assessing a fee for the use of the equipment to determine a weight or measure;
 - (3) in determining the basis of an award using count, weight, or measure; or
 - (4) in computing any basic charge or payment for services rendered on the basis of weight or measure.
(Amended 2008 and 2022)
 - (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.
2. To weighing and measuring equipment in official use for the enforcement of law or the collection of statistical information by government agencies.

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

(Amended 2022)

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

(Amended 1972)

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

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

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

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

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

[Nonretroactive requirements are printed in italic type.]

(Amended 1989 and 2011)

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

G-S. Specifications

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

- (a) the name, initials, or trademark of the manufacturer or distributor;
- (b) a model identifier that positively identifies the pattern or design of the device;

- (1) *The model identifier shall be prefaced by the word “Model,” “Type,” or “Pattern.” These terms may be followed by the word “Number” or an abbreviation of that word. The abbreviation for the word “Number” shall, as a minimum, begin with the letter “N” (e.g., No or No.). The abbreviation for the word “Model” shall be “Mod” or “Mod.” Prefix lettering may be initial capitals, all capitals, or all lower case.*

[Nonretroactive as of January 1, 2003]

(Added 2000) (Amended 2001)

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

[Nonretroactive as of January 1, 1968]

(Amended 2003 and 2016)

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

[Nonretroactive as of January 1, 1986]

- (2) *Abbreviations for the word “Serial” shall, as a minimum, begin with the letter “S,” and abbreviations for the word “Number” shall, as a minimum, begin with the letter “N” (e.g., S/N, SN, Ser. No., and S. No.).*

[Nonretroactive as of January 1, 2001]

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

(Added 2003) (Amended 2016)

(1) *The version or revision identifier shall be:*

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

[Nonretroactive as of January 1, 2007]

(Added 2006)

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

(Added 2016)

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

[Nonretroactive as of January 1, 2022]

(Added 2016)

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

[Nonretroactive as of January 1, 2007]

(Added 2006) (Amended 2016)

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

[Nonretroactive as of January 1, 2003]

(Added 2001) (Amended 2016)

- (1) *The CC Number or a corresponding CC Addendum Number shall be prefaced by the terms “NTEP CC,” “CC,” or “Approval.” These terms may be followed by the word “Number” or an abbreviation of that word. The abbreviation for the word “Number” shall, as a minimum, begin with the letter “N” (e.g., No or No.).*

[Nonretroactive as of January 1, 2003]

(Added 2001) (Amended 2016)

The required information shall be so located that it is readily observable without the necessity of the disassembly of a part requiring the use of any means separate from the device.

(Amended 1985, 1991, 1999, 2000, 2001, 2003, 2006, and 2016)

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

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

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

[Nonretroactive as of January 1, 2004]

(Added 2003) (Amended 2006)

G-S.1.2. Devices and Main Elements Remanufactured as of January 1, 2002. – All devices and main elements remanufactured as of January 1, 2002, shall be clearly and permanently marked for the purposes of identification with the following information:

- (a) the name, initials, or trademark of the last remanufacturer or distributor; and
 - (b) the remanufacturer’s or distributor’s model designation, if different than the original model designation.
- (Added 2001) (Amended 2011)

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

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

(Amended 2007)

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

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

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

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

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

G-S.5. Indicating and Recording Elements.

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

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

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

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

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

[Nonretroactive as of January 1, 1986]

(Amended 1973 and 1985)

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

[Made retroactive as of January 1, 1975]

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

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

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

G-S.5.3.1. On Devices That Indicate or Record in More Than One Unit. – On devices designed to indicate or record in more than one unit of measurement, the values indicated and recorded shall be identified with an appropriate word, symbol, or abbreviation.

(Amended 1978 and 1986)

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 1 cent of money value. This does not apply to auxiliary digital indications intended for the operator's use only, when these indications are obtained from existing analog customer indications that meet this requirement.

(Amended 1973)

G-S.5.6. Recorded Representations. – Insofar as they are appropriate, the requirements for indicating and recording elements shall also apply to recorded representations. All recorded values shall be presented digitally. In applications where recorded representations are required by a specific code, the customer may be given the option of not receiving the recorded representation. Recorded representations referenced in specific codes shall be made available to the customer in hard copy form, unless otherwise specified by the customer. For systems equipped with the capability of issuing an electronic receipt, ticket, or other recorded representation, the customer may be given the option to receive any required information electronically (e.g., via cell phone, computer, etc.) in lieu of or in addition to a hard copy.

(Amended 1975, 2014, and 2023)

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

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

Note: SP 811 can be viewed or downloaded at www.nist.gov/pml/special-publication-811 or by going to www.nist.gov/pml/owm and selecting “Publications,” then selecting “NIST Special Publications,” and then clicking on the link below “**NIST SP 811: Guide for the Use of the International System of Units (SI)**” showing the year of the current edition.

(Added 2007)

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

(Added 1977) (Amended 2007)

Table 1. Representation of SI Units on Equipment Manufactured Prior to January 1, 2008, with Limited Character Sets				
Name of Unit	International Symbol (common use symbol)	Representation		
		Form I	Form II	
		(double case)	(single case lower)	(single case upper)
Base SI Units				
meter	m	m	m	M
kilogram	kg	kg	kg	KG
Derived SI Units				
newton	N	N	n	N
pascal	Pa	Pa	pa	PA
watt	W	W	w	W
volt	V	V	v	V
degree Celsius	°C	°C	°c	°C
Other Units				
liter	l or L	L	l	L
gram	g	g	g	G
metric ton	t	t	tne	TNE
bar	bar	bar	bar	BAR

(Table Amended 2007)

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

G-S.6. Marking Operational Controls, Indications, and Features. – All operational controls, indications, and features, including switches, lights, displays, push buttons, and other means, shall be clearly and definitely identified. The use of approved pictograms or symbols shall be acceptable.

[Nonretroactive as of January 1, 1977]

(Amended 1978 and 1995)

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

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

[Nonretroactive as of January 1, 1990]

A device may be fitted with an automatic or a semi-automatic calibration mechanism. This mechanism shall be incorporated inside the device. After sealing, neither the mechanism nor the calibration process shall facilitate fraud. (Added 1985) (Amended 1989 and 1993)

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

[Nonretroactive as of January 1, 2010]

Note: For devices that utilize an electronic form of sealing, in addition to the requirements in G-S.8.1., any appropriate audit trail requirements in an applicable specific device code also apply. Examples of identification of a change to the metrological parameters of a weighing or measuring element include, but are not limited to:

- (1) a broken, missing, or replaced physical seal on an individual weighing, measuring, or indicating element or active junction box;
- (2) a change in a calibration factor or configuration setting for each weighing or measuring element;
- (3) a display of the date of calibration or configuration event for each weighing or measuring element; or
- (4) counters indicating the number of calibration and/or configuration events for each weighing or measuring element.

(Added 2007)

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

- (1) an event logger in the device; or
- (2) a physical seal that must be broken in order to remove the digital storage device from the device (or system). If security is provided using an event logger, the event logger shall include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available on demand through the device or through another on-site device. In addition to providing a printed copy of the information, the information may be made available electronically. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: Does not require 1000 changes to be stored for each parameter.)

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

(Added 2019)

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

(Added 2016)

G-N. Notes

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

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

(Added 1976)

G-N.3. Test Methods. – Permissible test methods for verifying compliance of commercial weighing and measuring systems with the provisions of the General Code and Specific Codes include, but are not limited to, test methods and apparatus that have been approved by the Director as outlined in Appendix A - Fundamental Considerations, Section 3. Testing Apparatus.

(Added 2023)

G-T. Tolerances

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

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

(Amended 1989)

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

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

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-T.5. Tolerances on Tests When Type 2 Transfer Standards Are Used. – When Type 2 transfer standards are used, the following formula shall be used to compute the tolerance applicable to the device under test:

$$\text{Increased maximum permissible error (mpe)} = (2/3 \times \text{mpe} + U)$$

With an upper limit of $U_{\max} = 2/3 \text{ mpe}$, where mpe is the basic tolerance that applies when using a basic reference standard.

mpe = maximum permissible error

U = uncertainty associated with the Type 2 transfer standard

The increase in the applied tolerance when using a Type 2 transfer standard applies only to the basic tolerances for devices as defined in NIST Handbook 44; that is acceptance, maintenance, and minimum tolerances. Note that the repeatability tolerance and the special test tolerances are NOT increased.

Codes 5.56.(a) Grain Moisture Meters, 5.56.(b) Grain Moisture Meters, and 5.57. Near-Infrared Grain Analyzers are exempt from this requirement because NIST Handbook 159, Examination of Grain Moisture Meters Using Air-Oven Reference Method Transfer Standards has requirements for monitoring and retesting grain samples to ensure adequate stability and the tolerances for the devices under test already incorporate the uncertainty associated with the use of grain samples as transfer standards. Section 2.21. Belt-Conveyor Scale Systems Code is also exempt because relative and absolute tolerances are included in the code.

(Added 2023)

G-UR. User Requirements

G-UR.1. Selection Requirements.

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

(Amended 1974)

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

(Added 1976)

G-UR.1.3. Liquid-Measuring Devices. – To be suitable for its application, the minimum delivery for liquid-measuring devices shall be no less than 100 divisions, except that the minimum delivery for retail analog devices shall be no less than 10 divisions. Maximum division values and tolerances are stated in the specific codes.

(Added 1995)

G-UR.2. Installation Requirements.

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

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

(Added 1978)

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

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

- (a) inspecting and testing the device;
- (b) inspecting and applying security seals to the device; and

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

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

(Amended 1991)

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

(Added 1976)

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

(Amended 1974 and 1998)

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

(Amended 1977 and 1993)

G-UR.4. Maintenance Requirements.

G-UR.4.1. Maintenance of Equipment. – All equipment in service and all mechanisms and devices attached thereto or used in connection therewith shall be continuously maintained in proper operating condition throughout the period of such service. Equipment in service at a single place of business shall not be considered “maintained in a proper operating condition” if:

- (a) predominantly, equipment of all types or applications are found to be in error in a direction favorable to the device user; or
- (b) predominantly, equipment of the same type or application is found to be in error in a direction favorable to the device user.

(Amended 1973, 1991, and 2015)

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

(Added 1976)

G-UR.4.3. Use of Adjustments. – Weighing elements and measuring elements that are adjustable shall be adjusted only to correct those conditions that such elements are designed to control, and shall not be adjusted to

compensate for defective or abnormal installation or accessories or for badly worn or otherwise defective parts of the assembly. Any faulty installation conditions shall be corrected, and any defective parts shall be renewed or suitably repaired, before adjustments are undertaken. Whenever equipment is adjusted, the adjustments shall be so made as to bring performance errors as close as practicable to zero value.

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

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

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

- (a) When devices in commercial service require special test facilities, or must be removed from service for testing, or are routinely transported for the purpose of use (e.g., vehicle-mounted devices and devices used in multiple locations), the official with statutory authority may require that the devices be brought to a central location for testing. The dealer or owner of these devices shall provide transportation of the devices to and from the test location.
- (b) When the request for removal and delivery to a central test location involves devices used in submetering (e.g., electric, hydrocarbon vapor, or water meters), the owner or operator shall not interrupt the utility service to the customer or tenant except for the removal and replacement of the device. Provisions shall be made by the owner or operator to minimize inconvenience to the customer or tenant. All replacement or temporary meters shall be tested and sealed by a weights and measures official or bear a current, valid approval seal prior to use.

(Added 1994)

Section 2

Table of Contents

	Page
2.20. Scales	2-3
2.21. Belt-Conveyor Scale Systems	2-65
2.22. Automatic Bulk Weighing Systems	2-83
2.23. Weights	2-93
2.24. Automatic Weighing Systems	2-101
2.25. Weigh-In-Motion Systems Used for Vehicle Enforcement Screening – Tentative Code.....	2-119

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Table of Contents

	Page
Section 2.20. Scales.....	2-7
A. Application.....	2-7
A.1. General.....	2-7
A.2. Wheel-Load Weighers, Portable Axle-Load Weighers, and Axle-Load Scales.....	2-7
A.3. Additional Code Requirements.	2-7
S. Specifications.....	2-7
S.1. Design of Indicating and Recording Elements and of Recorded Representations.	2-7
S.1.1. Zero Indication.....	2-7
S.1.2. <i>Value of Scale Division Units.</i>	2-8
S.1.3. Graduations.....	2-10
S.1.4. Indicators.....	2-10
S.1.5. Weighbeams.	2-10
S.1.6. Poises.....	2-11
S.1.7. Capacity Indication, Weight Ranges, and Unit Weights.....	2-12
S.1.8. Computing Scales.....	2-12
S.1.9. Prepackaging Scales.....	2-13
S.1.10. Adjustable Components.....	2-14
S.1.11. <i>Provision for Sealing.</i>	2-14
S.1.12. <i>Manual Weight Entries.</i>	2-15
S.1.13. Vehicle On-Board Weighing Systems: Vehicle in Motion.	2-15
S.1.14. Weigh-in-Motion (WIM) Vehicle Scales.....	2-15
S.1.15. Recorded Representations, Multi-Independent Platform Vehicle Scale Systems.	2-16
S.2. Design of Balance, Tare, Level, Damping, and Arresting Mechanisms.....	2-17
S.2.1. Zero-Load Adjustment.	2-17
S.2.2. Balance Indicator.	2-18
S.2.3. Tare.	2-18
S.2.4. Level-Indicating Means.....	2-19
S.2.5. Damping Means.	2-19
S.3. Design of Load-Receiving Elements.	2-20
S.3.1. Travel of Pans of Equal-Arm Scale.....	2-20
S.3.2. Drainage.	2-20
S.3.3. Scoop Counterbalance.....	2-20
S.3.4. Length of Weigh-In-Motion Vehicle Scales.....	2-20
S.4. Design of Weighing Elements.....	2-20
S.4.1. Antifriction Means.	2-20
S.4.2. Adjustable Components.....	2-20
S.4.3. Multiple Load-Receiving Elements.....	2-20
S.5. <i>Design of Weighing Devices, Accuracy Class.</i>	2-21
S.5.1. <i>Designation of Accuracy Class.</i>	2-21
S.5.2. Parameters for Accuracy Class.	2-21
S.5.3. Multi-Interval and Multiple Range Scales, Division Value.	2-21
S.5.4. Relationship of Minimum Load Cell Verification Interval Value to the Verification Scale Interval.	2-21
S.6. Marking Requirements.....	2-23
S.6.1. Nominal Capacity; Vehicle and Axle-Load Scales.	2-23
S.6.2. Location of Marking Information.....	2-23

S.6.3.	Scales, Main Elements, and Components of Scales or Weighing Systems.	2-23
S.6.4.	Railway Track Scales.	2-28
S.6.5.	Livestock Scales.....	2-29
S.6.6.	Counting Feature, Minimum Individual Piece Weight, and Minimum Sample Piece Count.....	2-30
N.	Notes.....	2-30
N.1.	Test Procedures.	2-30
N.1.1.	Increasing-Load Test.	2-30
N.1.2.	Decreasing-Load Test (Automatic Indicating Scales).	2-30
N.1.3.	Shift Test.	2-30
N.1.4.	Sensitivity Test.....	2-34
N.1.5.	<i>Discrimination Test</i>	2-34
N.1.6.	RFI Susceptibility Tests, Field Evaluation.....	2-34
N.1.7.	Ratio Test.....	2-34
N.1.8.	Material Tests.	2-34
N.1.9.	Zero-Load Balance Change.	2-34
N.1.10.	Counting Feature Test.	2-35
N.1.11.	Substitution Test.	2-35
N.1.12.	Strain-Load Test.....	2-35
N.2.	Verification (Testing) Standards.....	2-35
N.3.	Minimum Test Weights and Test Loads.	2-35
N.3.1.	Minimum Test-Weight Load and Tests for Railway Track Scales.....	2-35
N.3.2.	Field Standard Weight Carts.....	2-36
N.4.	Coupled-in-Motion Railroad Weighing Systems.	2-37
N.4.1.	Weighing Systems Used to Weigh Trains of Less Than Ten Cars.	2-37
N.4.2.	Weighing Systems Placed in Service Prior to January 1, 1991, and Used to Weigh Trains of Ten or More Cars.	2-37
N.4.3.	Weighing Systems Placed in Service on or After January 1, 1991, and Used to Weigh Trains of Ten or More Cars.	2-37
N.5.	Uncoupled-in-Motion Railroad Weighing System.	2-38
N.6.	Nominal Capacity of Prescription Scales.	2-38
N.7.	Weigh-in-Motion Vehicle Scales Test Procedures.	2-39
N.7.1.	Reference Scale.....	2-39
N.7.2.	Reference Vehicle.	2-39
N.7.3.	Test Speeds.....	2-39
N.7.4.	Static Tests for Weigh-in-Motion Vehicle Scales.	2-39
N.7.5.	Dynamic Tests for Weigh-in-Motion Vehicle Scales.....	2-39
T.	Tolerances Applicable to Devices not Marked I, II, III, III L, or IIII.....	2-40
T.1.	Tolerance Values.	2-40
T.1.1.	General.	2-40
T.1.2.	Postal and Parcel Post Scales.	2-40
T.2.	Sensitivity Requirement (SR).....	2-42
T.2.1.	Application.	2-42
T.2.2.	General.	2-42
T.2.3.	Prescription Scales.	2-42
T.2.4.	Jewelers' Scales.	2-42
T.2.5.	Dairy-Product Test Scales.	2-42
T.2.6.	Grain Test Scales.....	2-42
T.2.7.	Vehicle, Axle-Load, Livestock, and Animal Scales.	2-42
T.2.8.	Railway Track Scales.	2-43

T.3.	Sensitivity Requirement, Equilibrium Change Required.	2-43
T.N.	Tolerances Applicable to Devices Marked I, II, III, III L, and IIII.....	2-43
T.N.1.	Principles.	2-43
T.N.1.1.	Design.....	2-43
T.N.1.2.	Accuracy Classes.	2-43
T.N.1.3.	Verification Scale Interval.	2-43
T.N.2.	Tolerance Application.....	2-43
T.N.2.1.	General.	2-43
T.N.2.2.	Type Evaluation Examinations.	2-43
T.N.2.3.	Subsequent Verification Examinations.....	2-43
T.N.2.4.	Multi-Interval and Multiple Range (Variable Division-Value) Scales.	2-44
T.N.2.5.	Ratio Tests.	2-44
T.N.3.	Tolerance Values.	2-44
T.N.3.1.	Maintenance Tolerance Values.	2-44
T.N.3.2.	Acceptance Tolerance Values.	2-44
T.N.3.3.	Wheel-Load Weighers and Portable Axle-Load Weighers of Class IIII.....	2-44
T.N.3.4.	Crane and Hopper (Other than Grain Hopper) Scales.	2-44
T.N.3.5.	Separate Main Elements: Load Transmitting Element, Indicating Element, Etc.....	2-44
T.N.3.6.	Coupled-In-Motion Railroad Weighing Systems.	2-44
T.N.3.7.	Uncoupled-in-Motion Railroad Weighing Systems.....	2-45
T.N.3.8.	Dynamic Monorail Weighing System.	2-45
T.N.3.9.	Materials Test on Customer-Operated Bulk Weighing Systems for Recycled Materials.....	2-45
T.N.3.10.	Prescription Scales with a Counting Feature.....	2-45
T.N.3.11.	Tolerances for Substitution Test.....	2-46
T.N.3.12.	Tolerances for Strain-Load Test.....	2-46
T.N.4.	Agreement of Indications.....	2-46
T.N.4.1.	Multiple Indicating/Recording Elements.	2-46
T.N.4.2.	Single Indicating/Recording Element.....	2-46
T.N.4.3.	Single Indicating Element/Multiple Indications.....	2-46
T.N.4.4.	Shift or Section Tests.....	2-46
T.N.4.5.	Time Dependence.....	2-46
T.N.4.6.	Time Dependence (Creep) for Load Cells during Type Evaluation.	2-47
T.N.4.7.	Creep Recovery for Load Cells During Type Evaluation.	2-48
T.N.5.	Repeatability.	2-48
T.N.6.	Sensitivity.	2-49
T.N.6.1.	Test Load.	2-49
T.N.6.2.	Minimum Change of Indications.....	2-49
T.N.7.	Discrimination.....	2-49
T.N.7.1.	Analog Automatic Indicating (i.e., Weighing Device with Dial, Drum, Fan, etc.).....	2-49
T.N.7.2.	Digital Automatic Indicating.	2-49
T.N.8.	Influence Factors.	2-49
T.N.8.1.	Temperature.....	2-50
T.N.8.2.	Barometric Pressure.	2-50
T.N.8.3.	Electric Power Supply.	2-50
T.N.9.	Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility.	2-50
UR.	User Requirements.....	2-51
UR.1.	Selection Requirements.....	2-51
UR.1.1.	General.	2-51
UR.1.2.	Grain Hopper Scales.....	2-52
UR.1.3.	Value of the Indicated and Recorded Scale Division.	2-52

UR.1.4. Grain-Test Scales: Value of the Scale Divisions.....	2-52
UR.1.5. <i>Recording Element, Class III L Railway Track Scales.</i>	2-53
UR.2. Installation Requirements.....	2-53
UR.2.1. Supports.....	2-53
UR.2.2. Suspension of Hanging Scale.....	2-53
UR.2.3. Protection From Environmental Factors.	2-53
UR.2.4. Foundation, Supports, and Clearance.	2-53
UR.2.5. Access to Weighing Elements.....	2-53
UR.2.6. Approaches.	2-53
UR.2.7. Stock Racks.	2-54
UR.2.8. Hoists.....	2-54
UR.2.9. <i>Provision for Testing Dynamic Monorail Weighing Systems.</i>	2-54
UR.2.10. <i>Primary Indicating Elements Provided by the User.</i>	2-54
UR.3. Use Requirements.....	2-54
UR.3.1. Recommended Minimum Load.....	2-54
UR.3.2. Maximum Load.....	2-55
UR.3.3. Single-Draft Vehicle Weighing.....	2-57
UR.3.4. Weighing of Axle Loads and Axle-Group Loads.....	2-57
UR.3.5. Wheel-Load Weighing.	2-58
UR.3.6. Special Designs.	2-58
UR.3.7. Wet Commodities.....	2-58
UR.3.8. Minimum Load on a Vehicle Scale.	2-58
UR.3.9. Minimum Load for Weighing Livestock.	2-58
UR.3.10. Use of Manual Weight Entries.	2-59
UR.3.11. Dynamic Monorail Weighing Systems.....	2-59
UR.3.12. Minimum Count.....	2-59
UR.3.13. Correct Stored Piece Weight.....	2-59
UR.3.14. Fault Indications for Weigh-in-Motion Vehicle Scales	2-59
UR.4. Maintenance Requirements.	2-59
UR.4.1. Balance Condition.....	2-59
UR.4.2. Level Condition.....	2-59
UR.4.3. Scale Modification.	2-59
UR.5. Coupled-in-Motion Railroad Weighing Systems.....	2-60
Scales Code Index.....	2-61

Section 2.20. Scales

A. Application

A.1. General. – This code applies to all types of weighing devices other than automatic bulk-weighing systems, belt-conveyor scales, and automatic weighing systems. The code comprises requirements that generally apply to all weighing devices, and specific requirements that are applicable only to certain types of weighing devices.
(Amended 1972 and 1983)

A.2. Wheel-Load Weighers, Portable Axle-Load Weighers, and Axle-Load Scales. – The requirements for wheel-load weighers, portable axle-load weighers, and axle-load scales apply only to such scales in official use for the enforcement of traffic and highway laws or for the collection of statistical information by government agencies.

A.3. Additional Code Requirements. – In addition to the requirements of this code, devices covered by the Scales code shall meet the requirements of Section 1.10. General Code.

S. Specifications

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

S.1.1. Zero Indication.

- (a) On a scale equipped with indicating or recording elements, provision shall be made to either indicate or record a zero-balance condition.
- (b) On an automatic-indicating scale or balance indicator, provision shall be made to indicate or record an out-of-balance condition on both sides of zero.
- (c) A zero-balance condition may be indicated by other than a continuous digital zero indication, provided that an effective automatic means is provided to inhibit a weighing operation or to return to a continuous digital indication when the scale is in an out-of-balance condition.

(Added 1987) (Amended 1993)

(Amended 1987)

S.1.1.1. Digital Indicating Elements.

- (a) A digital zero indication shall represent a balance condition that is within $\pm \frac{1}{2}$ the value of the scale division d.
- (b) *After zero-setting (gross zero or net zero after a tare operation) the effect of zero deviation on the result of the weighing shall be not more than $\pm 0.25 e$.*
[Nonretroactive as of January 1, 2025]
- (c) *A digital indicating device shall have a “center-of-zero” indicator that indicates a zero-balance condition when the deviation from zero is not more than $\pm 0.25 e$. A “center-of-zero” indicator may operate when zero is indicated for gross and/or net mode(s). The “center-of-zero” indicator is not mandatory on a device equipped with an auxiliary indication or equipped with an enabled zero tracking mechanism that maintains a “center-of-zero” condition to $\pm 0.25 e$.*
[Nonretroactive as of January 1, 1993]

- (d) *For electronic cash registers (ECRs) and point-of-sale systems (POS systems) the display of measurement units shall be a minimum of 9.5 mm ($\frac{3}{8}$ inch) in height.*

[Nonretroactive as of January 1, 2021]

(Added 2019)

(Amended 1992, 2008, 2019, and 2024)

S.1.1.2. No-Load Reference Value. – On a single draft manually operated receiving hopper scale installed below grade, used to receive grain, and utilizing a no-load reference value, provision shall be made to indicate and record the no-load reference value prior to the gross load value.

(Added 1983)

S.1.2. Value of Scale Units. – *Except for batching scales and weighing systems used exclusively for weighing in predetermined amounts, the value of a scale division “d” and the verification scale interval “e” expressed in a unit of weight shall be equal to:*

- (a) 1, 2, or 5; or

- (b) a decimal multiple or submultiple of 1, 2, or 5; or

Examples: scale divisions may be 10, 20, 50, 100; or 0.01, 0.02, 0.05; or 0.1, 0.2, 0.5, etc.

- (c) a binary submultiple of a specific unit of weight.

Examples: scale divisions may be $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, etc.

[Nonretroactive as of January 1, 1986]

(Amended 2024)

S.1.2.1. Digital Indicating Scales, Units. – *Except for postal scales, a digital-indicating scale shall indicate weight values using only a single unit of measure. Weight values shall be presented in a decimal format with the value of the scale division “d” expressed as 1, 2, or 5, or a decimal multiple or submultiple of 1, 2, or 5.*

The requirement that the value of the scale division “d” be expressed only as 1, 2, or 5, or a decimal multiple or submultiple of only 1, 2, or 5 does not apply to net weight indications and recorded representations that are calculated from gross and tare weight indications where the scale division “d” of the gross weight is different from the scale division “d” of the tare weight(s) on multi-interval or multiple range scales. For example, a multiple range or multi-interval scale may indicate and record tare weights in a lower weighing range (WR) or weighing segment (WS), gross weights in the higher weighing range or weighing segment, and net weights as follows:

55 kg Gross Weight (WR2 d = 5 kg)	10.05 lb Gross Weight (WS2 d = 0.05 lb)
– 4 kg Tare Weight (WR1 d = 2 kg)	– 0.06 lb Tare Weight (WS1 d = 0.02 lb)
= 51 kg Net Weight (Mathematically Correct)	= 9.99 lb Net Weight (Mathematically Correct)

[Nonretroactive as of January 1, 1989]

(Added 1987) (Amended 2008 and 2024)

S.1.2.2. Verification Scale Interval “e”.

S.1.2.2.1. Class I and II Scales and Dynamic Monorail Scales Equipped with an Auxiliary Indication. – Only a Class I or II scale or a dynamic monorail may be equipped with an auxiliary indication. The auxiliary indication may be either a rider or vernier on an analog device, or a scale division “d” to the right of the decimal point on a digital device that is differentiated, for example by size, shape, or color.

A scale with an auxiliary indication shall not be equipped with an extended display mode.

The verification scale interval “e” on a scale equipped with an auxiliary indication shall be determined as follows:

- (a) The value of “e” shall be greater than “d” and less than or equal to 10 “d” ($d < e \leq 10 d$), and
- (b) The value of “e” must satisfy the relationship, $e = 10^k$ of the unit of measure, where k is a positive or negative whole number or zero.

Examples:

$$10^{-2} = 0.01, 10^{-1} = 0.1, 10^0 = 1, 10^1 = 10, 10^2 = 100, \text{ etc.}$$

The requirement in subpart (a) does not apply to a Class I devices with $e = 1 \text{ mg}$, where d shall be less than “e” ($d < e$).

Examples:

If $e = 1 \text{ g}$ for Class I or II, then “d” may only be 0.5 g, 0.2 g, or 0.1 g

If $e = 1 \text{ mg}$ for Class I, then “d” may be 0.5 mg, 0.2 mg, 0.1 mg, 0.05 mg, 0.02 mg, etc.

(Added 1999) (Amended 2024)

S.1.2.2.2. Class III, III L, and IIII Scales. – The value of “e” is specified by the manufacturer as marked on the device. Except for dynamic monorail scales, “e” must be equal to “d”.

(Added 1999) (Amended 2024 and 2025)

S.1.2.2.2.1. Dynamic Monorail Scales. – On a dynamic monorail scale the value of “e” shall be equal to or greater than “d.”

(Added 2024)

S.1.2.2.2.2. Weight Classifiers. – On a weight classifier, such as a postal or shipping scale that rounds up and is marked for special use, the value of “e” shall be equal to “d.”

(Added 2024) (Amended 2025)

S.1.2.2.3. Extended Display Mode. – A scale with an auxiliary indication shall not be equipped with an extended display mode. When a scale is equipped with an extended display mode, displaying an indication with a scale division “d” smaller than “e” shall be possible only:

- (a) while pressing a key; or
- (b) for a period not exceeding 5 seconds after a manual command.

Printing or transferring data via interface shall not be possible while the extended display mode is in operation.

(Added 2024)

(Amended 2021 and 2024)

S.1.2.3. Prescription Scale with a Counting Feature. – A Class I or Class II prescription scale with an operational counting feature shall not calculate a piece weight or total count unless the sample used to determine the individual piece weight meets the following conditions:

- (a) minimum individual piece weight is greater than or equal to 3 e; and
 - (b) minimum sample piece count is greater than or equal to 10 pieces.
- (Added 2003)

S.1.3. Graduations.

S.1.3.1. Length. – Graduations shall be so varied in length that they may be conveniently read.

S.1.3.2. Width. – In any series of graduations, the width of a graduation shall in no case be greater than the width of the clear space between graduations. The width of main graduations shall be not more than 50 % greater than the width of subordinate graduations. Graduations shall be not less than 0.2 mm (0.008 in) wide.

S.1.3.3. Clear Space Between Graduations. – The clear space between graduations shall be not less than 0.5 mm (0.02 in) for graduations representing money-values, and not less than 0.75 mm (0.03 in) for other graduations. If the graduations are not parallel, the measurement shall be made:

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

S.1.4. Indicators.

S.1.4.1. Symmetry. – The index of an indicator shall be of the same shape as the graduations, at least throughout that portion of its length associated with the graduations.

S.1.4.2. Length. – The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case, the distance between the end of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 1.0 mm (0.04 in).

S.1.4.3. Width. – The width of the index of an indicator in relation to the series of graduations with which it is used shall be not greater than:

- (a) *the width of the narrowest graduation;*
[Nonretroactive as of January 1, 2002]
- (b) the width of the clear space between weight graduations; and
- (c) three-fourths of the width of the clear space 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.1.4.4. Clearance. – The clearance between the index of an indicator and the graduations shall in no case be more than 1.5 mm (0.06 in).

S.1.4.5. Parallax. – Parallax effects shall be reduced to the practicable minimum.

S.1.5. Weighbeams.

S.1.5.1. Normal Balance Position. – The normal balance position of the weighbeam of a beam scale shall be horizontal.

S.1.5.2. 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 Tables 1M and 1. When such limiting stops are not provided, the total travel at the weighbeam tip shall be not less than 8 % of the distance from the weighbeam fulcrum to the weighbeam tip.

Table 1M. Minimum Travel of Weighbeam of Beam Scale Between Limiting Stops	
Distance from Weighbeam Fulcrum to Limiting Stops (centimeters)	Minimum Travel Between Limiting Stops (millimeter)
≤ 30	10
> 30 to 50	13
> 50 to 100	18
> 100	23

Table 1. Minimum Travel of Weighbeam of Beam Scale Between Limiting Stops	
Distance from Weighbeam Fulcrum to Limiting Stops (inches)	Minimum Travel Between Limiting Stops (inch)
≤ 12	0.4
> 12 to 20	0.5
> 20 to 40	0.7
> 40	0.9

S.1.5.3. Subdivision. – A subdivided weighbeam bar shall be subdivided by scale division 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 positioned in relation to the notches to indicate notch values clearly and accurately.

S.1.5.4. 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.1.5.5. Capacity. – On an automatic-indicating scale having a nominal capacity of 15 kg (30 lb) 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.1.5.6. 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.1.6. Poles.

S.1.6.1. 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, the 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.1.6.2. Adjusting Material. – The adjusting material in a poise shall be securely enclosed and firmly fixed in position; if softer than brass, it shall not be in contact with the weighbeam.

S.1.6.3. 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. The 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.1.6.4. 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.1.7. Capacity Indication, Weight Ranges, and Unit Weights.

- (a) **Gross Capacity.** – An indicating or recording element shall not display nor record any values when the gross load (not counting the initial dead load that has been canceled by an initial zero-setting mechanism) is in excess of 105 % of scale capacity.
- (b) **Capacity Indication.** – *Electronic computing scales (excluding postal scales and weight classifiers) shall neither display nor record a gross or net weight in excess of scale capacity plus 9 d.*
[Nonretroactive as of January 1, 1993]

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.

This requirement does not apply to: (1) single-revolution dial scales, (2) multi-revolution dial scales not equipped with unit weights, (3) scales equipped with two or more weighbeams, nor (4) devices that indicate mathematically derived totalized values.

(Amended 1990, 1992, and 1995)

S.1.8. Computing Scales.

S.1.8.1. Money-Value Graduations, Metric Unit Prices. – The value of the graduated intervals representing money-values on a computing scale with analog indications shall not exceed:

- (a) 1 cent at all unit prices of 55 cents per kilogram and less;
- (b) 2 cents at unit prices of 56 cents per kilogram through \$2.75 per kilogram (special graduations defining 5-cent intervals may be employed but not in the spaces between regular graduations);
- (c) 5 cents at unit prices of \$2.76 per kilogram through \$7.50 per kilogram; or
- (d) 10 cents at unit prices above \$7.50 per kilogram.

Value figures and graduations shall not be duplicated in any column or row on the graduated chart. (Also see S.1.8.3. Money-Value Computation.)

S.1.8.2. Money-Value Graduations, U.S. Customary Unit Prices. – The value of the graduated intervals representing money-values on a computing scale with analog indications shall not exceed:

- (a) 1 cent at all unit prices of 25 cents per pound and less;
- (b) 2 cents at unit prices of 26 cents per pound through \$1.25 per pound (special graduations defining 5-cent intervals may be employed but not in the spaces between regular graduations);
- (c) 5 cents at unit prices of \$ 1.26 per pound through \$3.40 per pound; or
- (d) 10 cents at unit prices above \$3.40 per pound.

Value figures and graduations shall not be duplicated in any column or row on the graduated chart. (Also see S.1.8.3. Money-Value Computation.)

S.1.8.3. Money-Value Computation. – A computing scale with analog quantity indications used in retail trade may compute and present digital money-values to the nearest quantity graduation when the value of the minimum graduated interval is 0.005 kg (0.01 lb) or less. (Also see Section 1.10. General Code G-S.5.5. Money-Values, Mathematical Agreement.)

S.1.8.4. Customer's Indications. – Weight indications shall be shown on the customer's side of computing scales when these are used for direct sales to retail customers. Computing scales equipped on the operator's side with digital indications, such as the net weight, unit price, or total price, shall be similarly equipped on the customer's side. Unit price displays visible to the customer shall be in terms of single whole units of weight and not in common or decimal fractions of the unit. Scales indicating in metric units may indicate price per 100 g.

(Amended 1985 and 1995)

S.1.8.4.1. *Scales that will function as either a normal round off scale or as a weight classifier shall be provided with a sealable means for selecting the mode of operation and shall have a clear indication (annunciator), adjacent to the weight display on both the operator's and customer's side whenever the scale is operating as a weight classifier.*

[Nonretroactive as of January 1, 2001]

(Added 1999)

S.1.8.5. Recorded Representations, Point-of-Sale Systems. – The sales information recorded by cash registers when interfaced with a weighing element shall contain the following information for items weighed at the checkout stand:

- (a) the net weight;
- (b) the unit price;
- (c) the total price;
- (d) the product class or, in a system equipped with price look-up capability, the product name or code number; and
- (e) the tare weight.

[Nonretroactive as of January 1, 2025]

Weight values shall be identified as tare and net, or gross if applicable. The unit of weight shall be identified as kilograms, kg, grams, g, ounces, oz, pounds, or lb.

For devices interfaced with scales indicating in metric units, the unit price may be expressed in price per 100 grams.

(Amended 1995, 2005, and 2021)

S.1.9. Prepackaging Scales.

S.1.9.1. Value of the Scale Division. – On a prepackaging scale, the value of the intervals representing weight values shall be uniform throughout the entire reading face. The recorded weight values shall be identical with those on the indicator.

S.1.9.2. Label Printer. – A prepackaging scale or a device that 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.

S.1.10. Adjustable Components. – An adjustable component such as a pendulum, spring, or potentiometer shall be held securely in adjustment and, except for a zero-load balance mechanism, shall be located within the housing of the element.

(Added 1986)

S.1.11. Provision for Sealing.

S.1.11.1. Devices and Systems Adjusted Using a Removable Digital Storage Device. – For devices and systems in which the calibration or configuration parameters, as defined in Appendix D. Definitions can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices.

(Added 2019)

S.1.11.2. All Other Devices. – *Except on Class I scales and devices specified in S.1.11.1., the following provisions for sealing apply:*

- (a) *Except on Class I scales, provision shall be made for applying a security seal in a manner that requires the security seal to be broken before an adjustment can be made to any component affecting the performance of an electronic device.*

[Nonretroactive as of January 1, 1979]

- (b) *Except on Class I scales, a device shall be designed with provision(s) for applying a security seal that must be broken, or for using other approved means of providing security (e.g., data change audit trail available at the time of inspection), before any change that detrimentally affects the metrological integrity of the device can be made to any electronic mechanism.*

[Nonretroactive as of January 1, 1990]

- (c) *Except on Class I scales, audit trails shall use the format set forth in Table S.1.11. Categories of Device and Methods of Sealing.*

[Nonretroactive as of January 1, 1995]

(Amended 2019)

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

(Amended 1989, 1991, 1993, and 2019)

Table S.1.11. Categories of Device and Methods of Sealing	
Categories of Device	Methods of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode.	The hardware enabling access for remote communication must be at the device and sealed using a physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).	An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: Does not require 1000 changes to be stored for each parameter.)

[Nonretroactive as of January 1, 1995]
 (Table added 1993)

S.1.12. Manual Weight Entries. – A device when being used for direct sale shall accept an entry of a manual gross or net weight value only when the scale gross or net* weight indication is at zero. Recorded manual weight entries, except those on labels generated for packages of standard weights, shall identify the weight value as a manual weight entry by one of the following terms: “Manual Weight,” “Manual Wt,” or “MAN WT.” The use of a symbol to identify multiple manual weight entries on a single document is permitted, provided that the symbol is defined on the same page on which the manual weight entries appear and the definition of the symbol is automatically printed by the recording element as part of the document.

[Nonretroactive as of January 1, 1993] [*Nonretroactive as of January 1, 2005]
 (Added 1992) (Amended 2004)

S.1.13. Vehicle On-Board Weighing Systems: Vehicle in Motion. – When the vehicle is in motion, a vehicle on-board weighing system shall either:

- (a) be accurate; or
- (b) inhibit the weighing operation.

(Added 1993)

S.1.14. Weigh-in-Motion (WIM) Vehicle Scales.

S.1.14.1. Identification of a Fault. – Fault conditions shall be presented to the customer and the operator in a clear and unambiguous manner. No weight values shall be indicated or recorded when a fault condition is detected. The following fault conditions shall be identified, if applicable:

- (a) Vehicle speed was below the minimum or above the maximum speed as specified by the manufacturer.
- (b) A change in vehicle speed greater than that specified by the manufacturer was detected.

- (c) Vehicle direction of travel was not valid for the installation.
- (d) The amount of time all vehicle axles were simultaneously on the scale was below the minimum data acquisition time.
- (e) Vehicle path of travel was outside the lateral side edges of the load-receiving element.

S.1.14.2. Information to be Recorded. – In addition to the information that is normally recorded for vehicle scales, the following shall also be printed and/or stored electronically for each vehicle weighment, if applicable:

- (a) Scale identification if more than one lane at the site has the ability to weigh a vehicle in motion.
- (b) Vehicle direction of travel if the weigh-in-motion vehicle scale is bi-directional.

(Added 2021)

S.1.15. Recorded Representations, Multi-Independent Platform Vehicle Scale Systems. ^(See Note 1)

S.1.15.1. Axle and Axle-Group Loads. – All recorded representations of the different axle and axle-group loads of a vehicle when weighed in a single draft on a multi-independent platform vehicle scale system shall be identified by providing indication of either:

- (a) the portion of the vehicle to which they represent (e.g., “axle group 1, axle group 2, axle group 3,” or if using axle and axle group descriptions, “steering axle, drive axles, trailer axles”); or
- (b) the particular independent scale platform from which they were obtained (e.g., “Platform 1, Platform 2, Platform 3”).

S.1.15.2. Total Vehicle Weight. – If a summed total of all axle and axle-group loads of a vehicle weighed on a multi-independent platform vehicle scale system is recorded, the recorded value shall be clearly identified as:

- (a) “Total Vehicle Weight,” “Vehicle Weight,” (or other similar terms that clearly identify the value as the vehicle’s total weight) providing all axle(s) and axle groups of the vehicle weighed were positioned on a live portion of the weighing/load-receiving elements and weighed simultaneously when the summed total was determined ^(See Note 2); or
- (b) “Not-Legal-For-Trade” unless all axle and axle groups of the vehicle weighed were simultaneously positioned on a live portion of the weighing/load-receiving elements when the summed total was determined, or the vehicle was weighed using the alternative method described in Note 2 of this paragraph.

Note 1: Multi-independent platform means each platform of the scale is a single independent weighing/load-receiving element unattached to adjacent elements and with its own A/D conversion circuitry and displayed weight.

Note 2: Alternatively, the individual components of the vehicle being weighed may be uncoupled, positioned completely on the live elements of the scale, weighed separately, and then totaled.

(Added 2023)

S.2. Design of Balance, Tare, 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. Any loose material used for this purpose shall be enclosed so that it cannot shift in position and alter the balance condition of the scale.

Except for an initial zero-setting mechanism, an automatic zero adjustment outside the limits specified in S.2.1.3. Scales Equipped with an Automatic Zero-Tracking Mechanism is prohibited.

(Amended 2010)

S.2.1.2. Scales used in Direct Sales. – A manual zero-setting mechanism (except on a digital scale with an analog zero-adjustment mechanism with a range of not greater than one scale division) shall be operable or accessible only by a tool outside of and entirely separate from this mechanism, or it shall be enclosed in a cabinet. Except on Class I or II scales, a balance ball shall either meet this requirement or not itself be rotatable.

A semiautomatic zero-setting mechanism shall be operable or accessible only by a tool outside of and separate from this mechanism or it shall be enclosed in a cabinet, or it shall be operable only when the indication is stable within plus or minus:

- (a) 3.0 scale divisions for scales of more than 2000 kg (5000 lb) capacity in service prior to January 1, 1981, and for all axle-load, railway track, and vehicle scales; or
- (b) 1.0 scale division for all other scales.

S.2.1.3. Scales Equipped with an Automatic Zero-Tracking Mechanism.

S.2.1.3.1. Automatic Zero-Tracking Mechanism for Scales Manufactured Between January 1, 1981, and January 1, 2007. – The maximum load that can be “rezeroed,” when either placed on or removed from the platform all at once under normal operating conditions, shall be for:

- (a) bench, counter, and livestock scales: 0.6 scale division;
- (b) vehicle, axle-load, and railway track scales: 3.0 scale divisions; and
- (c) all other scales: 1.0 scale division.

(Amended 2005)

S.2.1.3.2. Automatic Zero-Tracking Mechanism for Scales Manufactured on or after January 1, 2007. – The maximum load that can be “rezeroed,” when either placed on or removed from the platform all at once under normal operating conditions, shall be:

- (a) for vehicle, axle-load, and railway track scales: 3.0 scale division; and
- (b) for all other scales: 0.5 scale division.

(Added 2005)

S.2.1.3.3. Means to Disable Automatic Zero-Tracking Mechanism on Class III L Devices. – *Class III L devices equipped with an automatic zero-tracking mechanism shall be designed with a sealable means that would allow zero tracking to be disabled during the inspection and test of the device.*

[Nonretroactive as of January 1, 2001]

(Added 1999) (Amended 2005)

S.2.1.4. Monorail Scales. – On a static monorail scale equipped with digital indications, means shall be provided for setting the zero-load balance to within 0.02 % of scale capacity. On a dynamic monorail weighing system, means shall be provided to automatically maintain these conditions.

(Amended 1999)

S.2.1.5. Initial Zero-Setting Mechanism. – Scales of accuracy Classes I, II, and III may be equipped with an initial zero-setting device.

(a) For weighing, load-receiving, and indicating elements in the same housing or covered on the same CC, an initial zero-setting mechanism shall not zero a load in excess of 20 % of the maximum capacity of the scale unless tests show that the scale meets all applicable tolerances for any amount of initial load compensated by this device within the specified range.

(b) *For indicating elements not permanently attached to weighing and load-receiving elements covered on a separate CC, the maximum initial zero-setting mechanism range of electronic indicators shall not exceed 20 % of the configured capacity.*

[Nonretroactive as of January 1, 2009]

(Added 2008)

(Added 1990) (Amended 2008)

S.2.1.6. Combined Zero-Tare (“0/T”) Key. – Scales not intended to be used in direct sales applications may be equipped with a combined zero and tare function key, provided that the device is clearly marked as to how the key functions. The device must also be clearly marked on or adjacent to the weight display with the statement “Not for Direct Sales.”

(Added 1998)

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. When the scale is in balance, the ends shall be separated by not more than 1.0 mm (0.04 in).

S.2.2.1. Dairy-Product Test, Grain-Test, Prescription, and Class I and II Scales. – Except on digital indicating devices, a dairy-product test, grain-test, prescription, or Class I or II scale shall be equipped with a balance indicator. If an indicator and a graduated scale are not in the same plane, the clearance between the indicator and the graduations shall be not more than 1.0 mm (0.04 in).

S.2.2.2. Equal-Arm Scale. – *An equal-arm scale shall be equipped with a balance indicator. If the indicator and balance graduation are not in the same plane, the clearance between the indicator and the balance graduation shall be not more than 1.0 mm (0.04 in).*

[Nonretroactive as of January 1, 1989]

(Added 1988)

S.2.3. Tare. – *On any scale (except a monorail scale equipped with digital indications and multi-interval scales or multiple range scales when the value of tare is determined in a lower weighing range or weighing segment), the value of the tare division shall be equal to the value of the scale division.** The tare mechanism

shall operate only in a backward direction (that is, in a direction of underregistration) with respect to the zero-load balance condition of the scale. *A device designed to automatically clear any tare value shall also be designed to prevent the automatic clearing of tare until a complete transaction has been indicated.**

*[*Nonretroactive as of January 1, 1983]*

(Amended 1985 and 2008)

Note: *On a computing scale, this requires the input of a unit price, the display of the unit price, and a computed positive total price at a readable equilibrium. Other devices require a complete weighing operation, including tare, net, and gross weight determination.**

*[*Nonretroactive as of January 1, 1983]*

S.2.3.1. Monorail Scales Equipped with Digital Indications. – On a static monorail weighing system equipped with digital indications, means shall be provided for setting any tare value of less than 5 % of the scale capacity to within 0.02 % of scale capacity. On a dynamic monorail weighing system, means shall be provided to automatically maintain this condition.

(Amended 1999)

S.2.4. Level-Indicating Means. – Except for portable wheel-load weighers and portable axle-load scales a portable scale shall be equipped with level -indicating means if its weighing performance is changed by an amount greater than the appropriate acceptance tolerance when it is tilted up to and including 5 % rise over run in any direction from a level position and rebalanced. The level-indicating means shall be readable without removing any scale parts requiring a tool.

[This requirement is nonretroactive as of January 1, 1986, for prescription, jewelers', and dairy-product test scales and scales marked Class I and II.]

Note: Portable wheel-load weighers and portable axle-load scales shall be accurate when tilted up to and including 5 % rise over run in any direction from a level position and rebalanced.

(Amended 1991 and 2008)

S.2.4.1. Vehicle On-Board Weighing Systems. – A vehicle on-board weighing system shall operate within tolerance when the weighing system is tilted up to and including 5 % rise over run in any direction from a level position and rebalanced. If the accuracy of the system is affected by out-of-level conditions normal to the use of the device, the system shall be equipped with an out-of-level sensor that inhibits the weighing operation when the system is out of level to the extent that the accuracy limits are exceeded.

(Added 1992) (Amended 2008)

S.2.5. Damping Means. – An automatic-indicating scale and a balance indicator shall be equipped with effective means to damp oscillations and to bring the indicating elements quickly to rest.

S.2.5.1. Digital Indicating Elements. – Digital indicating elements equipped with recording elements shall be equipped with effective means to permit the recording of weight values only when the indication is stable within plus or minus:

- (a) 3.0 scale divisions for scales of more than 2000 kg (5000 lb) capacity in service prior to January 1, 1981, hopper (other than grain hopper) scales with a capacity exceeding 22 000 kg (50 000 lb), and for all vehicle, axle-load, livestock, and railway track scales; and
- (b) 1.0 scale division for all other scales.

The values recorded shall be within applicable tolerances.

(Amended 1995)

S.2.5.2. Jewelers', Prescription, and Class I, and Class II Scales. – A jewelers', prescription, Class I, or Class II scales shall be equipped with appropriate means for arresting the oscillation of the mechanism.

S.2.5.3. Class I and Class II Prescription Scales with a Counting Feature. – A Class I or Class II prescription scale shall indicate to the operator when the piece weight computation is complete by a stable display of the quantity placed on the load-receiving element.

(Added 2003)

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 2M. and Table 2. Minimum Travel of Pans of Nonautomatic Indicating Equal-Arm Scale without Balance Indicator.

Table 2M. Minimum Travel of Pans of Nonautomatic Indicating Equal-Arm Scale without Balance Indicator		Table 2. Minimum Travel of Pans of Nonautomatic Indicating Equal-Arm Scale without Balance Indicator	
Nominal Capacity (kilograms)	Minimum Travel of Pans (millimeters)	Nominal Capacity (pounds)	Minimum Travel of Pans (inch)
2 or less	9	4 or less	0.35
2+ to 5, inclusive	13	4+ to 12, inclusive	0.5
5+ to 12, inclusive	19	12+ to 26, inclusive	0.75
Over 12	25	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 operator's and customer's sides of the scale whether it is positioned for the scoop to be on or off the scale.

S.3.4. Length of Weigh-In-Motion Vehicle Scales. – The load-receiving element shall be of sufficient length to allow the weighment of any vehicle intended to be weighed on the scale in a single draft (i.e., all axles of the vehicle are on the load-receiving element simultaneously during the weighment).

(Added 2021)

S.4. Design of Weighing Elements.

S.4.1. Antifriction Means. – Frictional effects shall be reduced to a minimum by suitable antifriction elements. Opposing surfaces and points shall be 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 Components. – An adjustable component such as a nose-iron or potentiometer shall be held securely in adjustment. The position of a nose-iron on a scale of more than 1000 kg (2000 lb) capacity, as determined by the factory adjustment, shall be accurately, clearly, and permanently defined.

(Amended 1986)

S.4.3. Multiple Load-Receiving Elements. – Except for mechanical bench and counter scales, a scale with a single indicating or recording element, or a combination indicating-recording element, that is coupled to two or more load-receiving elements with independent weighing systems, shall be provided with means to prohibit the activation of any load-receiving element (or elements) not in use, and shall be provided with automatic means to indicate clearly and definitely which load-receiving element (or elements) is in use.

S.5. Design of Weighing Devices, Accuracy Class.

S.5.1. Designation of Accuracy Class. – Weighing devices are divided into accuracy classes and shall be designated as I, II, III, III L, or IIII.

[Nonretroactive as of January 1, 1986]

S.5.2. Parameters for Accuracy Class. – The accuracy class of a weighing device is designated by the manufacturer and shall comply with parameters shown in Table 3.

[Nonretroactive as of January 1, 1986]

S.5.3. Multi-Interval and Multiple Range Scales, Division Value. – On a multi-interval scale and multiple range scale, the value of “e” shall be equal to the value of “d.”¹

(Added 1986) (Amended 1995)

S.5.4. Relationship of Minimum Load Cell Verification Interval Value to the Verification Scale Interval.

– The relationship of the value for the minimum load cell verification scale interval, v_{min} , to the verification scale interval, e , for a specific scale using National Type Evaluation Program (NTEP) certified load cells shall comply with the following formulae where N is the number of load cells in a single independent¹ weighing/load-receiving element (such as hopper, railroad track, or vehicle scale weighing/load-receiving elements):

$$(a) V_{min} \leq \frac{e}{\sqrt{N}} \text{ for scales without lever systems; and}$$

$$(b) V_{min} \leq \frac{e}{\sqrt{N} \times (\text{scale multiple})} \text{ for scales with lever systems.}$$

¹“Independent” means with a weighing/load-receiving element not attached to adjacent elements and with its own A/D conversion circuitry and displayed weight.

This requirement does not apply to complete weighing/load-receiving elements or scales, which satisfy all the following criteria:

- the complete weighing/load-receiving element or scale has been evaluated for compliance with T.N.8.1. Temperature under the NTEP;
- the complete weighing/load-receiving element or scale has received an NTEP Certificate of Conformance; and
- the complete weighing/load-receiving element or scale is equipped with an automatic zero-tracking mechanism which cannot be made inoperative in the normal weighing mode. (A test mode which permits the disabling of the automatic zero-tracking mechanism is permissible, provided the scale cannot function normally while in this mode.

[Nonretroactive as of January 1, 1994]

(Added 1993) (Amended 1996, 2016, and 2024)

¹ Footnote 1 to Table 3. Parameters for Accuracy Classes.

Table 3. Parameters for Accuracy Classes			
Class	Value of the Verification Scale Interval (e)	Number of Verification Scale ³ Intervals (n)	
		Minimum	Maximum
SI Units			
I	equal to or greater than 1 mg	50 000	--
II	1 mg to 50 mg, inclusive	100	100 000
III ^{1,4}	equal to or greater than 100 mg	5 000	100 000
	0.1 g to 2 g, inclusive	100	10 000
	equal to or greater than 5 g	500	10 000
III L ²	equal to or greater than 2 kg	2 000	10 000
IIII	equal to or greater than 5 g	100	1 200
U.S. Customary Units			
III ⁴	0.000 2 lb to 0.005 lb, inclusive	100	10 000
	0.005 oz to 0.125 oz, inclusive	100	10 000
	equal to or greater than 0.01 lb	500	10 000
	equal to or greater than 0.25 oz	500	10 000
III L ²	equal to or greater than 5 lb	2 000	10 000
IIII	greater than 0.01 lb	100	1 200
	greater than 0.25 oz	100	1 200

¹ A Class III scale marked “For prescription weighing only” may have a verification scale interval (e) not less than 0.01 g.
(Added 1986) (Amended 2003 and 2024)

² The value of a verification scale interval (e) for crane and hopper (other than grain hopper) scales shall be not less than 0.2 kg (0.5 lb). The minimum number of verification scale intervals (n) shall be not less than 1000.
(Amended 2024)

³ On a multiple range or multi-interval scale, the number of intervals for each range independently shall not exceed the maximum specified for the accuracy class. The number of verification scale intervals, (n), for each weighing range is determined by dividing the scale capacity for each range by the verification scale interval, (e), for each range. On a scale system with multiple load-receiving elements and multiple indications, each element considered shall not independently exceed the maximum specified for the accuracy class. If the system has a summing indicator, the n_{max} for the summed indication shall not exceed the maximum specified for the accuracy class.
(Added 1997) (Amended 2024)

⁴ The minimum number of verification scale intervals (n) for a Class III Hopper Scale used for weighing grain shall be 2000.
(Amended 2024)

[Nonretroactive as of January 1, 1986]

(Amended 1986, 1987, 1997, 1998, 1999, 2003, 2004, and 2024)

S.6. Marking Requirements. – (Also see G-S.1. Identification, G-S.4. Interchange or Reversal of Parts, G-S.6. Marking Operational Controls, Indications, and Features, G-S.7. Lettering, G-UR.2.1.1. Visibility of Identification, and UR.3.4.1. Use in Pairs.)

S.6.1. Nominal Capacity; Vehicle and Axle-Load Scales. – *For all vehicle and axle-load scales, the marked nominal capacity shall not exceed the concentrated load capacity (CLC) times the quantity of the number of sections in the scale minus 0.5.*

As a formula, this is stated as:

$$\text{nominal capacity} \leq \text{CLC} \times (N - 0.5)$$

where N = the number of sections in the scale.

[Nonretroactive as of January 1, 1989]

Note: When the device is used in a combination railway track and vehicle weighing application, the above formula shall apply only to the vehicle scale application.

(Added 1988) (Amended 1999 and 2002)

S.6.2. Location of Marking Information. – Scales that are not permanently attached to an indicating element, and for which the load-receiving element is the only part of the weighing/load-receiving element visible after installation, may have the marking information required in Section 1.10. General Code, G-S.1. Identification and Section 2.20. Scales Code, S.6. Marking Requirements located in an area that is accessible only through the use of a tool; provided that the information is easily accessible (e.g., the information may appear on the junction box under an access plate). The identification information for these scales shall be located on the weighbridge (load-receiving element) near the point where the signal leaves the weighing element or beneath the nearest access cover.

(Added 1989)

S.6.3. Scales, Main Elements, and Components of Scales or Weighing Systems. – Scales, main elements of scales when not contained in a single enclosure for the entire scale, load cells for which Certificates of Conformance (CC) have been issued under the National Type Evaluation Program (NTEP), and other equipment necessary to a weighing system, but having no metrological effect on the weighing system, shall be marked as specified in Table S.6.3.a. Marking Requirements and explained in the accompanying notes in Table S.6.3.b. Notes for Table S.6.3.a.

(Added 1990)

Table S.6.3.a. Marking Requirements					
To Be Marked With ↓	Weighing Equipment				
	Weighing, Load-Receiving, and Indicating Element in Same Housing or Covered on the Same CC ¹	Indicating Element not Permanently Attached to Weighing and Load-Receiving Element or Covered by a Separate CC	Weighing and Load-Receiving Element Not Permanently Attached to Indicating Element or Covered by a Separate CC	Load Cell with CC (11)	Other Equipment or Device (10)
Manufacturer's ID (1)	X	X	X	X	X
Model Designation and Prefix (1)	X	X	X	X	X
Serial Number and Prefix (2)	X	X	X	X	X (16)
Certificate of Conformance Number (CC) (23)	X	X	X	X	X (23)
Accuracy Class (17)	X	X (8)	X (19)	X	
Nominal Capacity (3)(18)(20)	X	X	X		
Value of Scale Division, "d" (3)(4)	X	X			
Value of Verification Scale Interval "e" (3)(4)	X	X			
Temperature Limits (5)	X	X	X	X	
Concentrated Load Capacity (CLC) (12)(20)(22)		X	X (9)		
Special Application (13)	X	X	X		
Maximum Number of Verification Scale Intervals ($n_{\max}$) (6)		X (8)	X (19)	X	
Minimum Verification Scale Interval ($e_{\min}$)			X (19)		
"S" or "M" (7)				X	
Direction of Loading (15)				X	
Minimum Dead Load				X	
Maximum Capacity				X	
Minimum and Maximum Speed (25)		X			
Maximum Speed Change (26)		X			
Vehicle Direction Restriction (27)		X			
Vehicle Restriction (28)		X			
Safe Load Limit				X	

Table S.6.3.a. Marking Requirements					
Load Cell Verification Interval (v_{min}) (21)				X	
Section Capacity and Prefix (14)(20)(22)(24)		X	X		
Note: For applicable notes, Table S.6.3.b. ¹ Weighing/load-receiving elements and indicators which are in the same housing or which are permanently attached will generally appear on the same CC. If not in the same housing, elements shall be hard-wired together or sealed with a physical seal or an electronic link. This requirement does not apply to peripheral equipment that has no input or effect on device calibrations or configurations. (Note Added 2001)					

(Added 1990) (Amended 1992, 1999, 2000, 2001, 2002, 2004, 2021, 2023, 2024, and 2025)

Table S.6.3.b. Notes for Table S.6.3.a. Marking Requirements	
<ol style="list-style-type: none"> Manufacturer's identification and model designation and <i>model designation prefix</i>.[*] [*Nonretroactive as of January 1, 2003] (Also see G-S.1. Identification.) [<i>Prefix lettering may be initial capitals, all capitals or all lower case</i>] (Amended 2000) Serial number [Nonretroactive as of January 1, 1968] and prefix [Nonretroactive as of January 1, 1986]. (Also see G-S.1. Identification.) The device shall be marked with the nominal capacity. The nominal capacity may be prefaced by the terms "capacity" or "Max." For any scale where the value of "e" is equal to the value of "d" (see S.1.2.2.), the nominal capacity shall be shown together with the value of the scale division "d" or the verification scale interval "e" (e.g., 15 × 0.005 kg, or capacity = 15 kg, d = 0.005 kg, or Max 15 kg e = 0.005 kg) in a clear and conspicuous manner and be readily apparent when viewing the reading face of the scale indicator unless already apparent by the design of the device. On multiple range or multi-interval scales the value of the scale division "d" or verification scale interval "e" shall be marked together with its associated nominal capacity. For any scale that has no "d" or any scale where "e" does not equal "d" refer to Note 4. [Nonretroactive as of January 1, 1983] (Amended 2005 and 2024) Exceptions to Note 3 regarding marking of "e" and "d". <ol style="list-style-type: none"> For an ungraduated scale such as an equal arm scale where the scale graduations do not represent a fixed weight quantity, the nominal capacity shall be shown together with the verification scale interval "e" (e.g. capacity 1,000 g e = 0.1 g, or Max 1,000 g e = 0.1 g). These devices have no "d". For a scale where e does not equal d, such as a scale equipped with an auxiliary indication, the nominal capacity shall be shown together with the verification scale interval "e," and the scale division "d" (e.g., capacity 1,000 g e = 0.1 g d = 0.01 g, or Max 1,000 g e = 0.1 g d = 0.01 g). [Nonretroactive as of January 1, 1986] (Amended 2024 and 2025) Required only on Class III, III L, and IIII devices if the temperature range on the NTEP CC is narrower than and within – 10 °C to 40 °C (14 °F to 104 °F). [Nonretroactive as of January 1, 1986] (Amended 1999) 	

Table S.6.3.b.
Notes for Table S.6.3.a. Marking Requirements

6. *This value may be stated on load cells in units of 1000; e.g., n: 10 is 10 000 divisions.*
[Nonretroactive as of January 1, 1988]

7. *Denotes compliance for single or multiple load cell applications. It is acceptable to use a load cell with the “S” or Single Cell designation in multiple load cell applications as long as all other parameters meet applicable requirements. A load cell with the “M” or Multiple Cell designation can be used only in multiple load cell applications.*
[Nonretroactive as of January 1, 1988]
 (Amended 1999)

8. *An indicating element not permanently attached to a weighing element shall be clearly and permanently marked with the accuracy Class of I, II, III, III L, or IIII, as appropriate, and the maximum number of verification scale intervals, n_{max} , for which the indicator complies with the applicable requirement. Indicating elements that qualify for use in both Class III and III L applications may be marked III/III L and shall be marked with the n_{max} for which the device complies with the applicable requirements for each accuracy class.*
[Nonretroactive as of January 1, 1988]
 (Amended 2024)

9. *For vehicle and axle-load scales only. The CLC shall be added to the load-receiving element of any such scale not previously marked at the time of modification.*
[Nonretroactive as of January 1, 1989]
 (Amended 2002)

10. *Necessary to the weighing system but having no metrological effect, e.g., auxiliary remote display, keyboard, etc.*

11. *The markings may be either on the load cell or in an accompanying document; except that, if an accompanying document is provided, the serial number shall appear both on the load cell and in the document. [Nonretroactive as of January 1, 1988] The manufacturer’s name or trademark, the model designation, and identifying symbols for the model and serial numbers as required by paragraph G-S.1. Identification shall also be marked both on the load cell and in any accompanying document.*
[Nonretroactive as of January 1, 1991]

12. *Required on the indicating element and the load-receiving element of vehicle and axle-load scales. Such marking shall be identified as “concentrated load capacity” or by the abbreviation “CLC.”**
*[*Nonretroactive as of January 1, 1989]*
 (Amended 2002)

13. *A scale designed for a special application rather than general use shall be conspicuously marked with suitable words, visible to the operator and to the customer, restricting its use to that application, e.g., postal scale, prepack scale, weight classifier, etc.* When a scale is installed with an operational counting feature, the scale shall be marked on both the operator and customer sides with the statement “The counting feature is not legal for trade,” except when a Class I or Class II prescription scale complies with all Handbook 44 requirements applicable to counting features.*
*[*Nonretroactive as of 1986]*
 (Amended 1994 and 2003)

14. *Required on livestock* and railway track scales. When marked on vehicle and axle-load scales manufactured before January 1, 1989, it may be used as the CLC. For livestock scales manufactured between January 1, 1989, and January 1, 2003, required markings may be either CLC or section capacity.*
*[*Nonretroactive as of January 1, 2003]*
 (Amended 2002)

Table S.6.3.b.
Notes for Table S.6.3.a. Marking Requirements

15. *Required if the direction of loading the load cell is not obvious.*
[Nonretroactive as of January 1, 1988]
16. *Serial number [Nonretroactive as of January 1, 1968] and prefix [Nonretroactive as of January 1, 1986].* (Also see G-S.1. Identification.) Modules without “intelligence” on a modular system (e.g., printer, keyboard module, cash drawer, and secondary display in a point-of-sale system) are not required to have serial numbers.
17. *The accuracy class of a device shall be marked on the device with the appropriate designation as I, II, III, III L, or IIII.*
[Nonretroactive as of January 1, 1986]
18. 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 capacity of the indicating or recording element, or elements, is not immediately apparent;
 - (d) on any scale with a nominal capacity less than the sum of the reading elements; and
 - (e) *on the load-receiving element (weighbridge) of vehicle, axle-load, and livestock scales.***[*Nonretroactive as of January 1, 1989]*
(Amended 1992)
19. *For weighing and load-receiving elements not permanently attached to indicating element or covered by a separate CC.*
[Nonretroactive as of January 1, 1988]
(Amended 1992)
20. *Combination vehicle/railway track scales must be marked with both the nominal capacity and CLC for vehicle weighing and the nominal capacity and section capacity for railway weighing. All other requirements relating to these markings will apply.*
[Nonretroactive as of January 1, 2000]
(Added 1999)
21. *The value of the load cell verification interval (v_{min}) must be stated in mass units. In addition to this information, a device may be marked with supplemental representations of v_{min} .*
[Nonretroactive as of January 1, 2001]
(Added 1999)
22. *Combination vehicle/livestock scales must be marked with both the CLC for vehicle weighing and the section capacity for livestock weighing. All other requirements relative to these markings will apply.*
[Nonretroactive as of January 1, 2003]
(Added 2002) (Amended 2003)
Note: *The marked section capacity for livestock weighing may be less than the marked CLC for vehicle weighing.*
(Amended 2003)
23. *Required only if a CC has been issued for the device or equipment.*
[Nonretroactive as of January 1, 2003]
(G-S.1. Identification (e) Added 2001)
24. *The section capacity shall be prefaced by the words “Section Capacity” or an abbreviation of that term. Abbreviations shall be “Sec Cap” or “Sec C.” All capital letters and periods may be used.*

<p style="text-align: center;">Table S.6.3.b. Notes for Table S.6.3.a. Marking Requirements</p>
<p><i>[Nonretroactive as of January 1, 2005]</i> (Added 2004)</p> <p>25. Weigh-in-motion vehicle scales must be marked with minimum and maximum vehicle speed limitations. (Added 2021)</p> <p>26. Weigh-in-motion vehicle scales must be marked with the maximum vehicle speed change allowed during the weighing. (Added 2021)</p> <p>27. Weigh-in-motion vehicle scales must be marked as “uni-directional” if the travel direction is restricted. (Added 2021)</p> <p>28. Weigh-in-Motion vehicle scales shall be marked with any vehicle restrictions, if applicable, using the terms specified on the NTEP Certificate of Conformance, which shall be readily apparent when viewing the reading face of the scale indicator. (Added 2023)</p>

S.6.4. Railway Track Scales. – A railway track scale shall be marked with the maximum capacity of each section of the load-receiving element of the scale. Such marking shall be accurately and conspicuously presented on, or adjacent to, the identification or nomenclature plate that is attached to the indicating element of the scale. The nominal capacity marking shall satisfy the following:

(a) For scales manufactured from January 1, 2002, through December 31, 2013:

- (1) the nominal capacity of a scale with more than two sections shall not exceed twice its rated section capacity; and
- (2) the nominal capacity of a two-section scale shall not exceed its rated section capacity.

(b) For scales manufactured on or after January 1, 2014, the nominal scale capacity shall not exceed the lesser of:

- (1) the sum of the Weigh Module Capacities as shown in Table S.6.4.M. and Table S.6.4.; or
- (2) the Rated Section Capacity (RSC) multiplied by the Number of Sections (Ns) minus the Number of Dead Spaces (Nd) minus 0.5. As a formula this is stated as:

$$RSC \times (Ns - Nd - 0.5)$$

;or

- (3) 290 300 kg (640 000 lb).

(Amended 1988, 2001, 2002, and 2013)

Table S.6.4.M. Railway Track Scale – Weigh Module Capacity	
Weigh Module Length (meters)	Weigh Module Capacity (kilograms)
< 1.5	36 300
1.5 to < 3.0	72 600
3.0 to < 4.5	108 900
4.5 to < 7.0	145 100
7.0 to < 9.0	168 700
9.0 to < 10.5	192 300
10.5 to < 12.0	234 100
12.0 to < 17.0	257 600
Note: The capacity of a particular module is based on its length as shown above. To determine the “sum of the weigh module capacities” referenced in paragraph S.6.4.(b)(1): (1) determine the length of each individual weigh module in the scale; (2) find its corresponding “weigh module capacity” in the table above; and (3) add all of the individual weigh module capacities.”	

(Table Added 2013)

Table S.6.4. Railway Track Scale – Weigh Module Capacity	
Weigh Module Length (feet)	Weigh Module Capacity (pounds)
< 5	80 000
5 to < 10	160 000
10 to < 15	240 000
15 to < 23	320 000
23 to < 29	372 000
29 to < 35	424 000
35 to < 40	516 000
40 to < 56	568 000
Note: The capacity of a particular module is based on its length as shown above. To determine the “sum of the weigh module capacities” referenced in paragraph S.6.4.(b)(1): (1) determine the length of each individual weigh module in the scale; (2) find its corresponding “weigh module capacity” in the table above; and (3) add all of the individual weigh module capacities.”	

(Table Added 2013)

S.6.5. Livestock Scales. – A livestock scale manufactured prior to January 1, 1989, or after January 1, 2003, shall be marked with the maximum capacity of each section of the load-receiving element of the scale. Livestock scales manufactured between January 1, 1989, and January 1, 2003, shall be marked with either the Concentrated Load Capacity (CLC) or the Section Capacity. Such marking shall be accurately and conspicuously presented on, or adjacent to the identification or nomenclature plate that is attached to the indicating element of the scale.

*The nominal capacity of a scale with more than two sections shall not exceed twice its rated section capacity. The nominal capacity of a two-section scale shall not exceed its rated section capacity.**

*[*Nonretroactive as of January 1, 2003]*

(Added 2002)

Also see Note 14 in Table S.6.3.b. Notes for Table S.6.3.a. Marking Requirements.

S.6.6. Counting Feature, Minimum Individual Piece Weight, and Minimum Sample Piece Count. – A Class I or Class II prescription scale with an operational counting feature shall be marked with the minimum individual piece weight and minimum number of pieces used in the sample to establish an individual piece weight.

(Added 2003)

N. Notes

N.1. Test 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. When the total test load is less than the nominal capacity, the 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 (Automatic Indicating Scales). – The decreasing-load test shall be conducted with the test load approximately centered on the load-receiving element of the scale.

N.1.2.1. Scales Marked I, II, III, or IIII. – Except for portable wheel load weighers, decreasing-load tests shall be conducted on scales marked I, II, III or IIII and with “n” equal to or greater than 1000 with test loads equal to the maximum test load at each tolerance value. For example, on a Class III scale, at test loads equal to 4000 d, 2000 d, and 500 d; for scales with n less than 1000, the test load shall be equal to one-half of the maximum load applied in the increasing-load test. (Also see Table 6. Maintenance Tolerances.)

(Amended 1998)

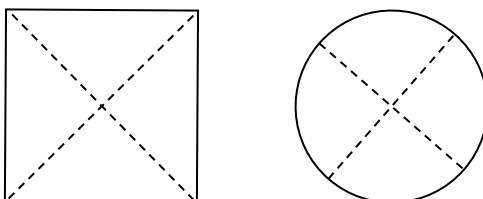
N.1.2.2. All Other Scales. – On all other scales, except for portable wheel load weighers, the decreasing-load test shall be conducted with a test load equal to one-half of the maximum load applied in the increasing-load test.

(Amended 1998)

N.1.3. Shift Test.

N.1.3.1. Dairy-Product Test Scales. – A shift test shall be conducted with a test load of 18 g successively positioned at all points on which a weight might reasonably be placed in the course of normal use of the scale.

N.1.3.2. Equal-Arm Scales. – A shift test shall be conducted with a half-capacity test load centered successively at four points positioned equidistance between the center and the front, left, back, and right edges of each pan as shown in the diagrams below. An equal test load shall be centered on the other pan.



N.1.3.3. Vehicle Scales, Axle-Load Scales, and Livestock Scales.

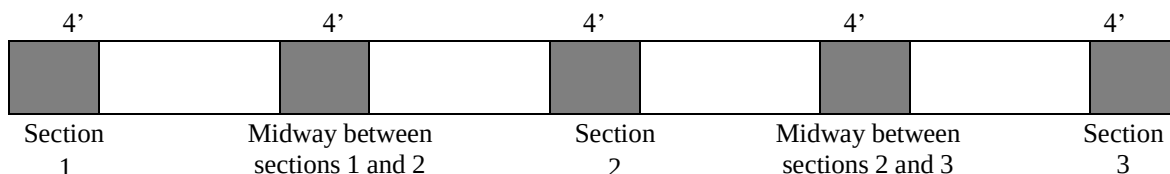
N.1.3.3.1. Vehicle Scales, Axle-Load Scales, and Combination Vehicle/Livestock Scales.

- (a) **Minimum Shift Test.** – At least one shift test shall be conducted with a minimum test load of 12.5 % of scale capacity, which may be performed anywhere on the load-receiving element using the prescribed test patterns and maximum test loads specified below. (Combination Vehicle/Livestock Scales shall also be tested consistent with N.1.3.3.2. Prescribed Test Pattern and Test Loads for Livestock Scales with More Than Two Sections and Combination Vehicle/Livestock Scales.)

(Amended 1991, 2000, and 2003)

- (b) **Prescribed Test Pattern and Loading for Vehicle Scales, Axle-Load Scales, and Combination Vehicle/Livestock Scales.** – The normal prescribed test pattern shall be an area of 1.2 m (4 ft) in length and 3.0 m (10 ft) in width or the width of the scale platform, whichever is less. Multiple test patterns may be utilized when loaded in accordance with paragraph (c), (d), or (e) as applicable. An example of a possible test pattern is shown in the diagram below.

(Amended 1997, 2001, and 2003)



- (c) **Loading Precautions for Vehicle Scales, Axle-Load Scales, and Combination Vehicle/Livestock Scales.** – When loading the scale for testing, one side of the test pattern shall be loaded to no more than half of the concentrated load capacity or test load before loading the other side. The area covered by the test load may be less than 1.2 m (4 ft) × 3.0 m (10 ft) or the width of the scale platform, whichever is less; for test patterns less than 1.2 m (4 ft) in length the maximum loading shall meet the formula: [(wheel base of test cart or length of test load divided by 48 in) × 0.9 × CLC]. The maximum test load applied to each test pattern shall not exceed the concentrated load capacity of the scale. When the test pattern exceeds 1.2 m (4 ft), the maximum test load applied shall not exceed the concentrated load capacity times the largest “r” factor in Table UR.3.2.1. Span Maximum Load for the length of the area covered by the test load. For load-receiving elements installed prior to January 1, 1989, the rated section capacity may be substituted for concentrated load capacity to determine maximum loading. An example of a possible test pattern is shown above.

(Amended 1997 and 2003)

- (d) **Multiple Pattern Loading.** – To test to the nominal capacity, multiple patterns may be simultaneously loaded in a manner consistent with the method of use.

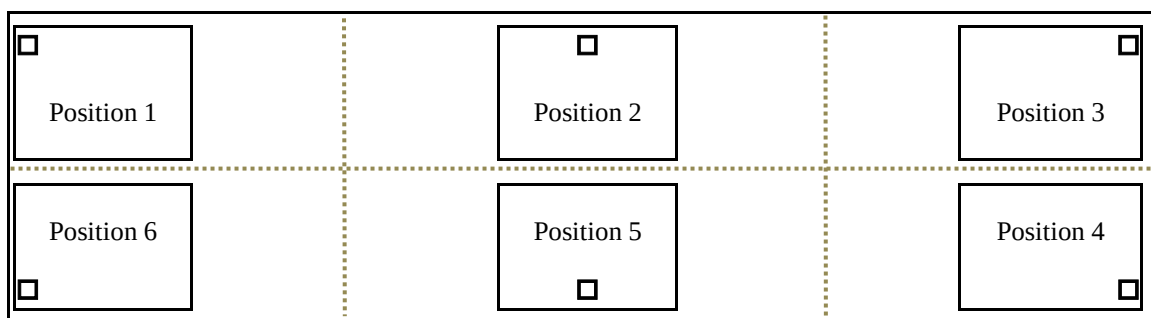
- (e) **Other Designs.** – Special design scales and those that are wider than 3.7 m (12 ft) shall be tested in a manner consistent with the method of use but following the principles described above.

(Amended 1988, 1991, 1997, 2000, 2001, and 2003)

(Amended 2003)

N.1.3.3.2. Prescribed Test Pattern and Test Loads for Livestock Scales with More Than Two Sections and Combination Vehicle/Livestock Scales. – A minimum test load of 5 000 kg (10 000 lb) or one-half of the rated section capacity, whichever is less, shall be placed, as nearly as possible,

successively over each main load support as shown in the diagram below. For livestock scales manufactured between January 1, 1989, and January 1, 2003, the required loading shall be no greater than one-half CLC.



□ = Load Bearing Point

(Added 2003) (Amended 2016)

N.1.3.3.3. Prescribed Test Patterns and Test Loads for Two-Section Livestock Scales. – A shift test shall be conducted using the following prescribed test loads and test patterns: 1) When a single field standard weight is used, the prescribed test load shall be applied centrally in the prescribed test pattern; or 2) When multiple field standard weights are used as the prescribed test load, the load shall be applied in a consistent pattern in the shift test positions throughout the test and applied in a manner that does not concentrate the load in a test pattern that is less than when the same load is a single field standard weights on the load-receiving element.

The shift test load shall not exceed one-half the rated section capacity or one-half the rated concentrated load capacity whichever is applicable, using either:

- (a) A one-half nominal capacity test load centered as nearly as possible, successively at the center of each quarter of the load-receiving element as shown in N.1.3.7. All Other Scales Except Crane Scales, Hanging Scales, Hopper Scales, Wheel-Load Weighers, and Portable Axle-Load Weighers Figure 1; or
- (b) A one-quarter nominal capacity test load centered as nearly as possible, successively over each main load support as shown in N.1.3.7. All Other Scales Except Crane Scales, Hanging Scales, Hopper Scales, Wheel-Load Weighers, and Portable Axle-Load Weighers Figure 2.

(Added 2007) (Amended 2016)

N.1.3.4. Railway Track Scales Weighing Individual Cars in Single Drafts. – A shift test shall be conducted with at least two different test loads, if available, distributed over, to the right and left of, each pair of main levers or other weighing elements supporting each section of the scale.

N.1.3.5. Monorail Scales, Static Test. – A shift test shall be conducted with a test load equal to the largest load that can be anticipated to be weighed in a given installation, but never less than one-half scale capacity. The load shall be placed successively on the right end, the left end, and the center of the live rail.

(Added 1985)

N.1.3.5.1. Dynamic Monorail Weighing Systems. – Dynamic tests with livestock carcasses or portions of carcasses shall be conducted during normal plant production. No less than 20 test loads using carcasses or portions of carcasses of the type normally weighed shall be used in the dynamic test. If the plant conveyor chain does not space or prevent the carcasses or portions of carcasses from touching one another, dynamic tests shall not be conducted until this condition has been corrected.

All carcasses or portions of carcasses shall be individually weighed statically on either the same scale being tested dynamically or another monorail scale with the same or smaller divisions and in close proximity. (The scale selected for static weighing of the carcasses or portions of carcasses shall first be tested statically with certified test weights that have been properly protected from the harsh environment of the packing plant to ensure they maintain accuracy.)

If the scale being tested is used for weighing freshly slaughtered animals (often referred to as a “hot scale”), care must be taken to get a static weightment as quickly as possible before or following the dynamic weightment to avoid loss due to shrink. If multiple dynamic tests are conducted using the same carcasses or portions of carcasses, static weights shall be obtained before and after multiple dynamic tests. If the carcass or portion of a carcass changes weight between static tests, the amount of weight change shall be taken into account, or the carcass or portion of a carcass shall be disregarded for tolerance purposes.

Note: For a dynamic monorail test, the reference scale shall comply with the principles in Appendix A, Fundamental Considerations, paragraph 3.2. Tolerances for Standards.

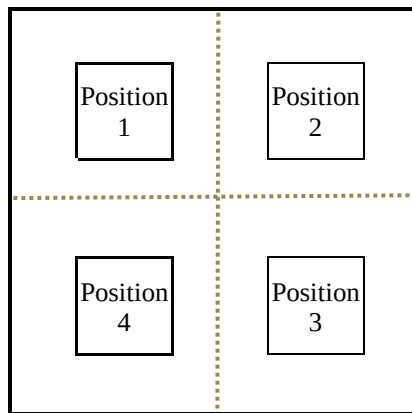
(Added 1996) (Amended 1999 and 2007)

N.1.3.6. Vehicle On-Board Weighing Systems. – The shift test for a vehicle on-board weighing system shall be conducted in a manner consistent with its normal use. For systems that weigh as part of the lifting cycle, the center of gravity of the load may be shifted in the vertical direction as well as from side to side. In other cases, the center of gravity may be moved to the extremes of the load-receiving element using loads of a magnitude that reflect normal use (i.e., the load for the shift test may exceed one-half scale capacity), and may, in some cases, be equal to the capacity of the scale. The shift test may be conducted when the weighing system is out of level to the extent that the weighing system remains operational.

(Added 1992)

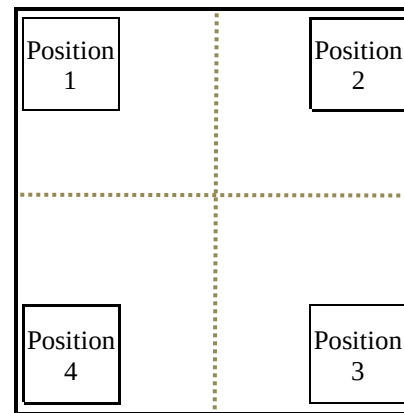
N.1.3.7. All Other Scales Except Crane Scales, Hanging Scales, Hopper Scales, Wheel-Load Weighers, and Portable Axle-Load Weighers. – A shift test shall be conducted using the following prescribed test loads and test patterns. A single field standard weight used as the prescribed test load shall be applied centrally in the prescribed test pattern. When multiple field standard weights are used as the prescribed test load, the load shall be applied in a consistent pattern in the shift test positions throughout the test and applied in a manner that does not concentrate the load in a test pattern that is less than when that same load is a single field standard weight on the load-receiving element.

- (a) For scales with a nominal capacity of 500 kg (1000 lb) or less, a shift test shall be conducted using a one-third nominal capacity test load (defined as test weights in amounts of at least 30 % of scale capacity, but not to exceed 35 % of scale capacity) centered as nearly as possible at the center of each quadrant of the load-receiving element using the prescribed test pattern as shown in Figure 1.
- (b) For scales with a nominal capacity greater than 500 kg (1000 lb), a shift test may be conducted by either using a one-third nominal capacity test load (defined as test weights in amounts of at least 30 % of scale capacity, but not to exceed 35 % of scale capacity) centered as nearly as possible at the center of each quadrant of the load-receiving element using the prescribed test pattern as shown in Figure 1, or by using a one-quarter nominal capacity test load centered as nearly as possible, successively, over each corner of the load-receiving element using the prescribed test pattern as shown in Figure 2.

Figure 1

(Added 2003)

(Amended 1987, 2003, and 2007)

Figure 2

N.1.4. Sensitivity Test. – A sensitivity test shall be conducted on nonautomatic-indicating (weighbeam) scales only, with the weighing device in equilibrium at zero-load and at maximum test load. The test shall be conducted by increasing or decreasing the test load in an amount equal to the applicable value specified in T.2. Sensitivity Requirement (SR) or T.N.6. Sensitivity.

N.1.5. Discrimination Test. – *Except for digital electronic scales designated Accuracy Class I or II in which the value of $e = d$ and is less than 5 mg, a discrimination test shall be conducted on all automatic indicating scales with the weighing device in equilibrium at or near zero load and at or near maximum test load, and under controlled conditions in which environmental factors are reduced to the extent that they will not affect the results obtained. For scales equipped with an Automatic Zero-Tracking Mechanism (AZT), the discrimination test may be conducted at a range outside of the AZT range.*

[Nonretroactive as of January 1, 1986]

(Added 1985) (Amended 2004 and 2021)

N.1.5.1. Digital Device. – On a digital device, this test is conducted from just below the lower edge of the zone of uncertainty for increasing load tests, or from just above the upper edge of the zone of uncertainty for decreasing-load tests.

N.1.6. RFI Susceptibility Tests, Field Evaluation. – An RFI test shall be conducted at a given installation when the presence of RFI has been verified and characterized if those conditions are considered “usual and customary.”

(Added 1986)

N.1.7. Ratio Test. – A ratio test shall be conducted on all scales employing counterpoise weights and on nonautomatic-indicating equal-arm scales.

N.1.8. Material Tests. – A material test shall be conducted on all customer-operated bulk weighing systems for recycled materials using bulk material for which the device is used. Insert into the device, in a normal manner, several accurately pre-weighed samples (free of foreign material) in varying amounts approximating average drafts.

N.1.9. Zero-Load Balance Change. – A zero-load balance change test shall be conducted on all scales after the removal of any test load. The zero-load balance should not change by more than the minimum tolerance applicable. (Also see G-UR.4.2. Abnormal Performance.)

N.1.10. Counting Feature Test. – A test of the counting function shall be conducted on all Class I and Class II prescription scales having an active counting feature used in “legal for trade” applications. The test should verify that the scale will not accept a sample with less than either the minimum sample piece count or the minimum sample weight of 30 e. Counting feature accuracy should be verified at a minimum of two test loads. Verification of the count calculations shall be based upon the weight indication of the test load.

Note:

- (1) The minimum sample weight is equal to the marked minimum individual piece weight times the marked minimum sample piece count.
 - (2) Test load as used in this section refers to actual calibration test weights selected from an appropriate test weight class.
- (Added 2003)

N.1.11. Substitution Test. – In the substitution test procedure, material or objects are substituted for known test weights, or a combination of known test weights and previously quantified material or objects, using the scale under test as a comparator. Additional test weights or other known test loads may be added to the known test load to evaluate higher weight ranges on the scale.

(Added 2003)

N.1.12. Strain-Load Test. – In the strain-load test procedure, an unknown quantity of material or objects are used to establish a reference load or tare to which test weights or substitution test loads are added.

(Added 2003)

N.2. Verification (Testing) Standards. – Field standard weights used in verifying weighing devices shall comply with requirements of NIST Handbook 105-Series standards (or other suitable and designated standards) or the tolerances expressed in Appendix A, Fundamental Considerations, paragraph 3.2. Tolerances for Standards (i.e., one-third of the smallest tolerance applied).

(Amended 1986)

N.3. Minimum Test Weights and Test Loads. – The minimum test weights and test loads for in-service tests (except railway track scales) are shown in Table 4. (Also see Footnote 2 in Table 4. Minimum Test Weights and Test Loads.)

(Added 1984) (Amended 1988)

N.3.1. Minimum Test-Weight Load and Tests for Railway Track Scales.

(Amended 1990 and 2012)

N.3.1.1. Initial and Subsequent Tests. – The test-weight load shall be not less than 35 000 kg (80 000 lb). A strain-load test conducted up to the used capacity of the weighing system is recommended.

(Added 1990) (Amended 2012)

N.3.1.2. Interim Test. – An Interim Test may be used to return a railway track scale into temporary service following repairs that could affect the accuracy of the weighing system providing all of the following conditions are met:

- (a) a test weight load of not less than 13 500 kg (30 000 lb) shall be used;
- (b) a shift (section) test shall be conducted using a test-weight load of not less than 13 500 kg (30 000 lb);
- (c) a strain-load test shall be conducted up to at least 25 % of scale capacity;
- (d) all test results shall be within applicable tolerances; and

- (e) the official with statutory authority shall be immediately notified when scales are repaired and placed in temporary service with an Interim Test. The length of temporary service following repair is at the discretion of the official with statutory authority.

(Added 1990) (Amended 2012)

N.3.1.3. Enforcement Action for Inaccuracy. – To take enforcement action on a scale that is found to be inaccurate, a minimum test load of 13 500 kg (30 000 lb) must be used.

(Added 1990)

Table 4. Minimum Test Weights and Test Loads¹					
Devices in Metric Units			Devices in U.S. Customary Units		
Device Capacity (kg)	Minimums (in terms of device capacity)		Device Capacity (lb)	Minimums (in terms of device capacity)	
	Test Weights (greater of)	Test Loads ²		Test Weights (greater of)	Test Loads ²
0 to 150	100 %		0 to 300	100 %	
151 to 1 500	25 % or 150 kg	75 %	301 to 3 000	25 % or 300 lb	75 %
1 501 to 20 000	12.5 % or 500 kg	50 %	3001 to 40 000	12.5 % or 1 000 lb	50 %
≥ 20 001	12.5 % or 5 000 kg	25 % ³	≥ 40 001	12.5 % or 10 000 lb	25 % ³
Where practicable: <ul style="list-style-type: none"> • Test weights to dial face capacity, 1000 d, or test load to used capacity, if greater than minimums specified. • During initial verification, a scale should be tested to capacity. 					
¹ If the amount of test weight in Table 4. Minimum Test Weights and Test Loads combined with the load on the scale would result in an unsafe condition, then the appropriate load will be determined by the official with statutory authority.					
² The term “test load” means the sum of the combination of field standard test weights and any other applied load used in the conduct of a test using substitution test methods. Not more than three substitutions shall be used during substitution testing, after which the tolerances for strain load tests shall be applied to each set of test loads.					
³ The scale shall be tested from zero to at least 12.5 % of scale capacity using known test weights and then to at least 25 % of scale capacity using either a substitution or strain load test that utilizes known test weights of at least 12.5 % of scale capacity. Whenever practical, a strain load test should be conducted to the used capacity of the scale. When a strain load test is conducted, the tolerances apply only to the test weights or substitution test loads. (Amended 1988, 1989, 1994, and 2003)					
Note: GIPSA requires devices subject to their inspection to be tested to at least “used capacity,” which is calculated based on the platform area of the scale and a weight factor assigned to the species of animal weighed on the scale. “Used capacity” is calculated using the formula:					
Used Scale Capacity = Scale Platform Area × Species Weight Factor					
Where species weight factor = 540 kg/m ² (110 lb/ft ²) for cattle, 340 kg/m ² (70 lb/ft ²) for calves and hogs, and 240 kg/m ² (50 lb/ft ²) for sheep and lambs.					

N.3.2. Field Standard Weight Carts. – Field Standard Weight Carts that comply with the tolerances expressed in Appendix A, Fundamental Considerations, paragraph 3.2. Tolerances for Standards (i.e., one-third of the

smallest tolerance applied) may be included as part of the minimum required test load (Also see Table 4. Minimum Test Weights and Test Loads.) for shift tests and other test procedures.

(Added 2004)

N.4. Coupled-in-Motion Railroad Weighing Systems.²

N.4.1. Weighing Systems Used to Weigh Trains of Less Than Ten Cars. – These weighing systems shall be tested using a consecutive-car test train consisting of the number of cars weighed in the normal operation run over the weighing system a minimum of five times in each mode of operation following the final calibration.

(Added 1990) (Amended 1992)

N.4.2. Weighing Systems Placed in Service Prior to January 1, 1991, and Used to Weigh Trains of Ten or More Cars. – The minimum test train shall be a consecutive-car test train of no less than ten cars run over the scale a minimum of five times in each mode of operation following final calibration.

(Added 1990) (Amended 1992)

N.4.3. Weighing Systems Placed in Service on or After January 1, 1991, and Used to Weigh Trains of Ten or More Cars.

- (a) These weighing systems shall be tested using a consecutive-car test train of no less than ten cars run over the scale a minimum of five times in each mode of operation following final calibration; or
- (b) if the official with statutory authority determines it necessary, the As-Used Test Procedures outlined in N.4.3.1. shall be used.

(Added 1990) (Amended 1992)

N.4.3.1. As-Used Test Procedures. – A weighing system shall be tested in a manner that represents the normal method of operation and length(s) of trains normally weighed. The weighing systems may be tested using either a:

- (a) consecutive-car test train of a length typical of train(s) normally weighed; or
- (b) distributed-car test train of a length typical of train(s) normally weighed.

However, a consecutive-car test train of a shorter length may be used, provided that initial verification test results for the shorter consecutive-car test train agree with the test results for the distributed-car or full-length consecutive-car test train as specified in N.4.3.1.1. Initial Verification.

The official with statutory authority shall be responsible for determining the minimum test train length to be used on subsequent tests.

(Added 1990) (Amended 1992)

N.4.3.1.1. Initial Verification. – Initial verification tests should be performed on any new weighing system and whenever either the track structure or the operating procedure changes. If a consecutive-car test train of length shorter than trains normally weighed is to be used for subsequent verification, the shorter consecutive-car test train results shall be compared either to a distributed-car or to a consecutive-car test train of length(s) typical of train(s) normally weighed.

The difference between the total train weight of the train(s) representing the normal method of operation and the weight of the shorter consecutive-car test train shall not exceed 0.15 %. If the difference in test

² A test weight car that is representative of one of the types of cars typically weighed on the scale under test may be used wherever reference weight cars are specified.

(Added 1991)

results exceeds 0.15 %, the length of the shorter consecutive-car test train shall be increased until agreement within 0.15 % is achieved. Any adjustments to the weighing system based upon the use of a shorter consecutive-car test train shall be offset to correct the bias that was observed between the full-length train test and the shorter consecutive-car test train.

(Added 1990) (Amended 1992 and 1993)

N.4.3.1.2. Subsequent Verification. – The test train may consist of either a consecutive-car test train with a length not less than that used in initial verification, or a distributed-car test train representing the number of cars used in the normal operation.

(Added 1990)

N.4.3.1.3. Distributed-Car Test Trains.

- (a) The length of the train shall be typical of trains that are normally weighed.
- (b) The reference weight cars shall be split into three groups, each group consisting of ten cars or 10 % of the train length, whichever is less.
(Amended 1991)
- (c) The test groups shall be placed near the front, around the middle, and near the end of the train.
- (d) Following the final adjustment, the distributed-car test train shall be run over the scale at least three times or shall produce 50 weight values, whichever is greater.
- (e) The weighing system shall be tested in each mode of operation.

(Added 1990) (Amended 1992)

N.4.3.1.4. Consecutive-Car Test Trains.

- (a) A consecutive-car test train shall consist of at least ten cars.
- (b) If the consecutive-car test train consists of between ten and twenty cars, inclusive, it shall be run over the scale a minimum of five times in each mode of operation following the final calibration.
- (c) If the consecutive-car test train consists of more than twenty cars, it shall be run over the scale a minimum of three times in each mode of operation.

(Added 1990) (Amended 1992)

N.5. Uncoupled-in-Motion Railroad Weighing System. – An uncoupled-in-motion scale shall be tested statically before being tested in motion by passing railroad reference weight cars over the scale. When an uncoupled-in-motion railroad weighing system is tested, the car speed and the direction of travel shall be the same as when the scale is in normal use. The minimum in-motion test shall be three reference weight cars passed over the scale three times. The cars shall be selected to cover the range of weights that are normally weighed on the system and to reflect the types of cars normally weighed.

(Added 1993)

N.6. Nominal Capacity of Prescription Scales. – The nominal capacity of a prescription scale shall be assumed to be one-half apothecary ounce, unless otherwise marked. (Applicable only to scales not marked with an accuracy class.)

N.7. Weigh-in-Motion Vehicle Scales Test Procedures.

N.7.1. Reference Scale. – A static scale as approved by the local jurisdiction shall be used to establish the weight of reference vehicles used in this procedure.

N.7.1.1. Dimension. – The reference scale shall be of such dimension and spacing as to weigh reference vehicles in a single draft.

N.7.1.2. Location. – The reference scale should be located near the weigh-in-motion vehicle scale to minimize the effect of vehicle fuel consumption. The reference scale and the weigh-in-motion vehicle scale may be the same scale.

N.7.1.3. Timing. – The reference scale shall be tested immediately prior to using it to establish reference vehicle weights. A subsequent test of the reference scale may be performed immediately following the establishment of the reference vehicle weights to ensure its repeatability.

N.7.1.4. Qualification. – The reference scale shall comply with the principles in Appendix A, Fundamental Considerations, paragraph 3.2. Tolerances for Standards.

N.7.2. Reference Vehicle. – One or more reference vehicles shall be used to provide varying weight conditions for testing. Reference vehicles should be representative of vehicles that are customarily weighed on the weigh-in-motion vehicle scale during normal operation. A motorized field standard weight cart with tests weights and a driver may be used as an additional reference vehicle.

N.7.2.1. Weight Conditions. – Reference vehicle(s) shall be selected to provide at least a high and a low weight condition. Different types of vehicles may be used.

N.7.2.2. Load Position. – Loads on the reference vehicle should be positioned equally side-to-side.

N.7.2.3. Static Weight. – Reference vehicle(s) shall be statically weighed on a reference scale as defined in N.7.1 Reference Scale immediately before being used to conduct the weigh-in-motion vehicle scale tests.

N.7.2.3.1. Rounding. – Error weights may be added to the reference vehicle to increase its weight to a whole scale division to minimize rounding errors.

N.7.2.3.2. Re-Weighing. – Reference vehicles may be re-weighed at the discretion of the testing authority.

N.7.3. Test Speeds. – The speed of the reference vehicle shall be maintained within the parameters as specified by the manufacturer during each test (see also paragraphs S.1.14.1.(a) Identification of a Fault, Vehicle Speed and S.1.14.1.(b) Identification of a Fault, Change in Vehicle Speed).

N.7.3.1. Range. – Various speeds of the reference vehicle shall be used between the minimum and maximum operating speeds specified for the weigh-in-motion vehicle scale. The minimum speed capability of the reference vehicle may be used as the minimum speed.

N.7.4. Static Tests for Weigh-in-Motion Vehicle Scales. – The weigh-in-motion vehicle scale shall comply with applicable vehicle scale tests defined in N.1. Test Procedures when tested statically.

N.7.5. Dynamic Tests for Weigh-in-Motion Vehicle Scales. – Test procedures shall simulate the normal intended use as closely as possible (i.e., test as used).

N.7.5.1. Vehicles. – The tests shall be performed using the reference vehicle(s) defined in N.7.2. Reference Vehicle.

N.7.5.2. Weighments. – Each reference vehicle shall have a minimum of five weighments at the speeds defined in N.7.3. Test Speeds.

N.7.5.3. Vehicle Position. – Reference vehicle(s) must stay within the defined roadway along the load-receiving element (see also S.1.14.1.(e) Identification of a Fault, Vehicle Path of Travel).

N.7.5.4. Travel Directions. – The tests shall be performed in both directions of travel unless travel direction is restricted by the marking.

N.7.5.5. Results. – At the conclusion of the weigh-in-motion tests, there shall be a minimum of 10 total weight readings for the reference vehicle(s) for each applicable direction of travel. The tolerance for each weight reading shall be based on the gross vehicle weight and the applicable tolerance values for Class III L.

(Added 2021)

T. Tolerances Applicable to Devices not Marked I, II, III, III L, or IIII

T.1. Tolerance Values.

T.1.1. General. – The tolerances applicable to devices not marked with an accuracy class shall have the tolerances applied as specified in Table T.1.1. Tolerances for Unmarked Scales.

Note: When Table T.1.1. refers to T.N. sections it shall be accepted that the scale division d on the unmarked scale always equals the verification scale interval e .

(Amended 1990 and 2024)

T.1.2. Postal and Parcel Post Scales. – The tolerances for postal and parcel post scales are given in Table T.1.1. Tolerances for Unmarked Scales and Table 5. Maintenance and Acceptance Tolerances for Unmarked Postal and Parcel Post Scales.

(Amended 1990)

Table T.1.1.
Tolerances for Unmarked Scales

Type of Device	Subcategory	Minimum Tolerance	Acceptance Tolerance	Maintenance Tolerance	Decreasing-Load Multiplier ¹	Other Applicable Requirements
Vehicle, axle-load, livestock, railway track (weighing statically), crane, and hopper (other than grain hopper)		Class III L, T.N.3.1 (Table 6) and T.N.3.2.			1.0	T.N.2., T.N.3., T.N.4.1., T.N.4.2., T.N.4.3., T.N.4.4., T.N.5., T.N.7.2., <i>T.N.8.1.4.⁴</i> , T.N.9.
Grain test scales	n ≤ 10 000 n > 10 000	Class III, T.N.3.1. (Table 6) and T.N.3.2. Class II, T.N.3.1. (Table 6) and T.N.3.2.			1.0	<i>T.N.8.1.4.⁴</i> , T.N.9.
Railway track scales weighing in motion		T.N.3.6. except that for T.N.3.6.2. (a), no single error shall exceed four times the maintenance tolerance.			1.0	<i>T.N.8.1.4.⁴</i> , T.N.9.
Monorail scales, in-motion		T.N.3.8.			1.0	<i>T.N.8.1.4.⁴</i> , T.N.9.
Customer-operated bulk-weighing systems for recycled materials		± 5 % of applied material test load. Average error on 10 or more test loads ≤ 2.5 %.			1.0	<i>T.N.8.1.4.⁴</i> , T.N.9.
Wheel-load weighers and portable axle-load scales	Tested individually or in pairs ²	0.5 d or 50 lb, whichever is greater	1 % of test load	2 % of test load	1.5 ³	<i>T.N.8.1.4.⁴</i> , T.N.9.
Prescription scales		0.1 grain (6 mg)	0.1 % of test load	0.1 % of test load	1.5	<i>T.N.8.1.4.⁴</i> , T.N.9.
Jewelers' scales	Graduated	0.5 d	0.05 % of test load	0.05 % of test load	1.5	<i>T.N.8.1.4.⁴</i> , T.N.9.
	Ungraduated	Sensitivity or smallest weight, whichever is less				
Dairy-product test scale	Loads < 18 g 18 g load	0.2 grain 0.2 grain	0.2 grain 0.3 grain	0.2 grain 0.5 grain	1.5	<i>T.N.8.1.4.⁴</i> , T.N.9.
Postal and parcel post scales designed/used to weigh loads < 2 lb	Loads < 2 lb	15 grain, 1 g, 1/32 oz, 0.03 oz, or 0.002 lb	15 grain, 1 g, 1/32 oz, 0.03 oz, or 0.002 lb	15 grain, 1 g, 1/32 oz, 0.03 oz, or 0.002 lb	1.5	<i>T.N.8.1.4.⁴</i> , T.N.9.
	Loads ≤ 2 lb	Table 5	Table 5	Table 5		
Other postal and parcel post scales		Table 5	Table 5	Table 5	1.5	<i>T.N.8.1.4.⁴</i> , T.N.9.
All other scales (including grain hopper)	n > 5000	0.5 d or 0.05 % of scale capacity, whichever is less	0.05 % of test load	0.1 % of test load	1.5	T.N.2.5., T.N.4.1., T.N.4.2., T.N.4.3., T.N.5., T.N.7.2., <i>T.N.8.1.4.⁴</i> , T.N.9.
	n ≤ 5000	Class III, T.N.3.1., Table 6 and T.N.3.2.			1.0	T.N.2., T.N.3., T.N.4.1., T.N.4.2., T.N.4.3., T.N.5., T.N.7.2., <i>T.N.8.1.4.⁴</i> , T.N.9.
¹ The decreasing load test applies only to automatic indicating scales.				³ The decreasing load test does not apply to portable wheel load weighers.		
² If marked and tested as a pair, the tolerance shall be applied to the sum of the indication.				⁴ <i>T.N.8.1.4. Operating Temperature. is nonretroactive and effective for unmarked devices manufactured as of January 1, 1981.</i>		

(Table Added 1990) (Amended 1992, 1993, and 2012)

Table 5. Maintenance and Acceptance Tolerances for Unmarked Postal and Parcel Post Scales					
Scale Capacity	Test Loads	Maintenance Tolerance (±)		Acceptance Tolerance (±)	
(lb)	(lb)	(oz)	(lb)	(oz)	(lb)
0 to 4*	0 to 1	1/32	0.002	1/32	0.002
	> 1	1/8	0.008	1/16	0.004
> 4*	0 to 7	3/16	0.012	3/16	0.012
	> 7 to 24	3/8	0.024	3/16	0.012
	> 24 to 30	1/2	0.030	1/4	0.015
	> 30	0.1 % of Test Load		0.05 % of Test Load	
*Also see Table T.1.1. Tolerances for Unmarked Scales for scales designed and/or used to weigh loads less than 2 lb.					

T.2. Sensitivity Requirement (SR).

T.2.1. Application. – The sensitivity requirement (SR) is applicable to all nonautomatic-indicating scales not marked I, II, III, III L, or IIII, and is the same whether acceptance or maintenance tolerances apply.

T.2.2. General. – Except for scales specified in paragraphs T.2.3. Prescription Scales through T.2.8. Railway Track Scales: 2 e, 0.2 % of the scale capacity, or 40 lb, whichever is least.
(Amended 2024)

T.2.3. Prescription Scales. 6 mg (0.1 grain).

T.2.4. Jewelers' Scales.

T.2.4.1. With One-Half Ounce Capacity or Less. – 6 mg (0.1 grain).

T.2.4.2. With More Than One-Half Ounce Capacity. – 1 e or 0.05 % of the scale capacity, whichever is less.
(Amended 2024)

T.2.5. Dairy-Product Test Scales.

T.2.5.1. Used in Determining Butterfat Content. – 32 mg (0.5 grain).

T.2.5.2. Used in Determining Moisture Content. – 19 mg (0.3 grain).

T.2.6. Grain Test Scales. – The sensitivity shall be as stated in T.N.6. Sensitivity.
(Amended 1987)

T.2.7. Vehicle, Axle-Load, Livestock, and Animal Scales.

T.2.7.1. Equipped With Balance Indicators. – 1 e.
(Amended 2024)

T.2.7.2. Not Equipped With Balance Indicators. – 2 e or 0.2 % of the scale capacity, whichever is less.
(Amended 2024)

T.2.8. Railway Track Scales. – 3 e or 100 lb, whichever is less.

(Amended 2024)

T.3. Sensitivity Requirement, Equilibrium Change Required. – The minimum change in equilibrium with test loads equal to the values specified in T.2. Sensitivity Requirements (SR) shall be as follows:

- (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) **Scale with a Single Balance Indicator and Having a Nominal Capacity of Less Than 250 kg (500 lb).** – The position of rest of the indicator shall change 1.0 mm (0.04 in) or one division on the graduated scale, whichever is greater.
- (c) **Scale with a Single Balance Indicator and Having a Nominal Capacity of 250 kg (500 lb) or Greater.** – The position of rest of the indicator shall change 6.4 mm (0.25 in) or 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 3.2 mm (0.125 in) or one division on the graduated scale, whichever is greater.
- (d) **Scale with Two Opposite-Moving Balance Indicators.** – The position of rest of the two indicators moving in opposite directions shall change 1.0 mm (0.04 in) with respect to each other.
- (e) **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.

T.N. Tolerances Applicable to Devices Marked I, II, III, III L, and IIII.

T.N.1. Principles.

T.N.1.1. Design. – The tolerance for a weighing device is a performance requirement independent of the design principle used.

T.N.1.2. Accuracy Classes. – Weighing devices are divided into accuracy classes according to the number of verification scale intervals (n) and the value of the verification scale intervals (e).

(Amended 2024)

T.N.1.3. Verification Scale Interval. – The tolerance for a weighing device is related to the value of the verification scale interval (e) and is expressed in terms of e.

(Amended 2024)

T.N.2. Tolerance Application.

T.N.2.1. General. – The tolerance values are positive (+) and negative (–) with the weighing device adjusted to zero at no load. When tare is in use, the tolerance values are applied from the tare zero reference (zero net weight indication); the tolerance values apply to the net weight indication for any possible tare load using certified test loads.

(Amended 2008)

T.N.2.2. Type Evaluation Examinations. – For type evaluation examinations, the tolerance values apply to increasing and decreasing load tests within the temperature, power supply, and barometric pressure limits specified in T.N.8.

T.N.2.3. Subsequent Verification Examinations. – For subsequent verification examinations, the tolerance values apply regardless of the influence factors in effect at the time of the conduct of the examination. (Also see G-N.2. Testing with Nonassociated Equipment.)

T.N.2.4. Multi-Interval and Multiple Range (Variable Division-Value) Scales. – For multi-interval and multiple range scales, the tolerance values are based on the value of the verification scale interval of the range in use.
(Amended 2025)

T.N.2.5. Ratio Tests. – For ratio tests, the tolerance values are 0.75 of the applicable tolerances.

T.N.3. Tolerance Values.

T.N.3.1. Maintenance Tolerance Values. – The maintenance tolerance values are as specified in Table 6. Maintenance Tolerances.

T.N.3.2. Acceptance Tolerance Values. – The acceptance tolerance values shall be one-half the maintenance tolerance values.

T.N.3.3. Wheel-Load Weighers and Portable Axle-Load Weighers of Class III. – The tolerance values are two times the values specified in T.N.3.1. Maintenance Tolerance Values and T.N.3.2. Acceptance Tolerance Values.
(Amended 1986)

T.N.3.4. Crane and Hopper (Other than Grain Hopper) Scales. – The maintenance and acceptance tolerances shall be as specified in T.N.3.1. Maintenance Tolerance Values and T.N.3.2. Acceptance Tolerance Values for Class III L, except that the tolerance for crane and construction materials hopper scales shall not be less than 1 e or 0.1 % of the scale capacity, whichever is less.
(Amended 1986 and 2024)

Table 6. Maintenance Tolerances (All values in this table are in verification scale intervals (e))				
Tolerance				
	1	2	3	5
Class	Test Load Applied			
I	0 to 50 000	50 001 to 200 000	200 001 +	
II	0 to 5 000	5 001 to 20 000	20 001 +	
III	0 to 500	501 to 2 000	2 001 to 4 000	4 001 +
IIII	0 to 50	51 to 200	201 to 400	401 +
III L	0 to 500	501 to 1 000	Add 1 e for each additional 500 e or fraction thereof (Only applies to Class III L)	

(Amended 2024)

T.N.3.5. Separate Main Elements: Load Transmitting Element, Indicating Element, Etc. – If a main element separate from a complete weighing device is submitted for laboratory type evaluation, the tolerance for the main element is 0.7 that for the complete weighing device. This fraction includes the tolerance attributable to the testing devices used.
(Amended 2015)

T.N.3.6. Coupled-In-Motion Railroad Weighing Systems. – The maintenance and acceptance tolerance values for the group of weight values appropriate to the application must satisfy the following conditions:
(Amended 1990 and 1992)

T.N.3.6.1. – For any group of weight values, the difference in the sum of the individual in-motion car weights of the group as compared to the sum of the individual static weights shall not exceed 0.2 %.

(Amended 1990)

T.N.3.6.2. – If a weighing system is used to weigh trains of five or more cars, and if the individual car weights are used, any single weight value within the group must meet the following criteria:

- (a) no single error may exceed three times the static maintenance tolerance;
- (b) not more than 5 % of the errors may exceed two times the static maintenance tolerance; and
- (c) not more than 35 % of the errors may exceed the static maintenance tolerance.

(Amended 1990 and 1992)

T.N.3.6.3. – For any group of weight values wherein the sole purpose is to determine the sum of the group, T.N.3.6.1. alone applies.

(Amended 1990)

T.N.3.6.4. – For a weighing system used to weigh trains of less than five cars, no single car weight within the group may exceed the static maintenance tolerance.

(Amended 1990 and 1992)

T.N.3.7. Uncoupled-in-Motion Railroad Weighing Systems. – The maintenance and acceptance tolerance values for any single weighment within a group of non-interactive (i.e., uncoupled) loads, the weighment error shall not exceed the static maintenance tolerance.

(Amended 1992)

T.N.3.8. Dynamic Monorail Weighing System. – Acceptance tolerance shall be the same as the maintenance tolerance shown in Table 6. Maintenance Tolerances. On a dynamic test of twenty or more individual test loads, 10 % of the individual test loads may be in error, each not to exceed two times the tolerance. The error on the total of the individual test loads shall not exceed ± 0.2 %. (Also see Note in N.1.3.5.1. Dynamic Monorail Weighing Systems.) *For equipment undergoing type evaluation, a tolerance equal to one-half the maintenance tolerance values shown in Table 6. Maintenance Tolerances shall apply.*

[Nonretroactive January 1, 2002]

(Added 1986) (Amended 1999 and 2001)

T.N.3.9. Materials Test on Customer-Operated Bulk Weighing Systems for Recycled Materials. – The maintenance and acceptance tolerance shall be ± 5 % of the applied materials test load except that the average error on ten or more test materials test loads shall not exceed ± 2.5 %.

(Added 1986)

T.N.3.10. Prescription Scales with a Counting Feature. – In addition to Table 6. Maintenance Tolerances (for weight), the indicated piece count value computed by a Class I or Class II prescription scale counting feature shall comply with the tolerances in Table T.N.3.10. Maintenance and Acceptance Tolerances in Excess and in Deficiency for Count.

Table T.N.3.10. Maintenance and Acceptance Tolerances in Excess and in Deficiency for Count	
Indication of Count	Tolerance (piece count)
0 to 100	0
101 to 200	1
201 or more	0.5 %

(Added 2003)

T.N.3.11. Tolerances for Substitution Test. – Tolerances are applied to the scale based on the substitution test load.

(Added 2003)

T.N.3.12. Tolerances for Strain-Load Test. – Tolerances apply only to the test weights or substitution test loads.

(Added 2003)

T.N.4. Agreement of Indications.

T.N.4.1. Multiple Indicating/Recording Elements. – In the case of a scale or weighing system equipped with more than one indicating element or indicating element and recording element combination, where the indicators or indicator/recorder combination are intended to be used independently of one another, tolerances shall be applied independently to each indicator or indicator/recorder combination.

(Amended 1986)

T.N.4.2. Single Indicating/Recording Element. – In the case of a scale or weighing system with a single indicating element or an indicating/recording element combination, and equipped with component parts such as unit weights, weighbeam and weights, or multiple weighbeams that can be used in combination to indicate a weight, the difference in the weight value indications of any load shall not be greater than the absolute value of the applicable tolerance for that load, and shall be within tolerance limits.

(Amended 1986)

T.N.4.3. Single Indicating Element/Multiple Indications. – In the case of an analog indicating element equipped with two or more indicating means within the same element, the difference in the weight indications for any load other than zero shall not be greater than one-half the value of the verification scale interval (e) and be within tolerance limits.

(Amended 1986 and 2024)

T.N.4.4. Shift or Section Tests. – The range of the results obtained during the conduct of a shift test or a section test shall not exceed the absolute value of the maintenance tolerance applicable and each test result shall be within applicable tolerances.

(Added 1986)

T.N.4.5. Time Dependence. – A time dependence test shall be conducted during type evaluation and may be conducted during field verification, provided test conditions remain constant.

(Amended 1989 and 2005)

T.N.4.5.1. Time Dependence: Class II, III, and IIII Non-Automatic Weighing Instruments. – A non-automatic weighing instrument of Classes II, III, and IIII shall meet the following requirements at constant test conditions. During type evaluation, this test shall be conducted at $20\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ ($68\text{ }^{\circ}\text{F} \pm 4\text{ }^{\circ}\text{F}$):

- (a) When any load is kept on an instrument, the difference between the indication obtained immediately after placing the load and the indication observed during the following 30 minutes shall not exceed 0.5 e.

However, the difference between the indication obtained at 15 minutes and the indication obtained at 30 minutes shall not exceed 0.2 e.

- (b) If the conditions in (a) are not met, the difference between the indication obtained immediately after placing the load on the instrument and the indication observed during the following four hours shall not exceed the absolute value of the maximum permissible error at the load applied.

(Added 2005) (Amended 2006 and 2010)

T.N.4.5.2. Time Dependence: Class III L Non-Automatic Weighing Instruments. – A non-automatic weighing instrument of Class III L shall meet the following requirements:

- (a) When any load is kept on an instrument, the difference between the indication obtained immediately after placing the load and the indication observed during the following 30 minutes shall not exceed 1.5 e. However, the difference between the indication obtained at 15 minutes and the indication obtained at 30 minutes shall not exceed 0.6 e.
- (b) If the conditions in (a) are not met, the difference between the indication obtained immediately after placing the load on the instrument and the indication observed during the following four hours shall not exceed the absolute value of the maximum permissible error at the load applied.

(Added 2005) (Amended 2010)

T.N.4.5.3. Zero Load Return: Non-automatic Weighing Instruments. – A non-automatic weighing instrument shall meet the following requirements at constant test conditions. During type evaluation, this test shall be conducted at $20\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ ($68\text{ }^{\circ}\text{F} \pm 4\text{ }^{\circ}\text{F}$). The deviation on returning to zero as soon as the indication has stabilized, after the removal of any load which has remained on the instrument for 30 minutes shall not exceed:

- (a) 0.5 e for Class II and III devices,
- (b) 0.5 e for Class III devices with 4 000 or fewer divisions,
- (c) 0.83 e for Class III devices with more than 4 000 divisions, or
- (d) one-half of the absolute value of the applicable tolerance for the applied load for Class III L devices.

For a multi-interval instrument, the deviation shall not exceed $0.83\text{ }e_1$ (where e_1 is the interval of the first weighing segment of the scale).

On a multiple range instrument, the deviation on returning to zero from Max_i (load in the applicable weighing range) shall not exceed $0.83\text{ }e_i$ (interval of the weighing range). Furthermore, after returning to zero from any load greater than Max_i (capacity of the first weighing range) and immediately after switching to the lowest weighing range, the indication near zero shall not vary by more than e_1 (interval of the first weighing range) during the following five minutes.

(Added 2010)

T.N.4.6. Time Dependence (Creep) for Load Cells during Type Evaluation. – A load cell (force transducer) marked with an accuracy class shall meet the following requirements at constant test conditions:

- (a) **Permissible Variations of Readings.** – With a constant maximum load for the measuring range (D_{max}) between 90 % and 100 % of maximum capacity (E_{max}), applied to the load cell, the difference between the initial reading and any reading obtained during the next 30 minutes shall not exceed the absolute value of the maximum permissible error (mpe) for the applied load. (Also see Table T.N.4.6. Maximum Permissible Error (mpe) for Load Cells During Type Evaluation.) The difference between the reading obtained at 20 minutes and the reading obtained at 30 minutes shall not exceed 0.15 times the absolute value of the mpe. (Also see Table T.N.4.6. Maximum Permissible Error (mpe) for Load Cells During Type Evaluation)

- (b) Apportionment Factors.** – The mpe for creep shall be determined from Table T.N.4.6. Maximum Permissible Error (mpe) for Load Cells During Type Evaluation using the following apportionment factors (p_{LC}):

$p_{LC} = 0.7$ for load cells marked with S (single load cell applications),

$p_{LC} = 1.0$ for load cells marked with M (multiple load cell applications), and

$p_{LC} = 0.5$ for Class III L load cells marked with S or M.

(Added 2005) (Amended 2006)

Table T.N.4.6. Maximum Permissible Error (mpe)* for Load Cells During Type Evaluation				
mpe in Load Cell Verifications Divisions (v) = $p_{LC} \times \text{Basic Tolerance in v}$				
Class	$p_{LC} \times 0.5 \text{ v}$	$p_{LC} \times 1.0 \text{ v}$		$p_{LC} \times 1.5 \text{ v}$
I	0 v to 50 000 v	50 001 v to	200 000 v	200 001 v +
II	0 v to 5 000 v	5 001 v to	20 000 v	20 001 v +
III	0 v to 500 v	501 v to	2 000 v	2 001 v +
III L	0 v to 50 v	51 v to	200 v	201 v +
III L	0 v to 500 v	501 v to	1 000 v	(Add 0.5 v to the basic tolerance for each additional 500 v or fraction thereof up to a maximum load of 10 000 v)
v represents the load cell verification interval p_{LC} represents the apportionment factors applied to the basic tolerance $p_{LC} = 0.7$ for load cells marked with S (single load cell applications) $p_{LC} = 1.0$ for load cells marked with M (multiple load cell applications) $p_{LC} = 0.5$ for Class III L load cells marked with S or M *mpe = $p_{LC} \times \text{Basic Tolerance in load cell verifications divisions (v)}$				

(Table Added 2005) (Amended 2006)

T.N.4.7. Creep Recovery for Load Cells During Type Evaluation. – The difference between the initial reading of the minimum load of the measuring range (D_{min}) and the reading after returning to minimum load subsequent to the maximum load (D_{max}) having been applied for 30 minutes shall not exceed:

- 0.5 times the value of the load cell verification interval (0.5 v) for Class II and III L load cells;
- 0.5 times the value of the load cell verification interval (0.5 v) for Class III load cells with 4 000 or fewer divisions;
- 0.83 times the value of the load cell verification interval (0.83 v) for Class III load cells with more than 4 000 divisions; or
- 2.5 times the value of the load cell verification interval (2.5 v) for Class III L load cells.

(Added 2006) (Amended 2009 and 2011)

T.N.5. Repeatability. – The results obtained from several weighings of the same load under reasonably static test conditions shall agree within the absolute value of the maintenance tolerance for that load, and shall be within applicable tolerances.

T.N.6. Sensitivity. – This section is applicable to all nonautomatic-indicating scales marked I, II, III, III L, or IIII.

T.N.6.1. Test Load.

- (a) The test load for sensitivity for nonautomatic-indicating vehicle, axle-load, livestock, and animal scales shall be 1 e for scales equipped with balance indicator, and 2 e or 0.2 % of the scale capacity, whichever is less, for scales not equipped with balance indicators.
 - (b) For all other nonautomatic-indicating scales, the test load for sensitivity shall be 1 e at zero and 2 e at maximum test load.
- (Amended 2024)

T.N.6.2. Minimum Change of Indications. – The addition or removal of the test load for sensitivity shall cause a minimum permanent change as follows:

- (a) for a scale with trig loop but without a balance indicator, the position of the weighbeam shall change from the center to the outer limit of the trig loop;
- (b) for a scale with balance indicator, the position of the indicator shall change one division on the graduated scale, the width of the central target area, or the applicable value as shown below, whichever is greater:

Scale of Class I or II: 1 mm (0.04 in),

Scale of Class III or IIII with a maximum capacity of 30 kg (70 lb) or less: 2 mm (0.08 in),

Scale of Class III, III L, or IIII with a maximum capacity of more than 30 kg (70 lb): 5 mm (0.20 in);

- (c) for a scale without a trig loop or 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.

(Amended 1987)

T.N.7. Discrimination.

T.N.7.1. Analog Automatic Indicating (i.e., Weighing Device with Dial, Drum, Fan, etc.). – A test load equivalent to 1.4 d shall cause a change in the indication of at least 1.0 d. (Also see N.1.5. Discrimination Test.)

T.N.7.2. Digital Automatic Indicating. – A test load equivalent to 1.4 d shall cause a change in the indicated or recorded value of at least 2.0 d. This requires the zone of uncertainty to be not greater than three-tenths of the value of the scale division. (Also see N.1.5.1. Digital Device.)

T.N.8. Influence Factors. – The following factors are applicable to tests conducted under controlled conditions only, provided that:

- (a) types of devices approved prior to January 1, 1986, and manufactured prior to January 1, 1988, need not meet the requirements of this section;
- (b) new types of devices submitted for approval after January 1, 1986, shall comply with the requirements of this section; and
- (c) all devices manufactured after January 1, 1988, shall comply with the requirements of this section.

(Amended 1985)

T.N.8.1. Temperature. – Devices shall satisfy the tolerance requirements under the following temperature conditions:

T.N.8.1.1. If not specified in the operating instructions for Class I or II scales, or if not marked on the device for Class III, III L, or IIII scales, the temperature limits shall be: – 10 °C to 40 °C (14 °F to 104 °F).

T.N.8.1.2. If temperature limits are specified for the device, the range shall be at least that specified in Table T.N.8.1.2. Temperature Range by Class.

Table T.N.8.1.2. Temperature Range by Class	
Class	Temperature Range
I	5 °C (9 °F)
II	15 °C (27 °F)
III, III L, and IIII	30 °C (54 °F)

T.N.8.1.3. Temperature Effect on Zero-Load Balance. – The zero-load indication shall not vary by more than:

- (a) three e per 5 °C (9 °F) change in temperature for Class III L devices; or
 - (b) one e per 5 °C (9 °F) change in temperature for all other devices.
- (Amended 1990 and 2024)

T.N.8.1.4. Operating Temperature. – Except for Class I and II devices, an indicating or recording element shall not display nor record any usable values until the operating temperature necessary for accurate weighing and a stable zero balance condition have been attained.

T.N.8.2. Barometric Pressure. – Except for Class I scales, the zero indication shall not vary by more than one scale division for a change in barometric pressure of 1 kPa over the total barometric pressure range of 95 kPa to 105 kPa (28 in to 31 in of Hg).

T.N.8.3. Electric Power Supply.

T.N.8.3.1. Power Supply, Voltage and Frequency.

- (a) Weighing devices that operate using alternating current must perform within the conditions defined in paragraphs T.N.3. Tolerance Values through T.N.7. Discrimination, inclusive, when tested over the range of – 15 % to + 10 % of the marked nominal line voltage(s) at 60 Hz, or the voltage range marked by the manufacturer, at 60 Hz.
- (Amended 2003)
- (b) Battery operated instruments shall not indicate nor record values outside the applicable tolerance limits when battery power output is excessive or deficient.

T.N.8.3.2. Power Interruption. – A power interruption shall not cause an indicating or recording element to display or record any values outside the applicable tolerance limits.

T.N.9. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility. – The difference between the weight indication due to the disturbance and the weight indication without the disturbance shall not exceed one e; or the equipment shall:

- (a) blank the indication; or

- (b) provide an error message; or
- (c) the indication shall be so completely unstable that it cannot be interpreted, or transmitted into memory or to a recording element, as a correct measurement value.

The tolerance in T.N.9. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility is to be applied independently of other tolerances. For example, if indications are at allowable basic tolerance error limits when the disturbance occurs, then it is acceptable for the indication to exceed the applicable basic tolerances during the disturbance.

(Amended 1997 and 2024)

UR. User Requirements

UR.1. Selection Requirements. – 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 capacity, number of scale divisions, value of the scale division or verification scale division, minimum capacity, and computing capability.³

UR.1.1. General.

- (a) For devices marked with a class designation, the typical class or type of device for particular weighing applications is shown in Table 7a. Typical Class or Type of Device for Weighing Applications.
- (b) For devices not marked with a class designation, Table 7b. Applicable to Devices not Marked with a Class Designation applies.

Table 7a. Typical Class or Type of Device for Weighing Applications	
Class	Weighing Application or Scale Type
I	Precision laboratory weighing
II	Laboratory weighing, precious metals and gem weighing, grain test scales
III	All commercial weighing not otherwise specified, grain test scales, retail precious metals and semi-precious gem weighing, grain-hopper scales, animal scales, postal scales, vehicle on-board weighing systems with a capacity less than or equal to 30 000 lb, and scales used to determine laundry charges
III L	Vehicle scales (including weigh-in-motion vehicle scales), vehicle on-board weighing systems with a capacity greater than 30 000 lb, axle-load scales, livestock scales, railway track scales, crane scales, and hopper (other than grain hopper) scales
IIII	Wheel-load weighers and portable axle-load weighers used for highway weight enforcement
Note: A scale with a higher accuracy class than that specified as “typical” may be used.	

(Amended 1985, 1986, 1987, 1988, 1992, 1995, 2012, and 2021)

³ Purchasers and users of scales such as railway track, hopper, and vehicle scales should be aware of possible additional requirements for the design and installation of such devices.

(Footnote Added 1995)

Table 7b. Applicable to Devices Not Marked with a Class Designation	
Scale Type or Design	Maximum Value of d
Retail Food Scales, 50 lb capacity and less	1 oz
Animal Scales	1 lb
Grain Hopper Scales Capacity up to and including 50 000 lb Capacity over 50 000 lb	10 lb (not greater than 0.05 % of capacity) 20 lb
Crane Scales	not greater than 0.2 % of capacity
Vehicle and Axle-Load Scales Used in Combination Capacity up to and including 200 000 lb Capacity over 200 000 lb	20 lb 50 lb
Railway Track Scales With weighbeam Automatic indicating	20 lb 100 lb
Scales with capacities greater than 500 lb except otherwise specified	0.1 % capacity (but not greater than 50 lb)
Wheel-Load Weighers	0.25 % capacity (but not greater than 50 lb)
Note: For scales not specified in this table, G-UR.1.1. Suitability of Equipment and UR.1. Selection Requirements apply.	

(Added 1985) (Amended 1989)

UR.1.2. Grain Hopper Scales. – Hopper scales manufactured as of January 1, 1986, that are used to weigh grain shall be Class III and have a minimum of 2 000 scale divisions.

(Amended 2012)

UR.1.3. Value of the Indicated and Recorded Scale Division. – *The value of the scale division as recorded shall be the same as the division value indicated.*

[Nonretroactive as of January 1, 1986]

(Added 1985) (Amended 1999)

UR.1.3.1. Exceptions. – The provisions of UR.1.3. Value of the Indicated and Recorded Scale Division shall not apply to:

(a) Class I scales, or

(b) Dynamic monorail weighing systems when the value of d is less than the value of e.

(Added 1999)

UR.1.4. Grain-Test Scales: Value of the Scale Divisions. – The scale division for grain-test scales shall not exceed 0.2 g for loads through 500 g, and shall not exceed 1 g for loads above 500 g through 1 000 g.

(Added 1992)

UR.1.5. Recording Element, Class III L Railway Track Scales. – *Class III L Railway Track Scales must be equipped with a recording element.*

[Nonretroactive as of January 1, 1996]

(Added 1995)

UR.2. Installation Requirements.

UR.2.1. Supports. – A scale that is portable and that is being used on a counter, table, or 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 From Environmental Factors. – The indicating elements, the lever system or load cells, and the load-receiving element of a permanently installed scale, and the indicating elements of a scale not intended to be permanently installed, shall be adequately protected from environmental factors such as wind, weather, and RFI that may adversely affect the operation or performance of the device.

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, nor throughout the weighing range of the scale. An in-motion railway track scale is not required to provide clearance using rail gaps to separate the live rail portion of the weighing/load-receiving element from that which is not live if the scale is designed to be installed and operated using continuous rail. *On vehicle and livestock scales, the clearance between the load-receiving elements and the coping at the bottom edge of the platform shall be greater than at the top edge of the platform.**

*[*Nonretroactive as of January 1, 1973]*

(Amended 2014)

UR.2.5. Access to Weighing Elements. – Adequate provision shall be made for ready access to the pit of a vehicle, livestock, animal, axle-load, or railway track scale for the purpose of inspection and maintenance. Any of these scales without a pit shall be installed with adequate means for inspection and maintenance of the weighing elements.

(Amended 1985)

UR.2.6. Approaches.

UR.2.6.1. Vehicle Scales. – *On the entrance and exit end(s) of a vehicle scale there shall be a straight approach as follows:*

- (a) *the width at least the width of the platform,*
- (b) *the length at least one-half the length of the platform but not required to be more than 12 m (40 ft), and*
- (c) *not less than 3 m (10 ft) of any approach adjacent to the platform shall be in the same plane as the platform. Any slope in the remaining portion of the approach shall ensure (1) ease of vehicle access, (2) ease for testing purposes, and (3) drainage away from the scale.*

In addition to (a), (b), and (c), scales installed in any one location for a period of six months or more shall have not less than 3 m (10 ft) of any approach adjacent to the platform constructed of concrete or similar durable material to ensure that this portion remains smooth and level and in the same plane as the platform; however, grating of sufficient strength to withstand all loads equal to the concentrated load capacity of the scale may be installed in this portion.

[Nonretroactive as of January 1, 1976]

(Amended 1977, 1983, 1993, 2006, and 2010)

UR.2.6.2. Axle-Load Scales. – At each end of an axle-load scale there shall be a straight paved approach in the same plane as the platform. The approaches shall be the same width as the platform and of sufficient length 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.2.8. Hoists. – On vehicle scales equipped with means for raising the load-receiving element from the weighing element for vehicle unloading, means shall be provided so that it is readily apparent to the scale operator when the load-receiving element is in its designed weighing position.

UR.2.9. Provision for Testing Dynamic Monorail Weighing Systems. – Provisions shall be made at the time of installation of a dynamic monorail weighing systems for testing in accordance with N.1.3.5.1. *Dynamic Monorail Weighing Systems (a rail around or other means for returning the test carcasses to the scale being tested).*

[Nonretroactive as of January 1, 1998]

(Added 1997) (Amended 1999)

UR.2.10. Primary Indicating Elements Provided by the User. – Video display terminals and other user-provided indicating elements on scales interfaced with a cash register in a point-of-sale (POS) system shall comply with the minimum height requirements specified in part (d) of paragraph S.1.1.1. *Digital Indicating Elements.*

[Nonretroactive as of January 1, 2021]

(Added 2019)

UR.3. Use Requirements.

UR.3.1. Recommended Minimum Load. – A recommended minimum load is specified in Table 8. Recommended Minimum Load since the use of a device to weigh light loads is likely to result in relatively large errors.

Table 8. Recommended Minimum Load		
Class	Value of Scale Division (d or e*)	Recommended Minimum Load (d or e*)
I	equal to or greater than 0.001 g	100
II	0.001 g to 0.05 g, inclusive	20
	equal to or greater than 0.1 g	50
III	All	20**
III L	All	50
IIII	All	10
<p>*For Class I and II devices equipped with auxiliary reading means (i.e., a rider, a vernier, or a least significant decimal differentiated by size, shape or color), the value of the verification scale division “e” is the value of the scale division immediately preceding the auxiliary means. For Class III and IIII devices the value of “e” is specified by the manufacturer as marked on the device; “e” must be less than or equal to “d.” (Added 1999)</p> <p>**A minimum load of 10 d is recommended for a weight classifier marked in accordance with a statement identifying its use for special applications. (Added 1990)</p>		

(Amended 1990)

UR.3.1.1. Minimum Load, Grain Dockage Determination. – When determining the quantity of foreign material (dockage) in grain, the weight of the sample shall be equal to or greater than 500 scale divisions.

(Added 1985)

UR.3.2. Maximum Load. – A scale shall not be used to weigh a load of more than the nominal capacity of the scale.

UR.3.2.1. Maximum Loading for Vehicle Scales. – A vehicle scale shall not be used to weigh loads exceeding the maximum load capacity of its span as specified in Table UR.3.2.1. Span Maximum Load.

(Added 1996)

Table UR.3.2.1. Span Maximum Load								
Distance in Feet Between the Extremes of any Two or More Consecutive Axles	Ratio of CLC to Maximum Load (“r” factor) Carried on Any Group of Two or More Consecutive Axles.							
	2 axles	3 axles	4 axles	5 axles	6 axles	7 axles	8 axles	9 axles
4 ¹	1.000		INSTRUCTIONS: 1. Determine the scale’s CLC. 2. Count the number of axles on the vehicle in a given span and determine the distance in feet between the first and last axle in the span. 3. Multiply the CLC by the corresponding multiplier in the table.* 4. The resulting number is the scale’s maximum concentrated load for a single span based on the vehicle configuration. * note and formula found at the end of the table.					
5 ¹	1.000							
6 ¹	1.000							
7 ¹	1.000							
8 and less ¹	1.000	1.000						
More than 8 ¹	1.118	1.235						
9	1.147	1.257						
10	1.176	1.279						
11	1.206	1.301						
12	1.235	1.324	1.471	1.632				
13	1.265	1.346	1.490	1.651				
14	1.294	1.368	1.510	1.669				
15	1.324	1.390	1.529	1.688	1.853			
16	1.353	1.412	1.549	1.706	1.871			
17	1.382	1.434	1.569	1.724	1.888			
18	1.412	1.456	1.588	1.743	1.906			
19	1.441	1.478	1.608	1.761	1.924			
20	1.471	1.500	1.627	1.779	1.941			
21	1.500	1.522	1.647	1.798	1.959			
22	1.529	1.544	1.667	1.816	1.976			
23	1.559	1.566	1.686	1.835	1.994			
24	1.588	1.588	1.706	1.853	2.012	2.176		

Table UR.3.2.1. Span Maximum Load								
Distance in Feet Between the Extremes of any Two or More Consecutive Axles	Ratio of CLC to Maximum Load (“r” factor) Carried on Any Group of Two or More Consecutive Axles.							
	2 axles	3 axles	4 axles	5 axles	6 axles	7 axles	8 axles	9 axles
25	1.618	1.610	1.725	1.871	2.029	2.194		
26		1.632	1.745	1.890	2.047	2.211		
27		1.654	1.765	1.908	2.065	2.228		
28		1.676	1.784	1.926	2.082	2.245	2.412	
29		1.699	1.804	1.945	2.100	2.262	2.429	
30		1.721	1.824	1.963	2.118	2.279	2.445	
31		1.743	1.843	1.982	2.135	2.297	2.462	
32		1.765	1.863	2.000	2.153	2.314	2.479	2.647
33			1.882	2.018	2.171	2.331	2.496	2.664
34			1.902	2.037	2.188	2.348	2.513	2.680
35			1.922	2.055	2.206	2.365	2.529	2.697
36			2.000 ²	2.074	2.224	2.382	2.546	2.713
37			2.000 ²	2.092	2.241	2.400	2.563	2.730
38			2.000 ²	2.110	2.259	2.417	2.580	2.746
39			2.000	2.129	2.276	2.434	2.597	2.763
40			2.020	2.147	2.294	2.451	2.613	2.779
41			2.039	2.165	2.312	2.468	2.630	2.796
42			2.059	2.184	2.329	2.485	2.647	2.813
43			2.078	2.202	2.347	2.502	2.664	2.829
44			2.098	2.221	2.365	2.520	2.681	2.846
45			2.118	2.239	2.382	2.537	2.697	2.862
46			2.137	2.257	2.400	2.554	2.714	2.879
47			2.157	2.276	2.418	2.571	2.731	2.895
48			2.176	2.294	2.435	2.588	2.748	2.912
49			2.196	2.313	2.453	2.605	2.765	2.928
50			2.216	2.331	2.471	2.623	2.782	2.945
51			2.235	2.349	2.488	2.640	2.798	2.961
52			2.255	2.368	2.506	2.657	2.815	2.978
53			2.275	2.386	2.524	2.674	2.832	2.994

Table UR.3.2.1. Span Maximum Load								
Distance in Feet Between the Extremes of any Two or More Consecutive Axles	Ratio of CLC to Maximum Load (“r” factor) Carried on Any Group of Two or More Consecutive Axles.							
	2 axles	3 axles	4 axles	5 axles	6 axles	7 axles	8 axles	9 axles
54			2.294	2.404	2.541	2.691	2.849	3.011
55			2.314	2.423	2.559	2.708	2.866	3.028
56			2.333	2.441	2.576	2.725	2.882	3.044
57			2.353 ³	2.460	2.594	2.742	2.899	3.061
58				2.478	2.612	2.760	2.916	3.077
59				2.496	2.629	2.777	2.933	3.094
60				2.515	2.647	2.794	2.950	3.110
<p>*Note: This table was developed based upon the following formula. Values may be rounded in some cases for ease of use.</p> $W = r \times 500 \left[\left(\frac{LN}{N-1} \right) + 12N + 36 \right]$ <p>¹ Tandem Axle Weight.</p> <p>² Exception – These values in the third column correspond to the maximum loads in which the inner bridge dimensions of 36 ft, 37 ft, and 38 ft are considered to be equivalent to 39 ft. This allows a weight of 68 000 lb on axles 2 through 5.</p> <p>³ Corresponds to the Interstate Gross Weight Limit.</p>								

UR.3.3. Single-Draft Vehicle Weighing. – A vehicle or a coupled-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, the weight of:

- (a) 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; or
- (b) 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.

This paragraph does not apply to highway-law-enforcement scales, scales used for the collection of statistical data, or scales used to charge a fee for the service of providing weights of the different axle loads, axle-group loads, and total weight of vehicles and coupled-vehicle combinations when the only use of those values is to determine compliance with established highway weight requirements and safe distribution of the load.

(Added 1992) (Amended 2024)

UR.3.4. Weighing of Axle Loads and Axle-Group Loads. – Establishing weight values for the different individual axle loads and axle-group loads of a vehicle or coupled-vehicle combination is oftentimes necessary to verify compliance with established highway weight requirements and safe distribution of the load. When a fee is charged for this service, the scale’s application is considered “commercial” under the provisions of paragraph G-A.1.

Commercial and Law Enforcement Equipment and the scale shall comply with all applicable NIST Handbook 44 requirements for commercial weighing systems.

When weight values for axle loads and/or axle-group loads are obtained using multiple-independent platform vehicle scale systems in which all parts of the vehicle or coupled-vehicle combination being weighed are simultaneously positioned on live elements of the scale, the values for the different axle loads and axle-group loads may be summed to establish the legal gross vehicle weight.

In no case, however, shall a summed result of the different axle loads and axle-group loads of a vehicle or coupled vehicle combination weighed in multiple drafts be used as the legal gross vehicle weight unless subpart (a) or (b) of paragraph UR.3.3. Single-Draft Vehicle Weighing is met. (Also see paragraph S.1.15. Recorded Representations, Multi-Independent Platform Vehicle Scale Systems.)

(Added 2024)

UR.3.5. Wheel-Load Weighing.

UR.3.5.1. Use in Pairs. – When wheel-load weighers or portable axle-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.3.5.2. Level Condition. – A vehicle of which either an axle-load determination or a gross-load determination is being made utilizing wheel-load weighers or portable axle-load weighers, shall be in a reasonably level position at the time of such determination.

UR.3.6. Special Designs. – A scale designed and marked for a special application (such as a prepackaging scale or prescription scale with a counting feature) shall not be used for other than its intended purpose.⁴

(Amended 2003)

UR.3.7. Wet Commodities. – Wet commodities not in watertight containers shall be weighed only on a scale having a pan or platform that will drain properly.

(Amended 1988)

UR.3.8. Minimum Load on a Vehicle Scale. – A vehicle scale shall not be used to weigh net loads smaller than:

- (a) 10 d when weighing scrap material for recycling or weighing refuse materials at landfills and transfer stations; and
- (b) 50 d for all other weighing.

As used in this paragraph, scrap materials for recycling shall be limited to ferrous metals, paper (including cardboard), textiles, plastic, and glass.

(Amended 1988, 1992, and 2006)

UR.3.9. Minimum Load for Weighing Livestock. – A scale with scale divisions greater than 2 kg (5 lb) shall not be used for weighing net loads smaller than 500 d.

(Amended 1989)

⁴ Prepackaging scales and prescription scales with a counting feature (and other commercial devices) used for putting up packages in advance of sale are acceptable for use in commerce only if all appropriate provisions of NIST Handbook 44 are met. Users of such devices must be alert to the legal requirements relating to the declaration of quantity on a package. Such requirements are to the effect that, on the average, the contents of the individual packages of a particular commodity comprising a lot, shipment, or delivery must contain at least the quantity declared on the label. The fact that a prepackaging scale may overregister, but within established tolerances, and is approved for commercial service is not a legal justification for packages to contain, on the average, less than the labeled quantity.

(Amended 2003)

UR.3.10. Use of Manual Weight Entries. – Manual gross or net weight entries are permitted for use in the following applications only when:

- (a) a point-of-sale system interfaced with a scale is giving credit for a weighed item;
- (b) an item is pre-weighed on a legal for trade scale and marked with the correct net weight;
- (c) a device or system is generating labels for standard weight packages;
- (d) postal scales or weight classifiers are generating manifests for packages to be picked up at a later time; or
- (e) livestock and vehicle scale systems generate weight tickets to correct erroneous tickets.

(Added 1992) (Amended 2000 and 2004)

UR.3.11. Dynamic Monorail Weighing Systems. – When the value of d is different from the value of e, the commercial transaction must be based on e.

(Added 1999)

UR.3.12. Minimum Count. – A prescription scale with an operational counting feature shall not be used to count a quantity of less than 30 pieces weighing a minimum of 90 e.

(Added 2003)

Note: The minimum count as defined in this paragraph refers to the use of the device in the filling of prescriptions and is different from the minimum sample piece count as defined in S.1.2.3. Prescription Scale with a Counting Feature and as required to be marked on the scale by S.6.6. Counting Feature, Minimum Individual Piece Weight, and Minimum Sample Piece Count.

(Note Added 2004)

UR.3.13. Correct Stored Piece Weight. – For prescription scales with a counting feature, the user is responsible for maintaining the correct stored piece weight. This is especially critical when a medicine has been reformulated or comes from different lots.

(Added 2003)

UR.3.14. Fault Indications for Weigh-in-Motion Vehicle Scales. – The fault conditions defined in S.1.14.1. Identification of a Fault shall be presented to the customer and the operator in a clear and conspicuous manner.

(Added 2021)

UR.4. Maintenance Requirements.

UR.4.1. Balance Condition. – The zero-load adjustment of a scale shall be maintained so that, with no load on the load-receiving element and with all load-counterbalancing elements of the scale (such as poises, drop weights, or counterbalance weights) set to zero, the scale shall indicate or record a zero balance condition. A scale not equipped to indicate or record a zero-load balance shall be maintained in balance under any no-load condition.

UR.4.2. Level Condition. – If a scale is equipped with a level-condition indicator, the scale shall be maintained in level.

UR.4.3. Scale Modification. – The dimensions (e.g., length, width, thickness, etc.) of the load receiving element of a scale shall not be changed beyond the manufacturer's specifications, nor shall the capacity of a scale be increased beyond its design capacity by replacing or modifying the original primary indicating or recording element with one of a higher capacity, except when the modification has been approved by a competent 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.

(Amended 1996)

UR.5. Coupled-in-Motion Railroad Weighing Systems.

- (a) A coupled-in-motion weighing system placed in service on or after January 1, 1991, should be tested in the manner in which it is operated, with the locomotive either pushing or pulling the cars at the designed speed and in the proper direction. The cars used in the test train should represent the range of gross weights that will be used during the normal operation of the weighing system. Except as provided in N.4.2. Weighing Systems Placed in Service Prior to January 1, 1991, and Used to Weigh Trains of Ten or More Cars and N.4.3.(a) Weighing Systems Placed in Service on or After January 1, 1991, and Used to Weigh Trains of Ten or More Cars, normal operating procedures should be simulated as nearly as practical. Approach conditions for a train length in each direction of the scale site are more critical for a weighing system used for individual car weights than for a unit-train-weights-only facility, and should be considered prior to installation.
- (b) For coupled-in-motion point-based weighing systems used only for dynamic weighing, the user shall provide an alternate certified scale to be used as a reference scale. The weights and measures authority having jurisdiction over the weighing system shall determine if the reference scale provided is suitable in terms of size, capacity, minimum division, performance requirements, and the proximity to the weighing system under evaluation. The reference weight cars weighed on the reference scale may then be used for calibration and annual inspection by the jurisdiction with statutory authority for the system.

(Added 1990) (Amended 1992 and 2021)

Scales Code Index

A

Acceptance..... 19, 42, 44, 45
Acceptance tolerance..... 19, 42, 44, 45, 46
Accuracy..... 18, 19, 21, 22, 24, 26, 27, 38, 40, 43, 51
Accuracy class 18, 21, 22, 24, 26, 38, 40, 43, 51
Adjustable components.....14, 20
Adjustment..... 14, 17, 20, 38, 59
Apportionment factor 48
Approaches53, 54
Audit trail..... 14
Automatic zero-tracking mechanism 17, 21, 34
Axle and Axle-Group loads..... 16
Axle-Group-Loads..... 57
Axle-load scales 7, 19, 41, 49, 54

B

Balance condition.....7, 17, 18, 50, 59
Balance indicator..... 7, 18, 19, 20, 42, 43, 49
Balance position 10
Barometric pressure.....43, 50

C

Capacity11, 12, 15, 17, 18, 19, 20, 22, 23, 24, 25, 26, 27, 28, 30, 31, 32, 33, 35, 36, 38, 41, 42, 44, 49, 51, 52, 53, 55, 59
Capacity indication..... 12
Certificate of Conformance..... 21
Class8, 9, 14, 17, 19, 21, 22, 24, 25, 26, 27, 30, 35, 41, 44, 46, 47, 49, 50, 51, 52, 53, 54
Class I8, 9, 14, 17, 18, 19, 21, 22, 26, 27, 30, 40, 41, 42, 43, 44, 49, 50, 51, 52, 54
Class II8, 9, 17, 18, 19, 21, 22, 26, 27, 30, 40, 41, 42, 43, 44, 46, 47, 49, 50, 51, 54
Class III 9, 17, 18, 21, 22, 25, 26, 27, 30, 40, 41, 42, 43, 44, 46, 47, 49, 50, 51, 53, 54
Class III L. 17, 21, 22, 25, 26, 27, 40, 41, 42, 43, 44, 47, 49, 50, 51, 53, 54
Class IIII9, 21, 22, 25, 26, 27, 30, 40, 42, 43, 44, 46, 47, 49, 50, 51, 54
CLC..... 23, 24, 26, 27, 31, 55
Clearance 10, 18, 53
Concentrated load capacity 24
Consecutive-car test.....37, 38
Counting feature.....9, 19, 26, 30, 35, 45, 58, 59
Crane and hopper 44
Crane and hopper (other than grain hopper)..... 22
Creep.....47, 48

D

Dairy-product test.....18, 19, 30, 41, 42
Damping means..... 19

Decreasing load test 41, 43
Direct sales..... 11, 13, 17, 18, 20
Discrimination test.....34
Distributed-car test..... 37, 38
Dynamic-Monorail-Scales.....9

E

Electric power supply.....50
Environmental factors 34, 53
Exceptions-to-3.....25
Extended_Display-Mode.....9

F

Field standard 35, 36
Foundation53

G

Graduations 10, 11, 12, 13, 18
Grain-test..... 18, 52

H

Hoists54

I

Index of an indicator10
Indicating element..... 7, 19, 23, 24, 26, 28, 29, 44, 46, 53
Indicator 7, 10, 12, 13, 18, 19, 20, 22, 26, 43, 46, 49, 59
Influence factors 43, 49
Information to be recorded 16
Initial verification36, 37, 38
Initial zero-setting mechanism 12, 18
Installation requirements 53

J

Jewelers'42

L

Level 17, 19, 33, 53, 54, 58, 59
Level condition.....19, 58, 59
Level-indicating means 19
Load cell 21, 23, 25, 26, 27, 47, 48, 53
Load cell verification interval21, 27, 48

M

Main elements 23, 44
Maintenance 41, 42, 44, 45, 46, 48, 53, 59
Maintenance requirements.....59

Maintenance tolerance	41, 42, 44, 45, 46, 48
<i>Manual weight entries</i>	15, 59
Marking requirements.....	23, 24
Material test	34, 41
Maximum permissible error (mpe)	47, 48
Minimum load.....	54, 55, 58
Minimum test weights	35, 36
Money-value computation	13
Money-value graduations.....	12
Multi-independent platform.....	16
Multi-interval	21, 22, 44
Multiple range.....	21, 44

N

No-load reference value.....	8
Nominal capacity.....	11, 23, 24, 25, 27, 30, 31, 38, 43, 55
Non-automatic.....	46, 47

O

On-board.....	15, 19, 33, 51
Operating temperature	50

P

Parallax.....	10
Piece.....	9, 46, 59
Point-of-sale.....	13, 59
Poise.....	11, 12
Portable axle-load weighers	7, 33, 44, 51, 58
Power interruption.....	50
Prescription.....	18, 19, 22, 26, 30, 35, 38, 41, 42, 45, 58, 59

R

“r” factor.....	55
Ratio test.....	34, 44
Readability.....	11
Recorded representations	13, 16
Recording elements	7, 19, 46
Repeatability	48
RFI	34, 50, 53

S

Scale modification.....	59
Scales	
Automatic indicating	30, 34, 41
Axle load	26, 27, 31, 51, 52
Belt-conveyor.....	7
Computing	12, 13
Crane	33, 52
Dairy-product test.....	19, 30, 42
Gem weighing.....	51
Grain test	41, 51
Hanging	33, 53
Hopper.....	33, 44, 51, 52
Jewelers’	19, 41, 42

Livestock.....	17, 19, 23, 26, 27, 29, 31, 32, 49, 51, 53, 59
Monorail.....	8, 9, 18, 19, 32, 41
Parcel post	40, 41, 42
Postal	8, 12, 26, 40, 41, 42, 51, 59
Prepackaging	13, 58
Prescription.....	19, 35, 41, 45, 59
Railway track.....	17, 19, 26, 27, 28, 32, 35, 41, 43, 51, 52, 53
Vehicle.....	17, 19, 20, 23, 26, 27, 28, 31, 39, 49, 51, 53, 54, 55, 58, 59
Weighbeam.....	10
Sealing	14, 15
Security seal	14
Sensitivity requirement	42, 43
Sensitivity test	34
Shift test.....	30, 31, 32, 33, 37, 46
Single-draft.....	57
Stock racks	54
Strain-load test.....	35, 46
Subsequent verification	37, 38, 43
Substitution	35, 36, 46
Supports	30, 53
Symmetry	10

T

Tare.....	17, 18, 19, 43
Temperature	21, 24, 25, 43, 50
Test loads	30, 32, 35, 36, 41, 43, 45
Test pattern.....	31
Time dependence	46
Tolerances ..	18, 19, 35, 36, 40, 41, 42, 43, 44, 46, 48, 51, 58
Total vehicle weight.....	16
Travel.....	11, 20, 38
Type evaluation	23, 43, 44, 45, 46, 47, 48

U

Unit prices.....	12
Unit weights	12, 27, 46
Use requirements	54

V

Vehicle on-board weighing system	15, 19, 33, 51
Verification scale interval.....	21
Verification scale interval-e.....	8

W

Weighbeam	10
Weighing elements.....	20, 21, 31, 32, 53
Weighing systems	
Coupled-in-motion.....	37, 44, 60
Uncoupled-in-motion	38
Weight classifier	12, 13, 26, 54, 59
Weight ranges.....	12, 27
<i>Weight units</i>	8
Weight-Classifiers	9
Wheel-load weighers.....	7, 19, 33, 44, 52, 58

Z

Zero indication7, 50
Zero-load adjustment.....17, 59

Zero-load balance14, 17, 18, 34, 50, 59
Zero-tracking mechanism See Automatic zero-tracking
mechanism

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Table of Contents

	Page
Section 2.21. Belt-Conveyor Scale Systems	2-67
A. Application.....	2-67
A.1. General.....	2-67
A.2. Exceptions.....	2-67
A.3. Additional Code Requirements.	2-67
S. Specifications.....	2-67
S.1. Design of Indicating and Recording Elements.	2-67
S.1.1. General.	2-67
S.1.2. Units.	2-67
S.1.3. Value of the Scale Division.	2-67
S.1.4. <i>Recording Elements and Recorded Representations.</i>	2-68
S.1.5. <i>Rate of Flow Indicators and Recorders.</i>	2-68
S.1.6. Advancement of Primary Indicating or Recording Elements.	2-68
S.1.7. <i>Master Weight Totalizer.</i>	2-68
S.1.8. <i>Power Loss.</i>	2-68
S.1.9. <i>Zero-Ready Indicator.</i>	2-68
S.2. Design of Weighing Elements.....	2-69
S.2.1. Speed Measurement.	2-69
S.2.2. Adjustable Components.....	2-69
S.2.3. Overload Protection.....	2-69
S.3. Zero Setting.....	2-69
S.3.1. Design of Zero-Setting Mechanism.....	2-69
S.3.2. <i>Sensitivity at Zero Load (For Type Evaluation).</i>	2-69
S.4. <i>Accuracy Class.</i>	2-70
S.5. Marking Requirements.....	2-70
S.6. Provision for Sealing.	2-70
N. Notes.....	2-71
N.1. General.....	2-71
N.1.1. Official Test.	2-71
N.1.2. Simulated Test.	2-71
N.2. Conditions of Tests.....	2-71
N.2.1. Initial Verification.....	2-71
N.2.2. Subsequent Verification.....	2-72
N.2.3. Minimum Test Load.	2-73
N.3. Test Procedures.	2-73
N.3.1. Zero-Load Tests.	2-73
N.3.2. Material Tests.	2-74
N.3.3. Simulated Load Tests.	2-75
T. Tolerances	2-76
T.1. Tolerance Values.....	2-76
T.1.1. Tolerance Values – Test of Zero Stability.	2-76
T.2. Tolerance Values, Repeatability and Linearity.....	2-76
T.2.1. Tolerance Values, Repeatability Tests.....	2-76
T.2.2. Linearity Tests, for Systems that Operate Using Multiple or Variable Flow Rates.	2-76
T.3. Influence Factors.	2-77

T.3.1. Temperature.....	2-77
T.3.2. Power Supply, Voltage, and Frequency.....	2-77
UR. User Requirements.....	2-77
UR.1. Installation Requirements.....	2-77
UR.1.1. Protection from Environmental Factors.....	2-77
UR.1.2. Conveyor Installation.	2-77
UR.1.3. <i>Material Test</i>	2-79
UR.1.4. Belt Travel (Speed or Velocity).	2-79
UR.2. Use Requirements.....	2-79
UR.2.1. Rate of Operation.	2-79
UR.2.2. Minimum Totalized Load.	2-79
UR.2.3. Security Means.....	2-79
UR.2.4. Loading.....	2-79
UR.2.5. Diversion or Loss of Measured Product.	2-79
UR.2.6. Retention of Maintenance, Test, and Analog or Digital Recorder Information.....	2-79
UR.3. Maintenance Requirements – Scale and Conveyor Maintenance.	2-80
UR.4. Compliance.	2-82

Section 2.21. Belt-Conveyor Scale Systems

A. Application

A.1. General. – This code applies to belt-conveyor scale systems and weigh-belt systems used for the weighing of bulk materials.

(Amended 2015)

A.2. Exceptions. – The code does not apply to the following:

- (a) Devices used for discrete weighing while moving on conveyors.
- (b) Devices that measure quantity on a time basis.
- (c) Checkweighers.
- (d) Controllers or other auxiliary devices except as they may affect the weighing performance of the belt-conveyor scale.

A.3. Additional Code Requirements. – In addition to the requirements of this code, Belt-Conveyor Scale Systems shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1. Design of Indicating and Recording Elements.

S.1.1. General. – A belt-conveyor scale shall be equipped with a primary indicating element in the form of a master weight totalizer *and shall also be equipped with a recording element, and a rate of flow indicator and recorder (which may be analog).** An auxiliary indicator shall not be considered part of the master weight totalizer.

*[*Nonretroactive as of January 1, 1986]*

(Amended 1986)

S.1.2. Units. – A belt-conveyor scale shall indicate and record weight units in terms of pounds, tons, long tons, metric tons, or kilograms. The value of a scale division (d) expressed in a unit of weight shall be equal to:

- (a) 1, 2, or 5; or
- (b) a decimal multiple or submultiples of 1, 2, or 5.

S.1.3. Value of the Scale Division.

S.1.3.1. For Scales Not Marked with an Accuracy Class and Installed After January 1, 1986. – *The value of the scale division shall not be greater than 0.125 % (1/800) of the minimum totalized load.*

[Nonretroactive as of January 1, 1986]

(Added 1985) (Amended 2009 and 2019)

S.1.3.2. For Scales Installed Before January 1, 1986. – The value of the scale division shall not be greater than 1/1200 of the rated capacity of the device. However, provision shall be made so that compliance with the requirements of the zero-load test as prescribed in N.3.1. Zero Load Tests may be readily and accurately determined in 20 minutes of operation.

S.1.3.3. For Scales Marked with an Accuracy Class. – The value of the scale division shall not be greater than:

(a) 0.125 % (1/800) of the minimum totalized load for scales marked Class 0.25; and

(b) 0.05 % (1/2000) of the minimum totalized load for scales marked Class 0.1.

[Nonretroactive as of January 1, 2020]

(Added 2019)

S.1.4. Recording Elements and Recorded Representations. – The value of the scale division of the recording element shall be the same as that of the indicating element.

(a) The belt-conveyor scale system shall record the unit of measurement (i.e., kilograms, tonnes, pounds, tons, etc.), the date, and the time.

(b) The belt-conveyor scale system shall record the initial indication and the final indication of the master weight totalizer and the quantity.*

All of the information in (a) and (b) must be recorded for each delivery.*

[Nonretroactive as of January 1, 1986]

[*Nonretroactive as of January 1, 1994]

(Amended 1993)

S.1.4.1. The belt-conveyor scale system shall be capable of recording the results of automatic or semi-automatic zero load tests.

[**Nonretroactive as of January 1, 2004]

(Added 2002)

S.1.5. Rate of Flow Indicators and Recorders. - A belt-conveyor scale shall be equipped with a rate of flow indicator and an analog or digital recorder. Permanent means shall be provided to produce an audio or visual signal when the rate of flow is equal to or less than 20 % and when the rate of flow is equal to or greater than 100 % of the rated capacity of the scale. The type of alarm (audio or visual) shall be determined by the individual installation.

[Nonretroactive as of January 1, 1986]

(Amended 1989 and 2004)

S.1.6. Advancement of Primary Indicating or Recording Elements. – The master weight totalizer shall advance only when the belt conveyor is in operation and under load.

(Amended 1989)

S.1.7. Master Weight Totalizer. – The master weight totalizer shall not be resettable without breaking a security means.

[Nonretroactive as of January 1, 1986]

S.1.8. Power Loss. – In the event of a power failure of up to 24 hours, the accumulated measured quantity on the master weight totalizer of an electronic digital indicator shall be retained in memory during the power loss.

[Nonretroactive as of January 1, 1986]

(Amended 1989)

S.1.9. Zero-Ready Indicator. – A belt-conveyor scale shall be equipped with a zero-ready indicator that produces an audio or visual signal during an unloaded belt condition when the zero balance is within:

- (a) ± 0.12 % of the rated capacity of the scale for scales not marked with an accuracy class;
- (b) ± 0.12 % of the rated capacity of the scale for scales marked Class 0.25; and
- (c) ± 0.05 % for scales marked Class 0.1.

The type of indication (audio or visual) shall be determined by the individual installation.

[Nonretroactive as of January 1, 2014]

(Added 2012) (Amended 2019)

S.2. Design of Weighing Elements. – A belt-conveyor scale system shall be designed to combine automatically belt travel with belt load to provide a determination of the weight of the material that has passed over the scale.

S.2.1. Speed Measurement. – A belt-conveyor scale shall be equipped with a belt speed or travel sensor that will accurately sense the belt speed or travel whether the belt is empty or loaded.

S.2.2. Adjustable Components. – An adjustable component that can affect the performance of the device (except as prescribed in S.3.1. Design of Zero-Setting Mechanism) shall be held securely in adjustment.

(Amended 1998)

S.2.3. Overload Protection. – The load-receiving elements shall be equipped with means for overload protection of not less than 150 % of rated capacity. The accuracy of the scale in its normal loading range shall not be affected by overloading.

S.3. Zero Setting.

S.3.1. Design of Zero-Setting Mechanism. – Automatic and semiautomatic zero-setting mechanisms shall be so constructed that the resetting operation is carried out only after a whole number of belt revolutions and the completion of the setting or the whole operation is indicated. *An audio or visual signal shall be given when the automatic and semiautomatic zero-setting mechanisms reach the limit of adjustment of the zero-setting mechanism.**

(Amended 1999 and 2002)

*Except for systems that record the zero-load reference at the beginning and end of a delivery, the range of the zero-setting mechanism shall not be greater than ± 2 % of the rated capacity of the scale without breaking the security means. For systems that record the zero-load reference at the beginning and end of a delivery, the range of zero-setting mechanism shall not be greater than ± 5 % without breaking the security means.***

*[*Nonretroactive as of January 1, 1990]*

*[**Nonretroactive as of January 1, 2004]*

(Amended 1989 and 2002)

S.3.1.1. Automatic Zero-Setting Mechanism. – *The automatic zero-setting mechanism shall indicate or record any change in the zero reference.*

[Nonretroactive as of January 1, 2010]

(Added 2009)

S.3.2. Sensitivity at Zero Load (For Type Evaluation). – *When a system is operated for a time period equal to the time required to deliver the minimum test load and with a test load calculated to indicate two scale divisions applied directly to the weighing element, the totalizer shall advance not less than one or more than three scale divisions. An alternative test of equivalent sensitivity, as specified by the manufacturer, shall also be acceptable.*

[Nonretroactive as of January 1, 1986]

S.4. Accuracy Class. – Weighing devices shall be marked with an appropriate accuracy class as either Class 0.25 or as Class 0.1. This designation is determined by the manufacturer.

[Nonretroactive as of January 1, 2020]

(Added 2019)

S.5. Marking Requirements. – Belt-conveyor scale systems and weigh-belt systems shall be marked with the following: (Also see also G-S.1. Identification.)

- (a) the rated capacity in units of weight per hour (minimum and maximum);
- (b) the value of the scale division;
- (c) the belt speed in terms of feet (or meters) per minute at which the belt will deliver the rated capacity, or the maximum and minimum belt speeds at which the conveyor system will be operated for variable speed belts;
- (d) the load in terms of pounds per foot or kilograms per meter (determined by material tests);
- (e) the operational temperature range if other than -10°C to 40°C (14°F to 104°F); and
[Nonretroactive as of January 1, 1986]
- (f) the accuracy classification as declared by the manufacturer.
[Nonretroactive as of January 1, 2020]

(Amended 2015 and 2019)

S.6. Provision for Sealing. – For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices.

All other devices shall be designed using the format set forth in Table S.6. with provision(s) for applying a security seal that must be broken, or for using other approved means of providing security (e.g., data change audit trail available at the time of inspection), before any change that affects the metrological integrity of the device can be made to any electronic mechanism.

[Nonretroactive as of January 1, 1999]

(Added 1998) (Amended 2019)

Table S.6. Categories of Device and Methods of Sealing	
Categories of Devices	Methods of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 3: Remote configuration capability.	An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: Does not require 1000 changes to be stored for each parameter.)

[Nonretroactive as of January 1, 1999]

(Table Added 1998)

N. Notes

N.1. General. – The performance of belt-conveyor scales can be detrimentally affected by the conditions of the installation. (Also see User Requirements.) The performance of the equipment is not to be determined by averaging the results of the individual tests. The results of all tests shall be within the tolerance limits.

(Amended 2002 and 2019)

N.1.1. Official Test. – An official test of a belt-conveyor scale system shall include tests specified in N.3.1. Zero Load Tests, N.3.2. Material Tests, and, if applicable, N.3.3. Simulated Load Tests.

(Amended 2006)

N.1.2. Simulated Test. – Simulated loading conditions as recommended by the manufacturer and approved by the official with statutory authority may be used to properly monitor the system operational performance between official tests, but shall not be used for official certification.

(Amended 1991)

N.2. Conditions of Tests. – A belt-conveyor scale shall be tested after it is installed on the conveyor system with which it is to be used and under such environmental conditions as may normally be expected. Each test shall be conducted with test loads no less than the minimum test load. Before each test run, the inspector shall check the zero setting and adjust as necessary.

(Amended 1986, 2004, and 2009)

N.2.1. Initial Verification. – A belt-conveyor scale system or a weigh-belt system shall be tested using test runs as indicated in Table N.2.1. Initial Verification.

The minimum testing shall be two test runs performed consecutively and under the same (or practically identical) test conditions; the range of the results of those test runs shall not exceed the absolute value of the tolerance as specified in T.2.1. Tolerance Values, Repeatability Tests. The results of each individual test shall be within the tolerance as specified in T.1. Tolerance Values.

Test runs may also be conducted at any other rate of flow that may be used at the installation to establish linearity of the system.

A minimum of four test runs may be conducted at only one flow rate if evidence is provided that the system is used at a constant speed/constant loading setting and that rate does not vary by an amount more than plus or minus ($\pm$) 10 % of the normal flow rate that can be developed at the installation for at least 80 % of the time.

(Added 2004) (Amended 2009, 2015, and 2019)

Table N.2.1. Initial Verification		
Device Configuration	Minimum of Two Test Runs at Each of the Following Settings	Total Tests (Minimum)
Constant Belt Speed and Variable Loading	<ul style="list-style-type: none"> - Belt Loading: high (normal) - Belt Loading: medium (intermediate) - Belt Loading: low (35 %) 	6
Variable Belt Speed and Constant Loading	<ul style="list-style-type: none"> - Belt Speed: maximum - Belt Speed: medium - Belt Speed: minimum 	6
Variable Belt Speed and Variable Loading	<ul style="list-style-type: none"> - Belt Speed: maximum; Belt Loading: high (normal) - Belt Speed: maximum; Belt Loading: medium (intermediate) - Belt Speed: maximum; Belt Loading: low (35 %) - Belt Speed: minimum; Belt Loading: high (normal) - Belt Speed: minimum; Belt Loading: medium (intermediate) - Belt Speed: minimum; Belt Loading: low (35 %) 	12
Constant Belt Speed and Constant Loading	<ul style="list-style-type: none"> - When the system is operated only at a single flow rate, minimum of four test runs at the flowrate used in normal operation 	*4
<ol style="list-style-type: none"> 1. Use the device configurations in the left-hand column to identify the scale being tested. 2. Perform two test runs (minimum) at each of the settings shown in the center column. 3. The following terminology applies to “Belt Loading”: <ul style="list-style-type: none"> • Low: 35 % of the maximum rated capacity of the system. • Medium: an intermediate rate between the high and low settings. • High: maximum (normal use) operational rate. <p>*As provided in N.2.1. Initial Verification; for single flow rate systems, a minimum of four test runs at a single flow rate are required.</p>		

(Table Added 2015)

N.2.2. Subsequent Verification. – Subsequent testing shall include testing at the normal use flow rate and other flow rates used at the installation using a minimum of two consecutive test runs performed at each flow rate. The official with statutory authority may determine that testing only at the normal use flow rate is necessary for subsequent verifications if evidence is provided that the system is used to operate:

- (a) at no less than 70 % of the maximum rated capacity for at least 80 % of the time (excluding time that the belt is unloaded); or
- (b) with a normal use flow rate that does not vary by more than plus or minus ($\pm$) 10 % of the maximum rated capacity.

Example: If a belt-conveyor scale system has a maximum rated capacity of 200 tons per hour (tph), and the normal use flow rate is 150 tph (75 % of the maximum rated capacity), no testing at additional flow rates is required provided the flow rates remain above 140 tph for more than 80 % of the time. If the same device were operating with a normal use flow rate of 130 tph, it is operating at 65 % of the maximum rated capacity. In this case, testing at flow rates in addition to the normal use flow rate would be required if the normal use flow rate varies by more than 20 tph (10 % of the maximum rated capacity).

(Added 2004) (Amended 2019)

N.2.3. Minimum Test Load.

N.2.3.1. Minimum Test Load, Weigh-Belt Systems. – The minimum test load shall not be less than the largest of the following values:

- (a) 800 scale divisions for systems not marked with an accuracy class, 800 scale divisions for systems marked Class 0.25, and 2000 scale divisions for systems marked Class 0.1;
- (b) the load obtained at maximum flow rate in one revolution of the belt; or
- (c) the load obtained during at least one minute of operation.

(Amended 2015 and 2019)

N.2.3.2. Minimum Test Load, All Other Belt-Conveyor Scale Systems. – Except for applications where a normal weighment is less than ten minutes, the minimum test load shall not be less than the largest of the following values:

- (a) 800 scale divisions for systems not marked with an accuracy class, 800 scale divisions for systems marked Class 0.25, and 2000 scale divisions for systems marked Class 0.1; or
- (b) the load obtained at maximum flow rate in one revolution of the belt; or
- (c) the load obtained during at least ten minutes of operation.

For applications where a normal weighment is less than ten minutes (e.g., belt-conveyor scale systems used exclusively to issue net weights for material conveyed by individual vehicles and railway track cars) the minimum test load shall be the normal weighment that also complies with N.2.3.2.(a) and (b).

The official with statutory authority may determine that a smaller minimum totalized load down to 2 % of the load totalized in one hour at the maximum flow rate may be used for subsequent tests, provided that:

- 1. the smaller minimum totalized load is greater than the quantities specified in N.2.3.2.(a) and (b); and
- 2. consecutive official testing with the minimum totalized loads described in N.2.3.2.(a), (b), or (c) and the smaller minimum test load has been conducted that demonstrates the system complies with applicable tolerances for repeatability, acceptance, and maintenance.

(Added 2004) (Amended 2008, 2015, and 2019)

N.3. Test Procedures.

N.3.1. Zero-Load Tests. – A zero-load test shall be conducted to establish that the belt scale system (including the conveyor) is capable of holding a stable, in-service zero.

(Amended 1989 and 2002)

N.3.1.1. Determination of Zero. – A zero-load test is a determination of the error in zero, expressed as an internal reference, a percentage of the full-scale capacity, or a change in a totalized load over a whole number of complete belt revolutions. A zero-load test shall be performed as follows:

- (a) For belt-conveyor scales with electronic integrators, the test must be performed over a period of at least three minutes and with a whole number of complete belt revolutions.
- (b) For belt-conveyor scales with mechanical integrators, the test shall be performed with no less than three complete revolutions or ten minutes of operation, whichever is greater.

- (c) For weigh belt systems, the test must be performed over a period of at least one minute and at least one complete revolution of the belt.

(Added 2002) (Amended 2015)

N.3.1.2. Test of Zero Stability. – The conveyor system shall be operated to warm up the belt and the belt scale shall be zero adjusted as required. A series of zero-load tests shall be carried out immediately before conducting the simulated load or materials test until the three consecutive zero-load tests each indicate an error which does not exceed:

- (a) ± 0.06 % of the totalized load at full scale capacity for the duration of the test for scales not marked with an accuracy class;
- (b) ± 0.06 % of the totalized load at full scale capacity for the duration of the test for scales marked Class 0.25; or
- (c) ± 0.03 % of the totalized load of full scale capacity for the duration of the test for scales that are marked Class 0.1.

No adjustments can be made during the three consecutive zero-load test readings.

(Added 2002) (Amended 2004, 2009, and 2019)

N.3.1.3. Check for Consistency of the Conveyor Belt along Its Entire Length. – During a zero-load test with any operational low-flow lock-out disabled, the absolute value of the difference between the maximum and minimum totalizer readings indicated on the totalizer during any complete revolution of the belt shall not exceed 0.12 % of the minimum test load.

Note: The end value of the zero-load test must meet the values referenced in N.3.1.2. Test for Zero Stability of:

- (1) ± 0.06 % for scales not marked with an accuracy class;
- (2) ± 0.06 % for scales marked Class 0.25; or
- (3) ± 0.03 % for scales marked Class 0.1.

(Added 2002) (Amended 2004, 2011, and 2019)

N.3.2. Material Tests. – Material tests should be conducted using actual belt loading conditions. These belt loading conditions shall include but are not limited to conducting materials tests using different belt loading points, all types and sizes of products weighed on the scale, at least one other belt speed, and in both directions of weighing.

On subsequent verifications, at least two individual tests shall be conducted as specified in N.2.2. Subsequent Verification. The results of all these tests shall be within the tolerance limits.

Either pass a quantity of pre-weighed material over the belt-conveyor scale in a manner as similar as feasible to actual loading conditions or weigh all material that has passed over the belt-conveyor scale. Means for weighing the material test load will depend on the capacity of the belt-conveyor scale and availability of a suitable scale for the test. To assure that the test load is accurately weighed and determined, the following precautions shall be observed:

- (a) The containers, whether railroad cars, trucks, or boxes, must not leak, and shall not be overloaded to the point that material will be lost.
- (b) The actual empty or tare weight of the containers shall be determined at the time of the test. Stenciled tare weight of railway cars or trucks shall not be used. Gross and tare weights shall be determined on the same scale.

- (c) When a pre-weighed test load is passed over the scale, the belt-loading hopper shall be examined before and after the test to assure that the hopper is empty and that only the material of the test load has passed over the scale.
- (d) Where practicable, a reference scale should be tested within 24 hours preceding the determination of the weight of the test load used for a belt-conveyor scale material test.

A reference scale which is not “as found” within maintenance tolerance should have its accuracy re-verified after the belt-conveyor test with a suitable known weight load if the “as found” error of the belt-conveyor scale material test exceeds maintenance tolerance values.*

- (e) If any suitable known weight load other than a certified test weight load is used for re-verification of the reference scale accuracy, its weight shall be determined on the reference scale after the reference scale certification and before commencing the belt scale material test.*
- (f) The test shall not be conducted if the weight of the test load has been affected by environmental conditions.

***Note:** Even if the reference scale is within maintenance tolerance it may require adjusting to be able to meet paragraph N.3.2.1. Accuracy of Material.

(Amended 1986, 1989, 1998, 2000, 2002, 2009, and 2019)

N.3.2.1. Accuracy of Material.

- (a) For scales not marked with an accuracy class and those marked Class 0.25, the quantity of material used to conduct a material test shall be weighed on a reference scale to within an accuracy of 0.1 %.
- (b) For scales that are marked Class 0.1, the quantity of material used to conduct a material test shall be weighed on a reference scale to within an accuracy of 0.035 %.

Scales typically used for this purpose include Class III and III L scales or a scale without a class designation as described in Handbook 44, Section 2.20. Table T.1.1. Tolerances for Unmarked Scales.

(Added 1989) (Amended 1991, 1993, 1998, 2000, and 2019)

N.3.3. Simulated Load Tests.

- (a) As required by the official with statutory authority, simulated load tests as recommended by the manufacturer are to be conducted between material tests to monitor the system’s operational performance but shall not be used for official certification.

(Amended 1991)

- (b) A simulated load test consisting of at least three consecutive test runs shall be conducted as soon as possible, but not more than 12 hours after the completion of the material test, to establish the factor to relate the results of the simulated load test to the results of the material tests.

(Added 1990)

- (c) The results of the simulated load test shall repeat within 0.1 %.

(Added 1990)

(Amended 1989 and 1990)

T. Tolerances

T.1. Tolerance Values.¹ – Maintenance and acceptance tolerances on material tests, relative to the weight of the material, shall be:

- (a) ± 0.25 % of the test load for systems not marked with an accuracy class;
- (b) ± 0.25 % of the test load for systems marked Class 0.25; and
- (c) ± 0.1 % of the test load for systems marked Class 0.1.

(Amended 1993 and 2019)

T.1.1. Tolerance Values – Test of Zero Stability. – Immediately after material has been weighed over the belt-conveyor scale during the conduct of any material test run, the zero-load test shall be repeated. The change in the accumulated or subtracted weight during the zero-load test shall not exceed

- (a) 0.12 % of the totalized load at full scale capacity for the duration of that test for scales that are not marked with an accuracy class;
- (b) 0.12 % of the totalized load at full scale capacity for the duration of that test for scales marked Class 0.25; and
- (c) 0.06 % of the totalized load at full scale capacity for the duration of the test for scales that are marked Class 0.1.

If the range of zero adjustments during a complete (official) verification test exceeds 0.18 % of the totalized load at full scale capacity for the duration of the zero-load test for unmarked scales and those marked Class 0.25 or 0.09 % of the totalized load at full scale capacity for the duration of the zero-load test for scales marked Class 0.1, the official with statutory authority may establish an interval for zero-load testing during normal operation.

(Added 2004) (Amended 2009 and 2019)

T.2. Tolerance Values, Repeatability and Linearity.

T.2.1. Tolerance Values, Repeatability Tests. – In any group of totalization operations performed consecutively and under the same (or practically identical) test conditions during the conduct of material tests, the variation in values shall not be greater than:

- (a) 0.25 % (1/400) for systems not marked with an accuracy class;
- (b) 0.25 % (1/400) for systems marked Class 0.25; and
- (c) 0.1 % (1/1000) for systems marked Class 0.1.

(Amended 2019)

T.2.2. Linearity Tests, for Systems that Operate Using Multiple or Variable Flow Rates. – For totalization operations performed consecutively under different test conditions (e.g., different flow rates, different test loads,

¹ The variables and uncertainties included in the relative tolerance represent only part of the variables that affect the accuracy of the material weighed on belt-conveyor scales. If this tolerance was based on an error analysis beginning with mass standards through all of the test processes and following the principle expressed in Section 3.2. of the Fundamental Considerations in Appendix A, the tolerance would be 0.5 %.

(Added 1993)

different test material) during the conduct of material tests, the results relative to the weight of the reference material shall not exceed:

(a) $\pm 0.25\%$ (1/400) for systems not marked with an accuracy class;

(b) $\pm 0.25\%$ (1/400) for systems marked Class 0.25; and

(c) $\pm 0.1\%$ (1/1000) for systems marked Class 0.1.

(Added 2019)

T.3. Influence Factors. – The following factors are applicable to tests conducted under controlled conditions only, provided that:

(a) types of devices approved prior to January 1, 1986, and manufactured prior to January 1, 1988, need not meet the requirements of this section;

(b) new types of devices submitted for approval after January 1, 1986, shall comply with the requirements of the section; and

(c) all devices manufactured after January 1, 1988, shall comply with the requirements of this section.

T.3.1. Temperature. – Devices shall satisfy the tolerance requirements at temperatures from $-10\text{ }^{\circ}\text{C}$ to $40\text{ }^{\circ}\text{C}$ ($14\text{ }^{\circ}\text{F}$ to $104\text{ }^{\circ}\text{F}$).

T.3.1.1. Effect on Zero-Load Balance. – The zero-load indication shall not change by more than 0.035% of the rated capacity of the scale (without the belt) for a change in temperature of $10\text{ }^{\circ}\text{C}$ ($18\text{ }^{\circ}\text{F}$) at a rate not to exceed $5\text{ }^{\circ}\text{C}$ ($9\text{ }^{\circ}\text{F}$) per hour.

(Amended 2004)

T.3.1.2. Temperature Limits. – *If a temperature range other than $-10\text{ }^{\circ}\text{C}$ to $40\text{ }^{\circ}\text{C}$ ($14\text{ }^{\circ}\text{F}$ to $104\text{ }^{\circ}\text{F}$) is specified for the device, the range shall be at least $30\text{ }^{\circ}\text{C}$ ($54\text{ }^{\circ}\text{F}$).*

[Nonretroactive as of January 1, 1990]

(Added 1989)

T.3.2. Power Supply, Voltage, and Frequency. – A belt-conveyor scale system shall satisfy the tolerance requirements over a range of 100 V to 130 V or 200 V to 250 V as appropriate and over a frequency range of 59.5 Hz to 60.5 Hz .

UR. User Requirements

UR.1. Installation Requirements.

UR.1.1. Protection from Environmental Factors. – The indicating elements, the lever system or load cells, and the load-receiving element of a belt-conveyor scale shall be adequately protected from environmental factors such as wind, moisture, dust, weather, and radio frequency interference (RFI) and electromagnetic interference (EMI) that may adversely affect the operation or performance of the device.

UR.1.2. Conveyor Installation. – The design and installation of the conveyor leading to and from the belt-conveyor scale is critical with respect to scale performance. Installation shall be in accordance with the scale manufacturer's instructions and the following:

- (a) **Installation - General.** – A belt-conveyor scale shall be so installed that neither its performance nor operation will be adversely affected by any characteristic of the installation, including but not limited to, the foundation, supports, covers, or any other equipment.
(Amended 2002)
- (b) **Live Portions of Scale.** – All live portions of the scale shall be protected with appropriate guard devices and clearances, as recommended by the scale manufacturer, to prevent accidental interference with the weighing operation. (Also see UR.3.1. Scale and Conveyor Maintenance.)
(Amended 2004)
- (c) **Storage of Simulated Load Equipment.** – Suitable protection shall be provided for storage of any simulated load equipment.
- (d) **Take-up Device.** – Any take-up device shall provide constant and consistent tension for the belt under all operating conditions.
(Amended 2014)
- (e) **Scale Location and Training Idlers.** – The scale shall be so installed that the first weigh idler of the scale is at least 6 m (20 ft) or five idler spaces, whichever is greater, from loading point, skirting, head or tail pulley, or convex curve in the conveyor. Any training idler shall be located at least 18 m (60 ft) from the centerline of the weigh span of the scale. Training idlers shall not be restrained at any time in order to force belt alignment.
(Amended 1998)
- (f) **Concave Curve.** – If there is a concave curve in the conveyor, before or after the scale, the scale shall be installed so that the belt is in contact with all the idler rollers at all times for at least 6 m (20 ft) or five idler spaces, whichever is greater, before and after the scale.² A concave curve shall start no closer than 12 m (40 ft) from the scale to the tangent point of the concave curve.
(Amended 1998)
- (g) **Tripper and Movable Pulleys.** – There shall be no tripper or movable head pulleys in the conveyor.
- (h) **Conveyor Orientation.** – The conveyor may be horizontal or inclined, but, if inclined, the angle shall be such that slippage of material along the belt does not occur.
- (i) **Conveyor Stringers.** – Conveyor stringers at the scale and for not less than 6 m (20 ft) before and beyond the scale shall be continuous or securely joined and of sufficient size and so supported as to eliminate relative deflection between the scale and adjacent idlers when under load. The conveyor stringers should be so designed that the deflection between any two adjacent idlers within the weigh area does not exceed 0.6 mm (0.025 in) under load.
- (j) **Identification of Scale Area.** – The scale area and five idlers on both ends of the scale shall be of a contrasting color, or other suitable means shall be used to distinguish the scale from the remainder of the conveyor installation, and the scale shall be readily accessible.
(Amended 1998)

² Installing the belt scale five-idler spaces from the tail pulley or the infeed skirting will be in the area of least belt tension on the conveyor and should produce the best accuracy. The performance of a belt-conveyor scale may be adversely affected by a concave curve in the conveyor that is located between the loading point and the scale. Therefore, whenever possible, a belt-conveyor scale should not be installed with a concave curve in the conveyor between the loading point and the scale.

(Amended 1995 and 1998)

(k) Belt Composition and Maintenance. – In a loaded or unloaded condition, the belt shall make constant contact with horizontal and wing rollers of the idlers in the scale area. Splices shall not cause any undue disturbance in scale operation. (Also see N.3. Test Procedures.)

(Amended 1998, 2000, 2001, and 2015)

(l) Uniformity of Belt Loading and Flow. – The conveyor loading mechanism shall be designed to provide uniform belt loading. The distance from the loading point to the scale shall allow for adequate settling time of the material on the belt before it is weighed. Feeding mechanisms shall have a positive closing or stopping action so that material leakage does not occur. Feeders shall provide an even flow over the scale through the full range of scale operation. Sufficient impact idlers shall be provided in the conveyor under each loading point to prevent deflection of the belt during the time material is being loaded.

(m) Belt Alignment. – The belt shall not extend beyond the edge of the outermost roller of any carry side (top) roller in any area of the conveyor nor touch the conveyor structure on the return (bottom) side of the conveyor.

(Amended 1998 and 2008)

(Amended 2002, 2012, 2013, 2014, and 2015)

UR.1.3. Material Test. – *A belt-conveyor scale shall be installed so that a material test can be conveniently conducted.*

[Nonretroactive as of January 1, 1981]

UR.1.4. Belt Travel (Speed or Velocity). – The belt travel sensor shall be so positioned that it accurately represents the travel of the belt over the scale for all flow rates between the maximum and minimum values. The belt travel sensor shall be so designed and installed that there is no slip.

(Amended 2012)

UR.2. Use Requirements.

UR.2.1. Rate of Operation. – A belt-conveyor scale system shall be operated between 20 % and 100 % of its rated capacity.

(Amended 2004)

UR.2.2. Minimum Totalized Load. – Delivered quantities of less than the minimum test load shall not be considered a valid weighing.

UR.2.3. Security Means. – When a security means has been broken, it shall be reported to the official with statutory authority.

(Amended 1991)

UR.2.4. Loading. – The feed of material to the scale shall be controlled to assure that, during normal operation, the material flow is in accordance with the manufacturer's recommendation for rated capacity.

UR.2.5. Diversion or Loss of Measured Product. – There shall be no operation(s) or condition(s) of use that result in loss or diversion that adversely affects the quantity of measured product.

(Added 2005)

UR.2.6. Retention of Maintenance, Test, and Analog or Digital Recorder Information. – Records of calibration and maintenance, including conveyor alignment, analog or digital recorder, zero-load test, and material test data shall be maintained on site for at least the three concurrent years as a history of scale performance. Copies of any report as a result of a test or repair shall be mailed to the official with statutory authority as required.

The current date and correction factor(s) for simulated load equipment shall be recorded and maintained in the scale cabinet.

(Added 2002)

(Amended 2012)

UR.3. Maintenance Requirements – Scale and Conveyor Maintenance. – Weighing systems and idlers shall be maintained and serviced in accordance with manufacturer’s instructions and the following:

(a) Zero Balance. – The zero-balance condition of a belt-conveyor scale shall be maintained such that, prior to beginning any commercial transaction, with no load on the belt, the zero-balance condition is within:

(1) ± 0.12 % of the scale’s rated capacity for systems marked Class 0.25; and

(2) ± 0.05 % of the scale’s rated capacity for systems marked Class 0.1.

(Added 2012) (Amended 2019)

(b) Scale Clearance. – The scale and area surrounding the scale shall be kept clean of debris or other foreign material that can detrimentally affect the performance of the system.

(c) Weighed Material. – There shall be provisions to ensure that weighed material does not adhere to the belt and return to the scale system area.

(Added 2004)

(d) Simulated and Zero-Load Test Intervals. – Zero-load tests and simulated load or material tests shall be conducted at periodic intervals between official tests and after a repair or mechanical adjustment to the conveyor system in order to provide reasonable assurance that the device is performing correctly. The minimum interval for periodic zero-load tests and simulated load tests shall be established by the official with statutory authority or according to manufacturer recommendations.

(1) The actions to be taken as a result of the zero-load test are shown in the following table.

Table UR.3.(d)(i) Zero-Load Test Intervals and Actions	
Change in Zero ($\Delta 0$)	Actions to be Taken
If the change in zero is less than ± 0.25 % ($\Delta 0 < 0.25$ %)	Perform zero adjustment and proceed to simulated load test.
If the change in zero is ± 0.25 % to ± 0.5 % (0.25 % $\leq \Delta 0 \leq 0.5$ %)	Inspect the conveyor and weighing area for compliance with UR.1. Installation Requirements and repeat the zero-load test.
If the change in zero is greater than ± 0.5 % ($\Delta 0 > 0.5$ %)	Inspect the conveyor and weighing area for compliance with UR.1. Installation Requirements, repeat the zero-load test, and reduce the interval between zero-load tests.

(2) The action to be taken as a result of the simulated load or material tests is shown in the following table.

Table UR.3. (d)(ii) Simulated Load or Material Test Intervals and Actions	
Change in Factor (Reference) Established in N.3.3.(b) [Δ N.3.3.(b)]	Action to be Taken
For scales not marked with an accuracy class and those marked Class 0.25, if the error is less than 0.25 %: (Δ N.3.3.(b) < 0.25 %)	No Action
For scales marked Class 0.1, if the error is less than 0.1 %: (Δ N.3.3.(b) < 0.1 %)	
For scales not marked with an accuracy class and those marked Class 0.25, if the error is at least 0.25 % but not more than 0.6 %: ($0.25 \% \leq \Delta$ N.3.3.(b) $\leq 0.6 \%$)	Inspect the conveyor and weighing area for compliance with UR.1. Installation Requirements and, after compliance is verified, repeat the test. If the result of that test remains greater than $\pm 0.25 \%$, for scales not marked with an accuracy class and those marked Class 0.25, or greater than $\pm 0.1 \%$ for scales marked Class 0.1, a span correction shall be made and the official with statutory authority notified. (Amended 1991 and 2019)
For scales marked Class 0.1, if the error is at least 0.1% but not more than 0.25 %: ($0.1 \% \leq \Delta$ N.3.3.(b) $\leq 0.25 \%$)	
For scales not marked with an accuracy class and those marked Class 0.25, if the error is greater than 0.6 % but does not exceed 0.75 %: ($0.6 \% < \Delta$ N.3.3.(b) $\leq 0.75 \%$)	Inspect the conveyor and weighing area for compliance with UR.1. Installation Requirements and, after compliance is verified, repeat the test. If the result of that test remains greater than $\pm 0.6 \%$, for scales not marked with an accuracy class and those marked Class 0.25, or greater than $\pm 0.25 \%$ for scales marked Class 0.1, a span correction shall be made, the official with statutory authority shall be notified, and an official test shall be conducted. (Amended 1991 and 2019)
For scales marked Class 0.1, if the error is greater than 0.25 % but does not exceed 0.3 %: ($0.25 \% < \Delta$ N.3.3.(b) $\leq 0.3 \%$)	
For scales not marked with an accuracy class and those marked Class 0.25, if the error is greater than 0.75 %: (Δ N.3.3.(b) > 0.75 %)	An official test is required. (Amended 1987)
For scales marked Class 0.1, if the error is greater than 0.3 %: (Δ N.3.3.(b) > 0.3 %)	

(Amended 2002, 2009, and 2019)

- (e) Scale Alignment.** – Alignment checks shall be conducted in accordance with the manufacturer's recommendation. A material test is required after any realignment.

(Amended 1986, 2000, and 2015)

(f) Simulated Load Equipment. – Simulated load equipment shall be clean and properly maintained.

(g) Zero Load Reference Information. – When zero load reference information is recorded for a delivery, the information must be based upon zero load tests performed as a minimum both immediately before and immediately after the totalized load.

(Added 2002)

(Amended 1986, 2000, 2002, 2004, 2009, 2012, and 2015)

UR.4. Compliance. – Prior to initial verification, the scale manufacturer or installer shall certify to the owner that the scale meets code requirements. Prior to initial verification and each subsequent verification, the scale owner or his agent shall notify the official with statutory authority in writing that the belt-conveyor scale system is in compliance with this specification and ready for material testing.

(Amended 1991)

Table of Contents

	Page
Section 2.22. Automatic Bulk Weighing Systems.....	2-85
A. Application	2-85
A.1. General.....	2-85
A.2. Exceptions.....	2-85
A.3. Additional Code Requirements.....	2-85
S. Specifications.....	2-85
S.1. Design of Indicating and Recording Elements and Recorded Representations.	2-85
S.1.1. Zero Indication.....	2-85
S.1.2. <i>Value of Scale Division (d)</i>	2-85
S.1.3. Capacity Indication and Recorded Representation.	2-85
S.1.4. Weighing Sequence.	2-85
S.1.5. Recording Sequence.....	2-86
S.1.6. Provision for Sealing Adjustable Components on Electronic Devices.	2-86
S.2. Design of Balance and Damping Mechanism.....	2-86
S.2.1. Zero-Load Adjustment.....	2-86
S.2.2. Damping Means.....	2-86
S.3. Interlocks and Gate Control.	2-86
S.3.1. Gate Position.....	2-86
S.3.2. Interlocks.	2-86
S.3.3. Overfill Sensor.....	2-87
S.4. Design of Weighing Elements.	2-87
S.4.1. Antifriction Means.....	2-87
S.4.2. Adjustable Components.....	2-87
S.4.3. Multiple Load-Receiving Elements.	2-87
S.4.4. Venting.	2-87
S.5. Marking Requirements.....	2-87
S.5.1. Capacity and Value of the Scale Division.....	2-87
S.5.2. Weighing Elements.....	2-87
S.5.3. Temperature Limits.....	2-87
S.5.4. <i>Accuracy Class</i>	2-87
N. Notes.....	2-88
N.1. Testing Procedures.....	2-88
N.1.1. Test Weights.	2-88
N.1.2. Increasing-Load Test.	2-88
N.1.3. Decreasing-Load Test.	2-88
N.1.4. Zero-Balance or No-Load Reference Value Change Test.....	2-88
N.1.5. <i>Discrimination Test</i>	2-88
N.2. Verification (Testing) Standards.....	2-88
T. Tolerances.....	2-88
T.1. Tolerance Application.....	2-88
T.1.1. To Errors of Underregistration and Overregistration.	2-88
T.1.2. To Increasing-Load Tests.	2-89
T.1.3. To Decreasing-Load Tests.	2-89
T.1.4. To Tests Involving Digital Indications or Representations.....	2-89

T.2.	Minimum Tolerance Values.....	2-89
T.2.1.	For Systems Used to Weigh Construction Materials.	2-89
T.3.	Basic Tolerance Values.....	2-89
T.3.1.	Acceptance Tolerance.....	2-89
T.3.2.	For Systems Used to Weigh Grain.....	2-89
T.3.3.	For All Other Systems.	2-89
T.4.	<i>Time Dependence</i>	2-89
T.5.	Repeatability.	2-89
T.6.	Discrimination, Digital Automatic Indicating Scales.	2-89
T.7.	<i>Influence Factors</i>	2-89
T.7.1.	<i>Temperature</i>	2-90
T.7.2.	<i>Barometric Pressure</i>	2-90
T.7.3.	Electric Power Supply.....	2-90
UR.	User Requirements	2-90
UR.1.	Selection Requirements.	2-90
UR.1.1.	<i>For Systems used to Weigh Grain</i>	2-90
UR.1.2.	<i>For Systems used to Weigh Commodities other than Grain</i>	2-90
UR.2.	Installation Requirements.	2-91
UR.2.1.	Protection from Environmental Factors.	2-91
UR.2.2.	Foundation, Supports, and Clearance.....	2-91
UR.3.	Loading Requirements.	2-91
UR.3.1.	For Systems Used to Weigh Grain.....	2-91
UR.3.2.	<i>For Systems Used to Weigh Commodities Other than Grain</i>	2-91
UR.4.	System Modification.....	2-91

Section 2.22. Automatic Bulk Weighing Systems¹

A. Application

A.1. General. – This code applies to automatic bulk weighing systems, that is, weighing systems adapted to the automatic weighing of a commodity in successive drafts of predetermined amounts, automatically recording the no-load and loaded weight values and accumulating the net weight of each draft.

(Amended 1987)

A.2. Exceptions. – This code does not apply to batching systems.

(Added 2018)

A.3. Additional Code Requirements. – In addition to the requirements of this code, Automatic Bulk Weighing Systems shall meet the requirements of Section 1.10. General Code.

S. Specifications

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

S.1.1. Zero Indication. – Provisions shall be made to indicate and record a no-load reference value and, if the no-load reference value is a zero-value indication, to indicate and record an out-of-balance condition on both sides of zero.

S.1.1.1. Digital Zero Indication. – A digital zero indication shall represent a balance condition that is within $\pm \frac{1}{2}$ the value of the scale division.

S.1.2. Value of Scale Division (*d*). – *The value of the scale division (*d*), expressed in a unit of weight, shall be equal to:*

(a) 1, 2, or 5; or

(b) a decimal multiple or submultiple of 1, 2, or 5; or

(c) a binary submultiple of a unit of weight.

Examples: Scale divisions may be 0.01, 0.02, or 0.05; 0.1, 0.2, or 0.5; 1, 2, or 5; 10, 20, or 50; or $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, etc.

[Nonretroactive as of January 1, 1986]

(Amended 1987)

S.1.3. Capacity Indication and Recorded Representation. – An indicating or recording element shall not indicate or record any values when the gross load is in excess of 105 % of the capacity of the system.

S.1.4. Weighing Sequence. – For systems used to receive (weigh in), the no-load reference value shall be determined and recorded only at the beginning of each weighing cycle. For systems used to deliver (weigh out), the no-load reference value shall be determined and recorded only after the gross load reference value for each weighing cycle has been indicated and recorded.

¹ (Title amended 1986)

S.1.5. Recording Sequence. – Provision shall be made so that all weight values are indicated until the completion of the recording of the indicated value.

S.1.6. Provision for Sealing Adjustable Components on Electronic Devices. – For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices. For parameters adjusted using other means, provision shall be made for applying a security seal in a manner that requires the security seal to be broken before an adjustment can be made to any component affecting the performance of the device.

(Amended 2019)

S.2. Design of Balance and Damping Mechanism.

S.2.1. Zero-Load Adjustment. – The weighing system shall be equipped with manual or semiautomatic means by which the zero-load balance or no-load reference value indication may be adjusted. Automatic zero-tracking and automatic zero-setting mechanisms are prohibited.

(Amended 2010)

S.2.1.1. Manual. – A manual zero-load or no-load reference value setting mechanism shall be operable or accessible only by a tool outside of or entirely separate from this mechanism or enclosed in a cabinet.

S.2.1.2. Semiautomatic. – A semiautomatic zero-load or no-load reference value setting mechanism shall meet the provisions of S.2.1.1. Manual or shall be operable only when:

- (a) the indication is stable within ± 3 scale divisions; and
- (b) cannot be operated during a weighing operation.

S.2.2. Damping Means. – A system shall be equipped with effective means necessary to bring the indications quickly to a readable, stable equilibrium. Effective means shall also be provided to permit the recording of weight values only when the indication is stable within plus or minus three scale divisions for devices with 10 000 scale divisions, or plus or minus one division for devices with less than 10 000 scale divisions.

S.3. Interlocks and Gate Control.

S.3.1. Gate Position. – Provision shall be made to clearly indicate to the operator the position of the gates leading directly to and from the weigh hopper.

S.3.2. Interlocks. – Each automatic bulk weighing system shall have operating interlocks to provide for the following:

- (a) Product cannot be cycled and weighed if the weight recording element is disconnected or subjected to a power loss.
- (b) The recording element cannot print a weight if either of the gates leading directly to or from the weigh hopper is open.
- (c) A “low paper” sensor, when provided, is activated.
- (d) The system will operate only in the proper sequence in all modes of operation.
- (e) When an overfill alarm is activated, the system shall indicate and record an overfill condition.

(Amended 1993)

S.3.3. Overfill Sensor.

- (a) The weigh hopper shall be equipped with an overfill sensor which will cause the feed gate to close, activate an alarm, and inhibit weighing until the overfill condition has been corrected.

(Added 1993)

- (b) *If the system is equipped with a lower garner or surge bin, that garner shall also be equipped with an overfill sensor which will cause the gate of the weigh hopper to remain open, activate an alarm, and inhibit weighing until the overfill condition has been corrected.*

[Nonretroactive as of January 1, 1998]

(Amended 1997)

S.4. Design of Weighing Elements.

S.4.1. Antifriction Means. – 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 means, opposing surfaces and points being properly shaped, finished, and hardened.

S.4.2. Adjustable Components. – An adjustable component, such as a potentiometer, shall be held securely in adjustment and, except for a component for adjusting level or a no-load reference value, shall not be adjustable from the outside of the device.

S.4.3. Multiple Load-Receiving Elements. – A system with a single indicating or recording element, or a combination indicating recording element, that is coupled to two or more load-receiving elements with independent weighing systems, shall be provided with means to prohibit the activation of any load-receiving element (or elements) not in use, and shall be provided with automatic means to indicate clearly and definitely which load-receiving element (or elements) is in use.

S.4.4. Venting. – All weighing systems shall be vented so that any internal or external pressure will not affect the accuracy or operation of the system.

S.5. Marking Requirements. (Also see Section 1.10. General Code paragraph G-S.1. Identification.)

S.5.1. Capacity and Value of the Scale Division. – The capacity of the weighing system and the value of the scale division shall be clearly and conspicuously marked on the indicating element near the weight value indications.

S.5.2. Weighing Elements. – On a weighing element not permanently attached to an indicating element, there shall be clearly and permanently marked for the purposes of identification, the name, initials, or trademark of the manufacturer, the manufacturer's designation that positively identifies the pattern or design, and the nominal capacity.

S.5.3. Temperature Limits. – *Unless the temperature range is – 10 °C to + 40 °C (14 °F to 104 °F), the temperature range shall be marked on the device.*

[Nonretroactive as of January 1, 1986]

(Added 1985)

S.5.4. Accuracy Class.

- (a) *All systems used to weigh grain shall be marked Class III.**

- (b) *All other systems shall be marked either Class III or III L.**

*(*Also see Section 2.20. Scales Code for the parameters for these accuracy classes for scales. The specific requirements for automatic bulk weighing systems apply to these devices when there is a conflict between the Scales Code and the Automatic Bulk Weighing Systems Code.)*

[Nonretroactive as of January 1, 1986]

(Added 1985) (Amended 1992)

N. Notes

N.1. Testing Procedures.

N.1.1. Test Weights. – The increasing load test shall be conducted using test weights equal to at least 10 % of the capacity of the system:

(a) on automatic grain bulk-weighing systems installed after January 1, 1984; and

(b) on other automatic bulk-weighing systems installed after January 1, 1986.

(Amended 1987)

N.1.2. Increasing-Load Test. – An increasing-load test consisting of substitution and strain-load tests shall be conducted up to the used capacity of the weighing system.

(Amended 1987)

N.1.3. Decreasing-Load Test. – A decreasing-load test shall be conducted on devices used to weigh out.

(Added 1986)

N.1.4. Zero-Balance or No-Load Reference Value Change Test. – A test for change of zero-balance or no-load reference value shall be conducted on all scales after the removal of any test load. The change shall not be more than the minimum tolerance applicable.

N.1.5. Discrimination Test. – *A discrimination test shall be conducted on all automatic indicating scales with the weighing device in equilibrium at zero-load and at maximum test load, and under controlled conditions in which environmental factors are reduced to the extent that they will not affect the results obtained.*

[Nonretroactive as of January 1, 1986]

N.1.5.1. Digital Device. – On a digital device, this test is conducted from just below the lower edge of the zone of uncertainty for increasing-load tests, or from just above the upper edge of the zone of uncertainty for decreasing-load tests.

(Added 1987)

N.2. Verification (Testing) Standards. – Standard weights and masses used in verifying weighing devices shall comply with requirements of NIST Handbook 105-1 (Class F) or the tolerances expressed in Appendix A, Fundamental Considerations, paragraph 3.2. (i.e., one-third of the smallest tolerance applied).

T. Tolerances

T.1. Tolerance Application. – Tolerance values shall be applied to all indications and recorded representations of a weighing system.

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

T.1.2. To Increasing-Load Tests. – Basic tolerances shall be applied.

T.1.3. To Decreasing-Load Tests. – Basic tolerances shall be applied to systems used to weigh out.
(Added 1986)

T.1.4. 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 value of the scale division. This does not apply to digital indications or recorded representations that have been corrected for rounding using error weights.
(Added 1986)

T.2. Minimum Tolerance Values. – The minimum tolerance value shall not be less than half the value of the scale division.

T.2.1. For Systems Used to Weigh Construction Materials. – The minimum maintenance and acceptance tolerance shall be 0.1 % of the weighing capacity of the system, or the value of the scale division, whichever is less.
(Added 1986)

T.3. Basic Tolerance Values.

T.3.1. Acceptance Tolerance. – The basic acceptance tolerance shall be one-half the basic maintenance tolerance.

T.3.2. For Systems Used to Weigh Grain. – The basic maintenance tolerance shall be 0.1 % of test load.

T.3.3. For All Other Systems. – The basic maintenance tolerance shall be 0.2 % of test load.
(Amended 1986)

T.4. Time Dependence. – *At constant test conditions, the indication 20 seconds after the application of a load and the indication after one hour shall not differ by more than the absolute value of the applicable tolerance for the applied load.*
[Nonretroactive as of January 1, 1987]
(Added 1986)

T.5. Repeatability. – The results obtained by several weighings of the same load under reasonably static test conditions shall agree within the absolute value of the maintenance tolerance for that load, and shall be within applicable tolerances.
(Added 1986)

T.6. Discrimination, Digital Automatic Indicating Scales. – A test load equivalent to 1.4 d shall cause a change in the indicated or recorded value of at least 2.0 d. This requires the zone of uncertainty to be not greater than 0.3 times the value of the scale division.
(Added 1985)

T.7. Influence Factors. – *The following factors are applicable to tests conducted under controlled conditions only, provided that:*

(a) *types of devices approved prior to January 1, 1986, and manufactured prior to January 1, 1988, need not meet the requirements of this section; and*

(b) *new types of devices submitted for approval after January 1, 1986, shall comply with the requirements of this section; and*

(c) *all devices manufactured after January 1, 1988, shall comply with the requirements of this section.*
[Nonretroactive as of January 1, 1986]

T.7.1. Temperature. – Devices shall satisfy the tolerance requirements under the following temperature conditions:

T.7.1.1. If not marked on the device, the temperature limits shall be: – 10 °C to 40 °C (14 °F to 104 °F).

T.7.1.2. If temperature limits are specified for the device, the range shall be at least 30 °C (54 °F).

T.7.1.3. Temperature Effect on Zero-Load Balance. – The zero-load indicator shall not vary by more than one division per 5 °C (9 °F) change in temperature.

T.7.1.4. Operating Temperature. – An indicating or recording element shall not display or record any usable values until the operating temperature necessary for accurate weighing and a stable zero-balance condition has been attained.

[Nonretroactive as of January 1, 1986]

T.7.2. Barometric Pressure. – The zero indication shall not vary by more than one scale division for a change in barometric pressure of 1 kPa over the total barometric range of 95 kPa to 105 kPa (28 in to 31 in of mercury).

[Nonretroactive as of January 1, 1986]

T.7.3. Electric Power Supply.

T.7.3.1. Power Supply, Voltage, and Frequency.

- (a) Weighing devices that operate using alternating current must perform within the conditions defined in paragraphs T.2. through T.7., inclusive over the line voltage range of 100 V to 130 V or 200 V to 250 V rms as appropriate and over the frequency range of 59.5 Hz to 60.5 Hz.
- (b) Battery-operated instruments shall not indicate nor record values outside the applicable tolerance limits when battery power output is excessive or deficient.

T.7.3.2. Power Interruption. – A power interruption shall not cause an indicating or recording element to display or record any values outside the applicable tolerance limits.

[Nonretroactive as of January 1, 1986]

(Added 1985)

UR. User Requirements

UR.1. Selection Requirements.

UR.1.1. For Systems used to Weigh Grain. – The number of scale divisions of a weighing system shall not be less than 2 000 nor greater than 10 000 divisions.

[Nonretroactive as of January 1, 1984]

(Amended 1986 and 1992)

UR.1.2. For Systems used to Weigh Commodities other than Grain. – The number of scale divisions shall not be less than 500 nor greater than 10 000.

[Nonretroactive as of January 1, 1987]

(Added 1986)

UR.2. Installation Requirements.

UR.2.1. Protection from Environmental Factors. – The indicating elements, the lever system or load cells, the load-receiving element, and any permanently installed test weights shall be adequately protected from environmental factors such as wind, weather, and RFI that may adversely affect the operation or performance of the system.

UR.2.2. Foundation, Supports, and Clearance. – The foundation and supports of any system shall be such as to provide strength, rigidity, and permanence of all components, and clearance shall be provided around all live parts so that no contact can result before or during operation of the system.

UR.3. Loading Requirements.

UR.3.1. For Systems Used to Weigh Grain. – A system shall not be used to weigh drafts less than 40 % of the weighing capacity of the system except for a final partial draft. Loads shall not normally be retained on the weighing element for a period longer than a normal weighing cycle.

(Amended 1986)

UR.3.2. For Systems Used to Weigh Commodities Other than Grain. – *A system shall not be used to weigh drafts less than 20 % of the weighing capacity of the system except for a final partial draft. Loads shall not normally be retained on the weighing element for a period longer than a normal weighing cycle.*

[Nonretroactive as of January 1, 1987]

(Added 1986)

UR.4. System Modification. – The weighing system shall not be modified except when the modification has been approved by a competent engineering authority, preferably that of the engineering department of the manufacturer of the scale, and the official with statutory authority having jurisdiction over the scale.

(Amended 1991)

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Table of Contents

	Page
Section 2.23. Weights.....	2-95
A. Application	2-95
A.1. General.....	2-95
A.2. Exceptions.....	2-95
A.3. Additional Code Requirements.....	2-95
S. Specifications.....	2-95
S.1. Material.....	2-95
S.2. Design.....	2-95
S.2.1. Surface.....	2-95
S.2.2. Ring	2-95
S.3. Adjusting Material.....	2-95
S.4. Marking Requirements.....	2-95
S.4.1. General.....	2-95
S.4.2. Apothecaries' Weights.....	2-95
S.4.3. Troy Weights.....	2-95
S.4.4. Metric Weights.....	2-95
S.4.5. Carat Weights.....	2-95
S.4.6. Counterpoise Weight.....	2-95
N. Notes.....	2-96
N.1. Testing Procedures.....	2-96
T. Tolerances.....	2-96
T.1. In Excess and In Deficiency.....	2-96
T.2. On Avoirdupois Weights.....	2-96
T.3. On Metric Weights.....	2-97
T.4. On Carat Weights.....	2-97
T.5. On Apothecaries and Troy Weights.....	2-98

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Section 2.23. Weights

A. Application

A.1. General. – This code applies to commercial weights; that is, weights used in connection with commercial weighing devices.

A.2. Exceptions. – This code does not apply to test weights or to other “standards” of mass.

A.3. Additional Code Requirements. – In addition to the requirements of this code, Weights shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1. Material. – The material used for weights shall be as follows:

- (a) Weights of 6 grams or 100 grains and larger shall be made of a metal, or a metal alloy, not softer than brass.
- (b) Weights of less than 6 grams or 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 2 grams or 30 grains 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 2 grams or 30 grains, 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 symbol of the unit.

S.4.4. Metric Weights. – On metric weights, the symbols “kg,” “g,” and “mg” shall be used in combination with the nominal value of 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

N.1. Testing Procedures. – Commercial weights should be tested on a precision balance using standard weights, the errors of which, when used without correction, do not exceed $\frac{1}{3}$ of the smallest tolerance to be applied. (Also see Appendix A, Fundamental Considerations, paragraphs 3.2. Tolerance for Standards and 3.3. Accuracy of Field Standards.)

T. Tolerances

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. Maintenance Tolerance for Avoirdupois Weights. Acceptance tolerances shall be one-half the maintenance tolerances.

Table 1. Maintenance Tolerance for Avoirdupois Weights						
Maintenance Tolerance						
Nominal Value	Equal-Arm Weights		Counterpoise Weights			
			For scales with multiples of less than 1000		For scales with multiples of 1000 or over	
oz	grains	mg	grains	mg	grains	mg
$\frac{1}{64}$	0.1	6				
$\frac{1}{32}$	0.3	19				
$\frac{1}{16}$	0.4	26				
$\frac{1}{8}$	0.5	32				
$\frac{1}{4}$	1.0	65				
$\frac{1}{2}$	1.5	97	1.0	65		
1	1.7	110	1.0	65		
2	2.0	130	1.0	65		
3	2.0	130	1.5	97		
4	3.0	190	1.5	97	1.0	65
5	3.5	230	1.5	97	1.0	65
6	3.5	230	1.5	97		
8	4.0	260	2.0	130	1.5	97
10	4.0	260	2.5	160	2.0	130
12	5.0	320	2.5	160	2.0	130
lb	grains	mg	grains	mg	grains	mg
1	5.0	320	3.0	190	2.5	160
2	7.0	450	6.0	390	4.0	260
3	9.0	580	9.0	580	5.0	320
4	11.0	710	11.0	710	6.0	390
5	15.0	970	12.0	780	6.5	420
6	17.0	1190				
7	19.0	1200				
8	21.0	1400	15.0	970	9.0	580
9	23.0	1500				
10	25.0	1600	18.0	1160	10.0	650
15	28.0	1800				
20	30.0	1900				
25	35.0	2300				
30	40.0	2600				
40	45.0	2900				
50	50.0	3200				

T.3. On Metric Weights. – The maintenance tolerances shall be as shown in Table 2. Maintenance Tolerances for Metric Weights. Acceptance tolerances shall be one-half the maintenance tolerances.

T.4. On Carat Weights. – The maintenance tolerances shall be as shown in Table 2. Maintenance Tolerances for Metric Weights. Acceptance tolerances shall be one-half the maintenance tolerances.

Table 2. Maintenance Tolerances for Metric Weights			
Nominal Value (mg)	Maintenance Tolerance (mg)	Nominal Value (g)	Maintenance Tolerance (mg)
5 or less	0.1	1	4
10	0.3	2	6
20	0.4	3	8
30	0.6	5	10
50	0.8	10	15
100	1.0	20	20
200	1.5	30	30
300	2.0	50	40
500	3.0	100	70
		200	100
		300	150
		500	175
Nominal Value (kg)	Maintenance Tolerance (mg)	Nominal Value (carats)	Maintenance Tolerance (mg)
1	250	0.25*	0.6
2	400	0.5**	1.0
3	500	1.0	1.5
5	800	2.0	2.0
10	1000	3.0	3.0
20	1500	5.0	4.0
		10.0	6.0
		20.0	10.0
		30.0	12.0
		50.0	15.0
		100.0	25.0
		*25 points or less	
		**50 points	

T.5. On Apothecaries and Troy Weights. – The maintenance tolerances shall be as shown in Table 3, Maintenance Tolerances for Apothecaries' and Troy Weights. Acceptance tolerances shall be one-half the maintenance tolerances.

Table 3. Maintenance Tolerances for Apothecaries' and Troy Weights					
Nominal Value	Maintenance Tolerance		Nominal Value	Maintenance Tolerance	
grains	grains	mg	oz	grains	mg
1	0.01	0.6	1	0.4	25.0
2	0.02	1.3	2	0.6	40.0
3	0.03	2.0	3	1.0	65.0
5	0.03	2.0	4	1.5	100.0
10	0.04	2.5	5	1.6	105.0
20	0.06	4.0			
scruples	grains	mg	oz	grains	mg
1	0.06	4.0	6	1.8	115.0
2	0.10	6.5	7	1.9	125.0
			8	2.0	130.0
			9	2.1	135.0
			10	2.2	145.0
dr	grains	mg	oz	grains	mg
0.5	0.07	4.5	11	2.4	155.0
1.0	0.10	6.5	12	2.5	160.0
2.0	0.20	13.0	20	2.9	190.0
3.0	0.30	20.0	30	3.7	240.0
4.0	0.40	25.0	50	5.4	350.0
5.0	0.50	30.0			
6.0	0.60	40.0			
dwt	grains	mg	oz	grains	mg
1	0.06	4.0	100	7.7	500.0
2	0.10	6.5	200	12.3	800.0
3	0.15	10.0	300	15.4	1 000.0
4	0.20	13.0	500	23.1	1 500.0
5	0.30	20.0	1 000	38.6	2 500.0
10	0.40	25.0			

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Table of Contents

	Page
Section 2.24. Automatic Weighing Systems	103
A. Application.....	103
A.1.General.	103
A.2. Exceptions.....	103
A.3. Additional Code Requirements.....	104
S. Specifications	104
S.1. Design of Indicating and Recording Elements and of Recorded Representations.....	104
S.1.1. Zero Indication.....	104
S.1.2. Value of Division Units.....	104
S.1.3. Provision for Sealing.....	105
S.1.4. Automatic Calibration.....	105
S.1.5. Adjustable Components.....	106
S.2. Design of Zero and Tare Mechanisms.....	106
S.2.1. Zero Load Adjustment.....	106
S.2.2. Tare.....	106
S.3. Verification Scale Interval.....	106
S.3.1. Multiple Range and Multi-Interval Automatic Weighing System.....	106
S.3.2. Load Cell Verification Interval Value.....	106
S.3.3. Value of “e”.....	107
S.4.Weight Indicators, Weight Displays, Reports, and Labels.....	107
S.4.1. Additional Digits in Displays.....	107
S.4.2. Damping.....	107
S.4.3. Over Capacity Indication.....	107
S.4.4. Label Printer.....	107
S.5. Accuracy Class.....	107
S.5.1. Marking.....	107
S.6. Parameters for Accuracy Classes.....	107
S.7. Marking Requirements.....	108
S.7.1. Location of Marking Information.....	108
S.7.2. Marking Required on Components of Automatic Weighing Systems.....	110
N. Notes.....	111
N.1. Test Requirements for Automatic Weighing Systems.....	111
N.1.1. Test Pucks and Packages.....	111
N.1.2. Accuracy of Test Pucks or Packages.....	111
N.1.3. Verification (Testing) Standards.....	111
N.1.4. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility, Field Evaluation.....	111
N.1.5. Test Loads.....	111
N.2. Test Procedures.....	112
N.2.1. Non-Automatic Tests.....	112
N.2.2. Automatic Test Procedures.....	112
T. Tolerances	113
T.1. Principles.....	113
T.1.1. Design.....	113

T.1.2.	Scale Division.....	113
T.2.	Tolerance Application.....	113
T.2.1.	General.....	113
T.2.2.	Type Evaluation Examinations.....	113
T.2.3.	Subsequent Verification Examinations.....	113
T.2.4.	Multiple Range and Multi-Interval Automatic Weighing System.....	113
T.3.	Tolerance Values.....	114
T.3.1.	Tolerance Values - Class III Weigh-Labeler.....	114
T.3.2.	Tolerance Values - Class IIIS Weigh-labelers in Package Shipping Applications.....	114
T.3.3.	Tolerance Values.....	114
T.4.	Agreement of Indications.....	116
T.5.	Repeatability.....	116
T.6.	Discrimination.....	116
T.7.	Influence Factors.....	116
T.7.1.	Temperature.....	116
T.7.2.	Electric Power Supply.....	116
T.8.	Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility.....	117
UR.	User Requirements.....	117
UR.1.	Selection Requirements.....	117
UR.1.1.	General.....	117
UR.1.2.	Value of the Indicated and Recorded Scale Division.....	117
UR.2.	Installation Requirements.....	117
UR.2.1.	Protection from Environmental Factors.....	117
UR.2.2.	Foundation, Supports, and Clearance.....	117
UR.2.3.	Entry and Departure from Weighing Area.....	118
UR.3.	Use Requirements.....	118
UR.3.1.	Minimum Load.....	118
UR.3.2.	Maximum Load.....	118
UR.3.3.	Special Designs.....	118
UR.3.4.	Use of Manual Gross Weight Entries.....	118
UR.4.	Maintenance Requirements.....	118
UR.4.1.	Balance Condition.....	118
UR.4.2.	Level Condition.....	118
UR.4.3.	Automatic Weighing System Modification.....	118

Section 2.24. Automatic Weighing Systems

A. Application

A.1. General. – This code applies to devices used to automatically weigh pre-assembled discrete loads or single loads or loose materials in applications where automatic weighing systems¹ are used or employed in the determination of quantities, things, produce, or articles for distribution, for purchase, offered or submitted for sale, for distribution, purchase, or in computing any basic charge or payment for services rendered on the basis of weight, and in packaging plants subject to regulation by the USDA. Some weigh-labelers and checkweighers may also include a scale that is incorporated in a conveyor system that weighs packages in a static or non-automatic weighing mode.²

This includes:

- (a) Automatic weigh-labelers;
- (b) Combination automatic and non-automatic weigh-labelers;
- (c) Automatic checkweighers;
- (d) Combination automatic and non-automatic checkweighers; and
- (e) Automatic gravimetric filling machines that weigh discrete loads or single loads of loose materials and determine package and production lot compliance with net content representations.

(Amended 1997 and 2004)

A.2. Exceptions. – This code does not apply to:

- (a) Belt-Conveyor Scale Systems;
- (b) Railway Track Scales;
- (c) Monorail Scales;
- (d) Automatic Bulk-Weighing Systems;
- (e) Devices that measure quantity on a time basis;
- (f) Controllers or other auxiliary devices except as they may affect the weighing performance; or

¹ An automatic weighing system does not require the intervention of an operator during the weighing process. The necessity to give instructions to start a process or to release a load or the function of the instrument (static, dynamic, set-up, etc.) is not relevant in deciding the category of automatic or non-automatic instruments.

(Added 2004)

² Prepackaging scales (and other commercial devices) used for putting up packages in advance of sale are acceptable for use in commerce if all appropriate provisions of Handbook 44 are met. Users of such devices must be alert to the legal requirements relating to the declaration of quantity on a package. Such requirements are to the effect that, on the average, the contents of the individual packages of a particular commodity comprising a lot, shipment, or delivery must contain at least the quantity declared on the label. The fact that a scale or other commercial device may overregister, but within established tolerances, and is approved for commercial service is not a legal justification for packages to contain, on the average, less than the labeled quantity.

(Added 2004)

- (g) Automatic gravimetric filling machines and other automatic weighing systems employed in determining the weight of a commodity in a plant or business with a separate quantity control program (e.g., a system of statistical process control) using suitable weighing instruments and measurement standards traceable to national standards to determine production lot compliance with net content representations.³

(Added 2004)

A.3. Additional Code Requirements. – In addition to the requirements of this code, Automatic Weighing Systems shall meet the requirements of Section 1.10. General Code.

S. Specifications

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

S.1.1. Zero Indication.

- (a) A weigh-labeler shall be equipped with an indicating or recording element. Additionally, a weigh-labeler equipped with an indicating or recording element shall either indicate or record a zero-balance condition and an out-of-balance condition on both sides of zero.

(Amended 2004)

- (b) An automatic checkweigher may be equipped with an indicating or recording element.
- (c) A zero-balance condition may be indicated by other than a continuous digital zero indication, provided that effective automatic means is provided to inhibit a weighing operation or to return to a continuous digital indication when the device is in an out-of-balance condition.

S.1.1.1. Digital Indicating Elements.

- (a) A digital zero indication shall represent a balance condition that is within $\pm \frac{1}{2}$ scale division.
- (b) A digital indicating device shall either automatically maintain a “center of zero” condition to $\pm \frac{1}{4}$ scale division or less or have an auxiliary or supplemental “center-of-zero” indicator that defines a zero-balance condition to $\pm \frac{1}{4}$ scale division or less.
- (c) Verification of the accuracy of the center of zero indication to $\pm \frac{1}{4}$ scale division or less during automatic operation is not required on automatic checkweighers.

(Amended 2004)

S.1.2. Value of Division Units.

– The value of a division d expressed in a unit of weight shall be equal to:

- (a) 1, 2, or 5; or
- (b) a decimal multiple or submultiple of 1, 2, or 5.

The requirement that the value of the scale division be expressed only as 1, 2, or 5, or a decimal multiple or submultiple of only 1, 2, or 5 does not apply to net weight indications and recorded representations that are calculated from gross and tare weight indications where the scale division of the gross weight is different from the scale division of the tare weight(s) on multi-interval or multiple range scales. For example, a multiple range or multi-interval scale may indicate and record tare weights in a lower weighing range (WR) or weighing segment (WS), gross weights in the higher weighing range or weighing segment, and net weights as follows:

³ See NIST Handbook 130, “Uniform Laws and Regulations in the Area of Legal Metrology and Fuel Quality,” Interpretations and Guidelines, paragraph 2.6.11. Good Quantity Control Practices.

$ \begin{array}{r} 55 \text{ kg Gross Weight (WR2 d = 5 kg)} \\ - 4 \text{ kg Tare Weight (WR1 d = 2 kg)} \\ \hline = 51 \text{ kg Net Weight (Mathematically Correct)} \end{array} $	$ \begin{array}{r} 10.05 \text{ lb Gross Weight (WS2 d = 0.05 lb)} \\ - 0.06 \text{ lb Tare Weight (WS1 d = 0.02 lb)} \\ \hline = 9.99 \text{ lb Net Weight (Mathematically Correct)} \end{array} $
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(Amended 2008)

S.1.2.1. Weight Units. – Except for postal scales, indicating and recording elements for shipping and postal applications, and scales used to print standard pack labels, a device shall indicate weight values using only a single unit of measure.

(Amended 2004)

S.1.3. Provision for Sealing.

- (a) **Automatic Weighing Systems, Except Automatic Checkweighers.** – For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices.

For parameters adjusted using other means, a device shall be designed with provision(s) as specified in Table S.1.3. Categories of Device and Methods of Sealing for applying a security seal that must be broken, or for using other approved means of providing security (e.g., data change audit trail available at the time of inspection), before any change that detrimentally affects the metrological integrity of the device can be made to any electronic mechanism.

- (b) **For Automatic Checkweighers.** – Security seals are not required in applications where it would prohibit an authorized user from having access to the calibration functions of a device.

(Amended 2019)

Table S.1.3. Categories of Device and Methods of Sealing	
Categories of Device	Methods of Sealing
Category 1: No Remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode.	The hardware enabling access for remote communication must be at the device and sealed using a physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).	An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: Does not require 1000 changes to be stored for each parameter.)

S.1.4. Automatic Calibration. – A device may be fitted with an automatic or a semi-automatic calibration mechanism. This mechanism shall be incorporated inside the device. After sealing, neither the mechanism nor the calibration process shall facilitate fraud.

S.1.5. Adjustable Components. – Adjustable components shall be held securely in adjustment and, except for a zero-load balance mechanism, shall be located within the housing of the element.

S.2. Design of Zero and Tare Mechanisms.

S.2.1. Zero Load Adjustment.

S.2.1.1. Automatic Zero-Tracking Mechanism. – Except for automatic checkweighers, under normal operating conditions the maximum load that can be “rezeroed,” when either placed on or removed from the platform all at once, shall be 1.0 scale division.

Except for an initial zero-setting mechanism, an automatic zero adjustment outside these limits is prohibited.
(Amended 2004 and 2010)

S.2.1.2. Initial Zero-Setting Mechanism. – Except for automatic checkweighers, an initial zero-setting mechanism shall not zero a load in excess of 20 % of the maximum capacity of the automatic weighing system unless tests show that the scale meets all applicable tolerances for any amount of initial load compensated by this device within the specified range.

S.2.2. Tare. – On any automatic weighing system (except for multi-interval scales or multiple range scales when the value of tare is determined in a lower weighing range or weighing segment) the value of the tare division shall be equal to the value of the scale division. The tare mechanism shall operate only in a backward direction (i.e., in a direction of underregistration) with respect to the zero-load balance condition of the automatic weighing system. A device designed to automatically clear any tare value shall also be designed to prevent the automatic clearing of tare until a complete transaction has been indicated.

(Amended 2008)

Note: On a computing automatic weighing system, this requires the input of a unit price, the display of the unit price, and a computed positive total price at a readable equilibrium. Other devices require that a transaction or lot run be completed.

(Amended 2004)

S.3. Verification Scale Interval.

S.3.1. Multiple Range and Multi-Interval Automatic Weighing System. – The value of e shall be equal to the value of d.

S.3.2. Load Cell Verification Interval Value. – The relationship of the value for the load cell verification scale interval, v_{min} , to the scale division d for a specific scale installation shall be:

$$v_{min} \leq \frac{d}{\sqrt{N}} \text{ where } N \text{ is the number of load cells in the scale.}$$

Note: When the value of the scale division d differs from the verification scale division e for the scale, the value of e must be used in the formula above.

This requirement does not apply to complete weighing/load-receiving elements or scales which satisfy all the following criteria:

- *the complete weighing/load-receiving element or scale has been evaluated for compliance with T.7.1. Temperature under the National Type Evaluation Program (NTEP);*
- *the complete weighing/load-receiving element or scale has received an NTEP Certificate of Conformance; and*

- *the complete weighing/load-receiving element or scale is equipped with an automatic zero-tracking mechanism which cannot be made inoperative in the normal weighing mode. (A test mode which permits the disabling of the automatic zero-tracking mechanism is permissible, provided the scale cannot function normally while in this mode.)*

[Nonretroactive as of January 1, 2020]

(Amended 2019)

S.3.3. Value of “e”. – For automatic checkweighers, the value of e shall be specified by the manufacturer and may be larger than d, but in no case can e be more than ten times the value of d.

S.4. Weight Indicators, Weight Displays, Reports, and Labels.

S.4.1. Additional Digits in Displays. – Auxiliary digital displays that provide additional digits for use during performance evaluation may be included on automatic checkweighers. However, in cases where these indications are not valid for determining the actual weight of a package (e.g., only appropriate for use in statistical process control programs by users) they shall be clearly and distinctly differentiated from valid weight displays by indicating them to the user.

For example, the additional digits may be differentiated by color, partially covered by placing crosshatch overlays on the display, or made visible only after the operator presses a button or turns a key to set the device in a mode which enables the additional digits.

S.4.2. Damping. – An indicating element equipped with other than automatic recording elements shall be equipped with effective means to permit the recording of weight values only when the indication is stable within plus or minus one scale division. The values recorded shall be within applicable tolerances.

S.4.3. Over Capacity Indication. – An indicating or recording element shall not display nor record any values when the scale capacity is exceeded by nine scale divisions.

S.4.4. Label Printer. – A device that 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.

S.4.4.1. Label Printing. – If an automatic checkweigher prints a label containing weight information that will be used in a commercial transaction, it must conform to all of the requirements specified for weigh-labelers so that the printed ticket meets appropriate requirements.

S.5. Accuracy Class.

S.5.1. Marking. – Weigh-labelers and automatic checkweighers shall be Class III devices and shall be marked accordingly, except that a weigh-labeler marked Class IIIS may be used in package shipping applications.

(Amended 1997)

S.6. Parameters for Accuracy Classes. – The number of divisions for device capacity is designated by the manufacturer and shall comply with parameters shown in Table S.6. Parameters for Accuracy Classes.

Table S.6. Parameters for Accuracy Classes			
		Number of Divisions (n)	
Class	Value of the Verification Division (e)	Minimum	Maximum
SI Units			
III	0.1 g to 2 g, inclusive	100	10 000
	equal to or greater than 5 g	500	10 000
U.S. Customary Units			
III	0.000 2 lb to 0.005 lb, inclusive	100	10 000
	0.005 oz to 0.125 oz, inclusive	100	10 000
	equal to or greater than 0.01 lb	500	10 000
	equal to or greater than 0.25 oz	500	10 000
IIIS	greater than 0.01 lb	100	1 000
	greater than 0.25 oz	100	1 000
For Class III devices, the value of e is specified by the manufacturer as marked on the device; d shall not be smaller than 0.1 e. e shall be differentiated from d by size, shape, or color.			

(Amended 2004)

S.7. Marking Requirements. – [Also see G-S.1. Identification, G-S.4. Interchange or Reversal of Parts, G-S.6. Marking Operational Controls, Indications, and Features, G-S.7. Lettering, G-UR.2.1.1. Visibility of Identification, and UR.3.3. Special Designs]

S.7.1. Location of Marking Information. – Automatic weighing systems which are not permanently attached to an indicating element, and for which the load-receiving element is the only part of the weighing/load-receiving element visible after installation, may have the marking information required in Section 1.10. General Code, G-S.1. Identification, and Section 2.24. Automatic Weighing Systems Code, Table S.7.a. Marking Requirements and Table S.7.b. Notes for Table S.7.a. located in an area that is accessible only through the use of a tool; provided that the information is easily accessible (e.g., the information may appear on the junction box under an access plate). The identification information for these automatic weighing systems shall be located on the weighbridge (load-receiving element) near the point where the signal leaves the weighing element, or beneath the nearest access cover.

Table S.7.a. Marking Requirements					
To Be Marked With ↓	Weighing Equipment				
	Weighing, load-receiving, and indicating element in same housing	Indicating element not permanently attached to weighing and load-receiving element	Weighing and load-receiving element not permanently attached to indicating element	Load cell with CC (10)	Other equipment or device (9)
Manufacturer's ID (1)	X	X	X	X	X
Model Designation (1)	X	X	X	X	X
Serial Number and Prefix (2)	X	X	X	X	X (13)
Certificate of Conformance (CC) Number (16)	X	X	X	X	X (16)
Accuracy Class (14)	X	X (8)	X	X	
Nominal Capacity (3)(15)	X	X	X		
Value of Division, d (3)	X	X			
Value of e (4)	X	X			
Temperature Limits (5)	X	X	X	X	
Special Application (11)	X	X	X		
Maximum Number of Scale Divisions, $n_{\max}$ (6)		X (8)	X	X	
Minimum Verification Division, ($e_{\min}$)			X		
"S" or "M" (7)				X	
Direction of Loading (12)				X	
Minimum Dead Load				X	
Maximum Capacity (Max)	X			X	
Minimum Capacity (Min)	X				
Safe Load Limit				X	
Load Cell Verification Interval ($v_{\min}$)				X	
Maximum Belt Speed (m/sec or m/min)	X		X		
Note: Also see Table S.7.b. Notes for Table S.7.a. for applicable parenthetical notes.					

(Amended 1999)

Table S.7.b.
Notes for Table S.7.a.

1. Manufacturer's identification and model designation. (Also see G-S.1. Identification)
2. Serial number and prefix. Also see G-S.1. Identification)
3. The nominal capacity and value of the automatic weighing system division shall be shown together (e.g., 50 000 × 5 kg, or 30 × 0.01 lb) adjacent to the weight display when the nominal capacity and value of the automatic weighing system division are not immediately apparent. Each division value or weight unit shall be marked on variable-division value or division-unit automatic weighing systems.
4. Required only if different from d.
5. Required only on automatic weighing systems if the temperature range on the NTEP CC is narrower than and within – 10 °C to 40 °C (14 °F to 104 °F).
(Amended 2007)
6. This value may be stated on load cells in units of 1000; (e.g., $n_{\max}$ 10 is 10 000 divisions.)
7. Denotes compliance for single or multiple load cell applications.
8. An indicating element not permanently attached to a weighing element shall be clearly and permanently marked with the accuracy Class III, or IIIS and the maximum number of divisions, $n_{\max}$.
9. Necessary to the weighing system but having no metrological effect (e.g., auxiliary remote display, keyboard, etc.).
10. The markings may be either on the load cell or in an accompanying document; except that, if an accompanying document is provided, the serial number shall appear both on the load cell and in the document. The manufacturer's name or trademark, the model designation, and identifying symbol for the serial number shall also be marked both on the load cell and in any accompanying document.
11. An automatic weighing system designed for a special application rather than general use shall be conspicuously marked with suitable words visible to the operator and customer restricting its use to that application.
12. Required if the direction of loading the load cell is not obvious.
13. Serial number and prefix (Also see G-S.1. Identification) modules without "intelligence" on a modular system (e.g., printer, keyboard module, cash drawer, and secondary display in a point-of-sale system) are not required to have serial numbers.
14. The accuracy class of a device shall be marked on the device with the appropriate designation.
15. The nominal capacity shall be conspicuously marked on any automatic-indicating or recording automatic weighing system so constructed that the capacity of the indicating or recording element, or elements, is not immediately apparent.
16. Required only if a CC has been issued for the equipment.

S.7.2. Marking Required on Components of Automatic Weighing Systems. – The following components of automatic weighing systems shall be marked as specified in Tables S.7.a. Marking Requirements and S.7.b. Notes for Table S.7.2.a.:

- (a) Main elements and components when not contained in a single enclosure for the entire automatic weighing system;

- (b) Load cells for which Certificates of Conformance (CC) have been issued under the National Type Evaluation Program; and
- (c) Other equipment necessary to a weighing system but having no metrological effect on the weighing system.

N. Notes

N.1. Test Requirements for Automatic Weighing Systems.

N.1.1. Test Pucks and Packages.

- (a) Test pucks and packages shall be:
 - (1) representative of the type, size, and weight ranges to be weighed on a device; and
 - (2) stable while in motion, hence the length and width of a puck or package should be greater than its height.
- (b) For type evaluation the manufacturer shall supply the test pucks or packages for each range of test loads.
(Amended 1997)

N.1.2. Accuracy of Test Pucks or Packages. – The error in any test puck or package shall not exceed one-fourth ($\frac{1}{4}$) of the acceptance tolerance. If packages are used to conduct field tests on automatic weighing systems, the package weights shall be determined on a reference scale or balance with an inaccuracy that does not exceed one-fifth ($\frac{1}{5}$) of the smallest tolerance that can be applied to the device under test.

N.1.3. Verification (Testing) Standards. – Field standard weights shall comply with requirements of NIST Handbook 105-1, “Specifications and Tolerances for Field Standard Weights (Class F)” or the tolerances expressed in Fundamental Considerations, paragraph 3.2. (i.e., one-third of the smallest tolerance applied).

N.1.4. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility, Field Evaluation. – An RFI test shall be conducted at a given installation when the presence of RFI has been verified and characterized if those conditions are considered “usual and customary.”
(Added 2004)

N.1.5. Test Loads.

N.1.5.1. Initial Verification. – An initial verification test shall be conducted at a minimum of four different test loads according to Table N.1.5.1 Initial Verification Test Loads.
(Added 2025)

Table N.1.5.1 Initial Verification Test Loads
At or near minimum capacity
At or near maximum capacity
At two (2) critical points between minimum and maximum capacity
Tests may be conducted at other loads if the device is intended for use at other specific capacities

(Amended 2025)

N.1.5.2. Subsequent Verification. – Subsequent tests shall be conducted at a minimum of two different test loads at or near the minimum load and the maximum load expected during normal operation.

(Added 2025)

(Amended 2025)

N.2. Test Procedures.

N.2.1. Non-Automatic Tests. – If the automatic weighing system is designed to operate non-automatically and is used in that manner during normal operation, it shall be tested non-automatically using mass standards. The device shall not be tested non-automatically if it is used only in the automatic mode.

N.2.1.1. Increasing-Load Test. – The increasing-load test shall be conducted with the test loads approximately centered on the load-receiving element of the scale.

N.2.1.2. Decreasing-Load Test. – The decreasing-load test shall be conducted with the test loads approximately centered on the load-receiving element of the scale.

N.2.1.3. Shift Test. – To determine the effect of off-center loading, a test load equal to one-third ($\frac{1}{3}$) maximum capacity shall be placed in the center of each of the four points equidistant between the center and front, left, back, and right edges of the load receiver.

(Amended 2025)

N.2.1.4. Discrimination Test. – A discrimination test shall be conducted with the weighing device in equilibrium at zero-load and at maximum test load, and under controlled conditions in which environmental factors are reduced to the extent that they will not affect the results obtained. This test is conducted from just below the lower edge of the zone of uncertainty for increasing-load tests, or from just above the upper edge of the zone of uncertainty for decreasing-load tests.

N.2.1.5. Zero-Load Balance Change. – A zero-load balance change test shall be conducted on all automatic weighing systems after the removal of any test load. The zero-load balance should not change by more than the minimum tolerance applicable. (Also see G-UR.4.2. Abnormal Performance)

(Amended 2004 and 2025)

N.2.2. Automatic Test Procedures.

N.2.2.1. Automatic Tests for Weigh-Labelers. – The device shall be tested at the normal operating speed using test pucks or packages per N.1.1. Test Pucks and Packages. and N.1.2. Accuracy of Test Pucks or Packages. Each test load should be run a minimum of ten consecutive times.

(Amended 2025)

N.2.2.2. Automatic Tests for Automatic Checkweighers. – The device shall be tested at the highest speed in each weight range using test pucks or packages per N.1.1. Test Pucks and Packages. and N.1.2. Accuracy of Test Pucks or Packages. The number of consecutive test weighments shall be as specified in Table N.2.2.2. Number of Sample Weights per Test for Automatic Checkweighers.

(Amended 2025)

N.2.2.3. Shift Test (Dynamic). – The device shall be tested at the normal operating speed. A test load equal to one-third ($\frac{1}{3}$) maximum capacity shall be passed over the load receiver or transport belt (1) halfway between the center and front edge a minimum of 10 consecutive times, and (2) halfway between the center and back edge a minimum of 10 consecutive times.

Note: The shift test is not applicable if the device has a means to align packages.

(Added 2024)

(Amended 2004, 2024, and 2025)

Table N.2.2.2. Number of Sample Weights per Test for Automatic Checkweighers		
Weighing Range $m = \text{mass of test load}$	Number of Sample Weights per Test	
	Field	Type Evaluation
20 divisions $\leq m \leq 10 \text{ kg}$ 20 divisions $\leq m \leq 22 \text{ lb}$	30	60
10 kg $< m \leq 25 \text{ kg}$ 22 lb $< m \leq 55 \text{ lb}$	16	32
25 kg $< m \leq 100 \text{ kg}$ 55 lb $< m \leq 220 \text{ lb}$	10	20
100 kg (220 lb) $< m$	10	10

(Amended 2025)

T. Tolerances

T.1. Principles.

T.1.1. Design. – The tolerance for a weighing device is a performance requirement independent of the design principle used.

T.1.2. Scale Division. – The tolerance for a weighing device is related to the value of the scale division (d) or the value of the verification scale division (e) and is generally expressed in terms of d or e. The random tolerance for automatic checkweighers is expressed in terms of Maximum Allowable Variance (MAV).

T.2. Tolerance Application.

T.2.1. General. – The tolerance values are positive (+) and negative (–) with the weighing device adjusted to zero at no load. When tare is in use, the tolerance values are applied from the tare zero reference (zero net weight indication); the tolerance values apply to the net weight indication for any possible tare load using certified test loads.

(Amended 2008)

T.2.2. Type Evaluation Examinations. – For type evaluation examinations, the tolerance values apply to increasing and decreasing load tests within the temperature and power supply limits specified in T.7. Influence Factors.

(Amended 2004)

T.2.3. Subsequent Verification Examinations. – For subsequent verification examinations, the tolerance values apply regardless of the influence factors in effect at the time of the conduct of the examination. (Also see G-N.2. Testing with Nonassociated Equipment.)

(Added 2007)

T.2.4. Multiple Range and Multi-Interval Automatic Weighing System. – For multiple range and multi-interval devices, the tolerance values are based on the value of the scale division of the range in use.

T.3. Tolerance Values.

Table T.3. Class III - Tolerance in Divisions (e)		
Test Load in Divisions	Tolerance in Divisions	
Class III	Acceptance	Maintenance
0 to 500	± 0.5	± 1
501 to 2000	± 1.0	± 2
2001 to 4000	± 1.5	± 3
4001 +	± 2.5	± 5

T.3.1. Tolerance Values - Class III Weigh-Labeler. (Also see Section T.3.2. Class IIIS Weigh-Labelers.)

T.3.1.1. Non-automatic Tests. – Tolerance values shall be as specified in Table T.3. Class III - Tolerance in Divisions (e).

(Amended 2004)

T.3.1.2. Automatic Tests. – Acceptance tolerance values shall be the same as maintenance tolerance values specified in Table T.3. Class III - Tolerance in Divisions (e).

(Amended 2004)

T.3.2. Tolerance Values - Class IIIS Weigh-labelers in Package Shipping Applications.

T.3.2.1. Non-automatic Tests. – Tolerance values shall be as specified in Table T.3.2.1. Non-automatic Tolerances for Class IIIS Weigh-labelers.

(Amended 2004)

T.3.2.2. Automatic Tests. – Tolerance values specified in Table T.3.2.2. Automatic Tolerances for Class IIIS Weigh-labelers shall be applied.

(Amended 2004)

(Added 1997)

Table T.3.2.1. Non-Automatic Tolerances for Class IIIS Weigh-Labelers		
Test Load in Divisions	Tolerance in Divisions	
Class IIIS	Acceptance	Maintenance
0 to 50	± 0.5	± 1
51 to 200	± 1.0	± 2
201 to 1 000	± 1.5	± 3

(Added 1997) (Amended 2004)

Table T.3.2.2. Automatic Tolerances for Class IIIS Weigh-Labelers		
Test Load in Divisions	Tolerance in Divisions	
Class IIIS	Acceptance	Maintenance
0 to 50	± 1.5	± 2
51 to 200	± 2.0	± 3
201 to 1 000	± 2.5	± 4

(Added 1997) (Amended 2004)

T.3.3. Tolerance Values. – Automatic Checkweighers.**T.3.3.1. Laboratory Tests for Automatic Checkweighers.**

T.3.3.1.1. Non-Automatic Tests. – The acceptance tolerance values specified in Table T.3. Class III - Tolerance in Divisions (e), shall be applied.

(Amended 2004)

T.3.3.1.2. Automatic Tests.

- (a) The systematic error for each test run shall be within the acceptance tolerances specified in Table T.3. Class III - Tolerance in Divisions (e) for the test loads specified in Table N.1.5. Test Loads.

(Amended 2004)

- (b) The standard deviation of the results shall not exceed one-ninth ($\frac{1}{9}$) of the MAV for specific package weights (which means that three standard deviations cannot exceed one-third ($\frac{1}{3}$) of the MAV value) as required in the latest edition of NIST Handbook 133, “Checking the Net Contents of Packaged Goods.” This value does not change regardless of whether acceptance or maintenance tolerances are being applied to the device under test.

(Amended 2004)

- (1) For U.S. Department of Agriculture (USDA) inspected meat and poultry products packaged at a plant subject to inspection by the USDA Food Safety and Inspection Service, use NIST Handbook 133, Appendix A. Tables, Table 2-9, U.S. Department of Agriculture, Meat and Poultry, Groups and Lower Limits for Individual Packages;

- (2) for all other packages with a labeled net quantity in terms of weight, use NIST Handbook 133, Appendix A. Tables, Table 2-5, Maximum Allowable Variations (MAVs) for Packages Labeled by Weight; or

- (3) for all packages with a labeled net quantity in terms of liquid or dry volume use NIST Handbook 133, Appendix A. Tables, Table 2-6, Maximum Allowable Variations (MAVs) for Packages Labeled by Liquid or Dry Volume.

(Amended 2004)

T.3.3.2. Field Tests for Automatic Checkweighers.

T.3.3.2.1. Non-Automatic Test. – The tolerance values shall be as specified in Table T.3. Class III – Tolerance in Divisions (e).

(Amended 2004)

T.3.3.2.2. Automatic Test.

- (a) The systematic error requirement is not applied in a field test.

- (b) The standard deviation of the test results shall not exceed one-ninth ($\frac{1}{9}$) of the MAV for specific package weights (which means that three standard deviations cannot exceed one-third ($\frac{1}{3}$) of the MAV value) as required in the latest edition of NIST Handbook 133. This value does not change regardless of whether acceptance or maintenance tolerances are being applied to the device under test.

(Amended 2004)

- (1) For USDA inspected meat and poultry products packaged at a plant subject to inspection by the USDA Food Safety and Inspection Service, use NIST Handbook 133, Appendix A, Tables, Table 2-9, U.S. Department of Agriculture, Meat and Poultry, Groups and Lower Limits for Individual Packages;

- (2) for all other packages with a labeled net quantity in terms of weight, use NIST Handbook 133, Appendix A. Tables, Table 2-5, Maximum Allowable Variations (MAVs) for Packages Labeled by Weight; or
- (3) for all packages with a labeled net quantity in terms of liquid or dry volume use NIST Handbook 133, Appendix A. Tables, Table 2-6. Maximum Allowable Variations (MAVs) for Packages Labeled by Liquid or Dry Volume.

T.4. Agreement of Indications. – In the case of a weighing system equipped with more than one indicating element or indicating element and recording element combination, the difference in the weight value indications of any load shall not be greater than the absolute value of the applicable tolerance for that load and shall be within tolerance limits.

T.5. Repeatability. – The results obtained from several weighings of the same load under reasonably constant test conditions shall agree within the absolute value of the maintenance tolerance for that load and shall be within applicable tolerances.

(Amended 2004)

T.6. Discrimination. – A test load equivalent to 1.4 d shall cause a change in the indicated or recorded value of at least 2.0 d. This requires the zone of uncertainty to be not greater than 0.3 d (See N.2.1.4. Discrimination Test).

(Amended 2004)

T.7. Influence Factors. – The following factors are applicable to tests conducted under controlled conditions only.

T.7.1. Temperature. – Devices shall satisfy the tolerance requirements under the following temperature conditions:

T.7.1.1. if not specified in the operating instructions or if not marked on the device, the temperature limits shall be: – 10 °C to 40 °C (14 °F to 104 °F).

T.7.1.2. if temperature limits are specified for the device, the range shall be at least 30 °C (54 °F).

T.7.1.3. Temperature Effect on Zero-Load Balance. – The zero-load indication shall not vary by more than one division per 5 °C (9 °F) change in temperature.

T.7.1.4. Operating Temperature. – The indicating or recording element shall not display nor record any usable values until the operating temperature necessary for accurate weighing and a stable zero balance condition have been attained.

T.7.2. Electric Power Supply.

T.7.2.1. Range of Voltages.

- (a) Automatic weighing systems that operate using alternating current must perform within the conditions defined in paragraphs T.3. Tolerance Values through T.6. Discrimination, inclusive, when tested over the range of – 15 % to + 10 % of the marked nominal line voltage(s) at 60 Hz, or the voltage range marked by the manufacturer, at 60 Hz.
- (b) Automatic weighing systems that operate using DC current must perform within the conditions defined in paragraphs T.3. Tolerance Values through T.6. Discrimination, inclusive, when tested

over the range from minimum operating voltage⁴ to + 20 % of the voltage marked on the instrument (nominal voltage).

- (c) Battery-operated electronic automatic weighing systems with external or plug-in power supply (AC or DC) shall either continue to function correctly or not indicate any weight values if the voltage is below the manufacturer's specified value, the latter being larger than or equal to the minimum operating voltage.⁴

Note: This requirement applies only to metrologically significant voltage supplies.

(Amended 2001)

(Amended 2004)

T.7.2.2. Power Interruption. – A power interruption shall not cause an indicating or recording element to display or record any values outside the applicable tolerance limits.

T.8. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility. – The difference between the weight indication with the disturbance and the weight indication without the disturbance (also see N.1.4. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility, Field Evaluation) shall not exceed one scale division (d) or the equipment shall:

- (a) blank the indication;
- (b) provide an error message; or
- (c) the indication shall be so completely unstable that it could not be interpreted, or transmitted into memory or to a recording element, as a correct measurement value.

(Amended 2004)

UR. User Requirements

UR.1. Selection Requirements. – 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 capacity, number of scale divisions, value of the scale division or verification scale division, minimum capacity, and computing capability.

UR.1.1. General. – Automatic Weighing Systems shall be designated by the manufacturer for that service.

UR.1.2. Value of the Indicated and Recorded Scale Division. – The value of the division as recorded shall be the same as the division value indicated.

UR.2. Installation Requirements.

UR.2.1. Protection from Environmental Factors. – The indicating elements, the lever system or load cells, and the load-receiving element of a permanently installed scale, and the indicating elements of a scale not intended to be permanently installed, shall be adequately protected from environmental factors such as wind, weather, and RFI that may adversely affect the operation or performance of the device.

UR.2.2. 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

⁴ The minimum operating voltage is defined as the lowest possible operating voltage before the automatic weighing system no longer indicates nor records weight values.

(Added 2004)

provided around all live parts to the extent that no contacts may result when the load-receiving element is empty, nor throughout the weighing range of the scale.

UR.2.3. Entry and Departure from Weighing Area. – The belt or other conveyance that introduces the weighed load to the weighing zone and that carries the weighed load away from the weighing zone shall be maintained per the manufacturer's recommendations.

UR.3. Use Requirements.

UR.3.1. Minimum Load. – The minimum load shall be as specified by the manufacturer, but not less than twenty divisions since, the use of a device to weigh light loads is likely to result in relatively large errors.

UR.3.1.1. Minimum Load for Class IIIS Weigh-Labelers. – The minimum load shall be as specified by the manufacturer, but not less than ten divisions, since the use of a device to weigh light loads is likely to result in relatively large errors.

(Added 1997)

UR.3.2. Maximum Load. – An automatic weighing system shall not be used to weigh a load of more than its maximum capacity.

(Amended 2004)

UR.3.3. Special Designs. – An automatic weighing system designed and marked for a special application shall not be used for other than its intended purpose.

UR.3.4. Use of Manual Gross Weight Entries. – Manual entries are permitted only when a device or system is generating labels for standard weight packages.

UR.4. Maintenance Requirements.

UR.4.1. Balance Condition. – If an automatic weighing system is equipped with a zero-load display, the zero-load adjustment of an automatic weighing system shall be maintained so that the device indicates or records a zero-balance condition.

UR.4.2. Level Condition. – If an automatic weighing system is equipped with a level-condition indicator, the automatic weighing system shall be maintained in level.

UR.4.3. Automatic Weighing System Modification. – The length or the width of the load-receiving element of an automatic weighing system shall not be increased beyond the manufacturer's design dimension, nor shall the capacity of an automatic weighing system be increased beyond its design capacity by replacing or modifying the original primary indicating or recording element with one of a higher capacity, except when the modification has been approved by competent engineering authority, preferably that of the engineering department of the manufacturer of the automatic weighing system, and by the weights and measures authority having jurisdiction over the automatic weighing system.

Table of Contents

	Page
Section 2.25. Weigh-In-Motion Systems Used for Vehicle Enforcement Screening – Tentative Code	2-121
A. Application	2-121
A.1. General	2-121
A.2. Exception	2-121
A.3. Additional Code Requirements	2-121
S. Specifications	2-121
S.1. Design of Indicating and Recording Elements and of Recorded Representations	2-121
S.1.1. Ready Indication	2-121
S.1.2. Value of System Division Units	2-121
S.1.3. Maximum Value of Division	2-121
S.1.4. Value of Other Units of Measure	2-121
S.1.5. Capacity Indication	2-122
S.1.6. Identification of a Fault	2-122
S.1.7. Recorded Representations	2-122
S.1.8. Value of the Indicated and Recorded System Division	2-122
S.2. System Design Requirements	2-122
S.2.1. Violation Parameters	2-122
S.3. Design of Weighing Elements	2-123
S.3.1. Multiple Load-Receiving Elements	2-123
S.4. Design of Weighing Devices, Accuracy Class	2-123
S.4.1. Designation of Accuracy	2-123
S.5. Marking Requirements	2-123
S.5.1. Location of Marking Information	2-123
N. Notes	2-123
N.1. Test Procedures	2-123
N.1.1. Selection of Test Vehicles	2-123
N.1.2. Test Loads	2-124
N.1.3. Reference Scale	2-124
N.1.4. Test Speeds	2-124
N.1.5. Test Procedures	2-124
T. Tolerances	2-125
T.1. Principles	2-125
T.1.1. Design	2-125
T.2. Tolerance Values for Accuracy Class A	2-125
T.2.1. Tests Involving Digital Indications or Representations	2-125
T.2.2. Tolerance Values for Dynamic Load Test	2-125
T.2.3. Tolerance Value for Vehicle Position Test	2-125
T.2.4. Tolerance Value for Axle Spacing	2-125
T.3. Influence Factors	2-125
T.3.1. Temperature	2-126
T.4. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility	2-126
UR. User Requirements	2-126
UR.1. Selection Requirements	2-126

UR.1.1. General.....	2-126
UR.2. User Location Conditions and Maintenance.	2-126
UR.2.1. System Modification.....	2-126
UR.2.2. Foundation, Supports, and Clearance.....	2-126
UR.2.3. Access to Weighing Elements.....	2-126
UR.3. Maximum Load.....	2-126
Appendix D. Definitions	2-127
axle.	2-127
axle-group load.	2-127
axle load.....	2-127
axle spacing.	2-127
single-axle load.....	2-127
tandem-axle load.....	2-127
triple-axle load.....	2-127
weigh-in-motion (WIM).	2-127
weigh-in-motion screening scale.	2-127
wheel weight.....	2-127
WIM System.....	2-127

Section 2.25. Weigh-In-Motion Systems Used for Vehicle Enforcement Screening – Tentative Code

This tentative code has a trial or experimental status and is not intended to be enforced. The requirements are designed for study prior to the development and adoption of a final code. Officials wanting to conduct an official examination of a device or system are advised to see paragraph G-A.3. Special and Unclassified Equipment.

(Tentative Code Added 2015)

A. Application

A.1. General. – This code applies to systems used to weigh vehicles, while in motion, for the purpose of screening and sorting the vehicles based on the vehicle weight to determine if a static weighment is necessary.

A.2. Exception. – This code does not apply to weighing systems intended for the collection of statistical traffic data.

A.3. Additional Code Requirements. – In addition to the requirements of this code, weigh-in-motion screening systems shall meet the requirements of Section 1.10. General Code.

S. Specifications

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

S.1.1. Ready Indication. – The system shall provide a means of verifying that the system is operational and ready for use.

S.1.2. Value of System Division Units. – The value of a system division “d” expressed in a unit of weight shall be equal to:

- (a) 1, 2, or 5; or
- (b) a decimal multiple or submultiple of 1, 2, or 5.

Examples: divisions may be 10, 20, 50, 100; or 0.01, 0.02, 0.05; or 0.1, 0.2, 0.5, etc.

S.1.2.1. Units of Measure. – The system shall indicate weight values using only a single unit of measure.

S.1.3. Maximum Value of Division. – The value of the system division “d” for a Class A, weight-in-motion system shall not be greater than 50 kg (100 lb).

S.1.4. Value of Other Units of Measure.

S.1.4.1. Speed. – Vehicle speeds shall be measured in miles per hour or kilometers per hour.

S.1.4.2. Axle-Spacing (Length). – The center-to-center distance between any two successive axles shall be measured in:

- (a) meters and decimal submultiples of a meter;
- (b) feet and inches; or
- (c) feet and decimal submultiples of a foot.

S.1.4.3. Vehicle Length. – If the system is capable of measuring the overall length of the vehicle, the length of the vehicle shall be measured in feet and/or inches, or meters.

S.1.5. Capacity Indication. – An indicating or recording element shall not display nor record any values greater than 105 % of the specified capacity of the load receiving element.

S.1.6. Identification of a Fault. – Fault conditions shall be presented to the operator in a clear and unambiguous means. The following fault conditions shall be identified:

- (a) Vehicle speed is below the minimum or above the maximum speed as specified.
- (b) The maximum number of vehicle axles as specified has been exceeded.
- (c) A change in vehicle speed greater than that specified has been detected.

S.1.7. Recorded Representations.

S.1.7.1. Values to be Recorded. – At a minimum, the following values shall be printed and/or stored electronically for each vehicle weighment:

- (a) transaction identification number;
- (b) lane identification (required if more than one lane at the site has the ability to weigh a vehicle in motion);
- (c) vehicle speed;
- (d) number of axles;
- (e) weight of each axle;
- (f) identification and weight of axle groups;
- (g) axle spacing;
- (h) total vehicle weight;
- (i) all fault conditions that occurred during the weighing of the vehicle;
- (j) violations, as identified in paragraph S.2.1. Violation Parameters, which occurred during the weighing of the vehicle; and
- (k) time and date.

S.1.8. Value of the Indicated and Recorded System Division. – The value of the system’s division “(d),” as recorded, shall be the same as the division value indicated.

S.2. System Design Requirements.

S.2.1. Violation Parameters. – The instrument shall be capable of accepting user-entered violation parameters for the following items:

- (a) single axle weight limit;
- (b) axle group weight limit;

- (c) gross vehicle weight limit; and
- (d) bridge formula maximum.

The instrument shall display and/or record violation conditions when these parameters have been exceeded.

S.3. Design of Weighing Elements.

S.3.1. Multiple Load-Receiving Elements. – An instrument with a single indicating or recording element, or a combination indicating-recording element, that is coupled to two or more load-receiving elements with independent weighing systems, shall be provided with means to prohibit the activation of any load-receiving element (or elements) not in use, and shall be provided with automatic means to indicate clearly and definitely which load receiving element (or elements) is in use.

S.4. Design of Weighing Devices, Accuracy Class.

S.4.1. Designation of Accuracy. – Weigh-in-motion systems meeting the requirements of this code shall be designated as accuracy Class A.

Note: This does not preclude higher accuracy classes from being proposed and added to this Code in the future when it can be demonstrated that weigh-in-motion systems grouped within those accuracy classes can achieve the higher level of accuracy specified for those devices.

S.5. Marking Requirements. – In addition to the marking requirements in G-S.1. Identification (except G.S.1.(e)), the system shall be marked with the following information:

- (a) accuracy class;
- (b) value of the system division “d”;
- (c) operational temperature limits;
- (d) number of instrumented lanes (not required if only one lane is instrumented);
- (e) minimum and maximum vehicle speed;
- (f) maximum number of axles per vehicle;
- (g) maximum change in vehicle speed during weighment; and
- (h) minimum and maximum load.

S.5.1. Location of Marking Information. – The marking information required in Section 1.10. General Code, G-S.1. Identification and Section 2.25. Weigh-in-Motion Systems, S.5. Marking Requirements shall be visible after installation. The information shall be marked on the system or recalled from an information screen.

N. Notes

N.1. Test Procedures.

N.1.1. Selection of Test Vehicles. – All dynamic testing associated with the procedures described in each of the subparagraphs of N.1.5 shall be performed with a minimum of two test vehicles.

- (a) The first test vehicle may be a two-axle, six-tire, single-unit truck; that is, a vehicle with two axles with the rear axle having dual wheels. The vehicle shall have a maximum gross vehicle weight of 10 000 lb.
- (b) The second test vehicle shall be a five-axle, single-trailer truck with a maximum gross vehicle weight of 80 000 lb.

Note: Consideration should be made for testing the systems using vehicles which are typical to the system's daily operation.

N.1.1.1. Weighing of Test Vehicles. – All test vehicles shall be weighed on a reference scale before being used to conduct the dynamic tests.

N.1.1.2. Determining Reference Weights for Axle, Axle Groups, and Gross Vehicle Weight. – The reference weights shall be the average weight value of a minimum of three static weighments of all single axles, axle groups, and gross vehicle weight.

Note: The axles within an axle group are not considered single axles.

N.1.2. Test Loads.

N.1.2.1. Static Test Loads. – All static test loads shall use certified test weights.

N.1.2.2. Dynamic Test Loads. – Test vehicles used for dynamic testing shall be loaded to 85 % to 95 % of their legal maximum Gross Vehicle Weight. The “load” shall be non-shifting and shall be positioned to present as close as possible, an equal side-to-side load.

N.1.3. Reference Scale. – Each reference vehicle shall be weighed statically on a multiple platform vehicle scale comprised of three individual weighing/load-receiving elements, each an independent scale. The three individual weighing/load receiving elements shall be of such dimension and spacing to facilitate:

- (a) the single-draft weighing of all reference test vehicles;
- (b) the simultaneous weighing of each single axle and axle group of the reference test vehicles on different individual elements of the scale; and
- (c) gross vehicle weight determined by summing the values of the different reference axle and reference axle groups of a test vehicle.

The scale shall be tested immediately prior to using it to establish reference test loads and in no case more than 24 hours prior. To qualify for use as a suitable reference scale, it must meet NIST Handbook 44, Class III L maintenance tolerances.

N.1.3.1. Location of a Reference Scale. – The location of the reference scale must be considered since vehicle weights will change due to fuel consumption.

N.1.4. Test Speeds. – All dynamic tests shall be conducted within 20 % below or at the posted speed limit.

N.1.5. Test Procedures.

N.1.5.1. Dynamic Load Test. – The dynamic test shall be conducted using the test vehicles defined in N.1.1. Selection of Test Vehicles. The test shall consist of a minimum of 20 runs for each test vehicle at the speed as stated in N.1.4. Test Speeds.

At the conclusion of the dynamic test, there will be a minimum of 20 weight readings for each single axle, axle group, and gross vehicle weight of the test vehicle. The tolerance for each weight reading shall be based on the percentage values specified in Table T.2.2. Tolerances for Accuracy Class A.

N.1.5.2. Vehicle Position Test. – During the conduct of the dynamic testing, ensure the vehicle stays within the defined roadway along the width of the sensor. The test shall be conducted with 10 runs with the vehicle centered along the width of the sensor; 5 runs with the vehicle on the right side along the width of the sensor; and 5 runs with the vehicle on the left side along the width of the sensor. Only gross vehicle weight is used for this test and the tolerance for each weighment shall be based on the tolerance value specified in T.2.3. Tolerance Value for Vehicle Position Test.

N.1.5.3. Axle Spacing Test. – The axle spacing test is a review of the displayed and/or recorded axle spacing distance of the test vehicles. The tolerance value for each distance shall be based on the tolerance value specified in T.2.4. Tolerance Value for Axle Spacing.

T. Tolerances

T.1. Principles.

T.1.1. Design. – The tolerance for a weigh-in-motion system is a performance requirement independent of the design principle used.

T.2. Tolerance Values for Accuracy Class A.

T.2.1. Tests Involving Digital Indications or Representations. – To the tolerances that would otherwise be applied in paragraphs T.2.2. Tolerance Value for Dynamic Load Test and T.2.3. Tolerance Value for Vehicle Position Test, there shall be added an amount equal to one-half the value of the scale division to account for the uncertainty of digital rounding.

T.2.2. Tolerance Values for Dynamic Load Test. – The tolerance values applicable during dynamic load testing are as specified in Table T.2.2.

Table T.2.2. Tolerances for Accuracy Class A	
Load Description*	Tolerance as a Percentage of Applied Test Load
Axle Load	± 20 %
Axle Group Load	± 15 %
Gross Vehicle Weight	± 10 %
* No more than 5 % of the weighments in each of the load description subgroups shown in this table shall exceed the applicable tolerance.	

T.2.3. Tolerance Value for Vehicle Position Test. – The tolerance value applied to each gross vehicle weighment is ± 10 % of the applied test load.

T.2.4. Tolerance Value for Axle Spacing. – The tolerance value applied to each axle spacing measurement shall be ± 0.15 m (0.5 ft).

T.3. Influence Factors. – The following factor is applicable to tests conducted under controlled conditions only.

T.3.1. Temperature. – Systems shall satisfy the tolerance requirements under all operating temperature unless a limited operating temperature range is specified by the manufacturer.

T.4. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility. – The difference between the weight indication due to the disturbance and the weight indication without the disturbance shall not exceed the tolerance value as stated in Table T.2.2. Tolerances for Accuracy Class A.

UR. User Requirements

UR.1. Selection Requirements. – 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 capacity, number of scale divisions, value of the scale division, or verification scale division and minimum capacity.

UR.1.1. General. – The typical class or type of device for particular weighing applications is shown in Table 1. Typical Class or Type of Device for Weighing Applications.

Table 1. Typical Class or Type of Device for Weighing Applications	
Class	Weighing Application
A	Screening and sorting of vehicles based on axle, axle group, and gross vehicle weight.
Note: A WIM system with a higher accuracy class than that specified as “typical” may be used.	

UR.2. User Location Conditions and Maintenance. – The system shall be installed and maintained as defined in the manufacturer’s recommendation.

UR.2.1. System Modification. – The dimensions (e.g., length, width, thickness, etc.) of the load receiving element of a system shall not be changed beyond the manufacturer’s specifications, nor shall the capacity of a scale be increased beyond its design capacity by replacing or modifying the original primary indicating or recording element with one of a higher capacity, except when the modification has been approved by a competent engineering authority, preferably that of the engineering department of the manufacturer of the system, and by the weights and measures authority having jurisdiction over the system.

UR.2.2. Foundation, Supports, and Clearance. – The foundation and supports shall be such as to provide strength, rigidity, and permanence of all components.

On load-receiving elements, which use moving parts for determining the load value, clearance shall be provided around all live parts to the extent that no contacts may result when the load-receiving element is empty, nor throughout the weighing range of the system.

UR.2.3. Access to Weighing Elements. – If necessary, adequate provision shall be made for inspection and maintenance of the weighing elements.

UR.3. Maximum Load. – A system shall not be used to weigh a load of more than the marked maximum load of the system.

Appendix D. Definitions

The specific code to which the definition applies is shown in the [brackets] at the end of the definition. Definitions for the General Code [1.10] apply to all codes in NIST Handbook 44.

A

axle. – The axis oriented transversely to the nominal direction of vehicle motion, and extending the full width of the vehicle, about which the wheel(s) at both ends rotate. [2.25]

axle-group load. – The sum of all tire loads of the wheels on a group of adjacent axles; a portion of the gross-vehicle weight. [2.25]

axle load. – The sum of all tire loads of the wheels on an axle; a portion of the gross-vehicle weight. [2.25]

axle spacing. – The distance between the centers of any two axles. When specifying axle spacing, the axels used also need to be identified. [2.25]

S

single-axle load. – The load transmitted to the road surface by the tires lying on the same longitudinal axis (that axis transverse to the movement of the vehicle and about which the wheels rotate). [2.25]

T

tandem-axle load. – The load transmitted to the road surface by the tires of two single-axles lying on the same longitudinal axis (that axis transverse to the movement of the vehicle and about which the wheels rotate). [2.25]

triple-axle load. – The load transmitted to the road surface by the tires of three single-axles lying on the same longitudinal axis (that axis transverse to the movement of the vehicle and about which the wheels rotate). [2.25]

W

weigh-in-motion (WIM). – A process of estimating a moving vehicle's gross weight and the portion of that weight that is carried by each wheel, axle, or axle group, or combination thereof, by measurement and analysis of dynamic vehicle tire forces. [2.25]

weigh-in-motion screening scale. – A weigh-in-motion system used to identify potentially overweight vehicles. [2.25]

wheel weight. – The weight value of any single or set of wheels on one side of a vehicle on a single axle. [2.25]

WIM System. – A set of sensors and supporting instruments that measure the presence of a moving vehicle and the related dynamic tire forces at specified locations with respect to time; estimate tire loads; calculate speed, axle spacing, vehicle class according to axle arrangement, and other parameters concerning the vehicle; and process, display, store, and transmit this information. This standard applies only to highway vehicles. [2.25]

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Section 3

Table of Contents

	Page
3.30. Liquid-Measuring Devices	3-3
3.31. Vehicle-Tank Meters	3-29
3.32. LPG and Anhydrous Ammonia Liquid-Measuring Devices	3-45
3.33. Hydrocarbon Gas Vapor-Measuring Devices.....	3-63
3.34. Cryogenic Liquid-Measuring Devices.....	3-75
3.35. Milk Meters	3-87
3.36. Water Meters	3-97
3.37. Mass Flow Meters	3-107
3.38. Carbon Dioxide Liquid-Measuring Devices.....	3-123
3.39. Hydrogen Gas-Measuring Devices.....	3-139
3.40. Electric Vehicle Fueling Systems.....	3-151
3.41. Non-Utility Electricity-Measuring Systems – Tentative Code.....	3-165

Note: In this section of Handbook 44, the reference temperature for the temperature compensation of refined petroleum products is shown as “15 °C (60 °F).” Although these values are not exact equivalents, they reflect industry usage when the SI and U.S. customary units are used in measurements.

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Table of Contents

Section 3.30.	Liquid-Measuring Devices.....	3-5
A.	Application	3-5
A.1.	General.....	3-5
A.2.	Exceptions.....	3-5
A.3.	Additional Code Requirements	3-5
S.	Specifications.....	3-5
S.1.	Indicating and Recording Elements and Recorded Representations.	3-5
S.1.1.	General.....	3-5
S.1.2.	Units.....	3-5
S.1.3.	Advancement of Indicating and Recording Elements	3-6
S.1.4.	Graduations.....	3-6
S.1.5.	Indicators.	3-6
S.1.6.	Additional Operating Requirements, Retail Devices (Except Slow-flow Meters).....	3-7
S.1.7.	Additional Operating Requirements, Wholesale Devices Only.	3-12
S.2.	Measuring Elements.....	3-12
S.2.1.	Air/Vapor Elimination.	3-12
S.2.2.	Provision for Sealing.....	3-12
S.2.3.	Directional Flow Valves.	3-13
S.2.4.	Stop Mechanism.	3-13
S.2.5.	Zero-Set-Back Interlock for Retail Devices.....	3-14
S.2.6.	<i>Temperature Determination – Wholesale Devices</i>	3-14
S.2.7.	Wholesale Devices Equipped with Automatic Temperature Compensators.....	3-14
S.2.8.	Exhaustion of Supply, Lubricant Devices Other than Meter Types.....	3-15
S.3.	Discharge Lines and Valves.....	3-15
S.3.1.	Diversion of Measured Liquid.	3-15
S.3.2.	Exceptions.....	3-15
S.3.3.	Pump-Discharge Unit.....	3-15
S.3.4.	Gravity-Discharge Unit.....	3-15
S.3.5.	Discharge Hose, Reinforcement.	3-15
S.3.6.	Discharge Valve.....	3-16
S.3.7.	Anti-drain Means.	3-16
S.4.	Marking Requirements.....	3-16
S.4.1.	Limitation on Use.	3-16
S.4.2.	Air Pressure.....	3-16
S.4.3.	Wholesale Devices.....	3-16
S.4.4.	<i>Retail Devices</i>	3-16
S.5.	<i>Totalizers for Retail Dispensers</i>	3-17
N.	Notes.....	3-17
N.1.	Test Liquid.....	3-17
N.1.1.	Type of Liquid.	3-17
N.1.2.	Labeling.	3-17
N.2.	Volume Change.	3-17
N.3.	Test Drafts.....	3-17
N.3.1.	Retail Piston-Type and Visible-Type Devices.....	3-17
N.3.2.	Slow-flow Meters.	3-17
N.3.3.	Lubricant Devices.....	3-17
N.3.4.	Other Retail Devices.	3-17

N.3.5.	Wholesale Devices.....	3-17
N.4.	Testing Procedures.....	3-18
N.4.1.	Normal Tests.....	3-18
N.4.2.	Special Tests.	3-18
N.4.3.	Money-Value Computation Tests.	3-19
N.4.4.	Pour and Drain Times.	3-19
N.4.5.	Verification of Linearization Factors.	3-20
N.4.6.	Repeatability Tests.....	3-20
N.5.	Temperature Correction on Wholesale Devices.....	3-20
T.	Tolerances.....	3-20
T.1.	Application to Underregistration and to Overregistration.....	3-20
T.2.	Tolerance Values.	3-20
T.3.	Repeatability.....	3-21
T.4.	<i>Automatic Temperature-Compensating Systems.....</i>	<i>3-21</i>
UR.	User Requirements	3-22
UR.1.	Selection Requirements.	3-22
UR.1.1.	Discharge Hose.....	3-22
UR.2.	Installation Requirements.	3-22
UR.2.1.	Manufacturer's Instructions.	3-22
UR.2.2.	Discharge Rate.....	3-22
UR.2.3.	Suction Head.....	3-22
UR.2.4.	Diversion of Liquid Flow.....	3-22
UR.2.5.	Product Storage Identification.	3-23
UR.3.	Use of Device.....	3-23
UR.3.1.	Return of Indicating and Recording Elements to Zero.	3-23
UR.3.2.	Unit Price and Product Identity.....	3-23
UR.3.3.	Computing Device.	3-23
UR.3.4.	Recorded Representations.....	3-24
UR.3.5.	Steps after Dispensing.....	3-24
UR.3.6.	Temperature Compensation, Wholesale.	3-24
UR.4.	Maintenance Requirements.....	3-25
UR.4.1.	Use of Adjustments.....	3-25
UR.4.2.	Security for Retail Motor-Fuel Devices (RMFD).	3-26
	Liquid-Measuring Device Code Index	3-27

Section 3.30. Liquid-Measuring Devices

A. Application

A.1. General. – This code applies to:

- (a) devices used for the measurement of liquids and
- (b) wholesale devices used for the measurement and delivery of agri-chemical liquids such as fertilizers, feeds, herbicides, pesticides, insecticides, fungicides, and defoliants.
(Added 1985)

A.2. Exceptions. – This code does not apply to:

- (a) meters mounted on vehicle tanks (Also see Section 3.31. Code for Vehicle-Tank Meters.);
- (b) devices used for dispensing liquefied petroleum gases (Also see Section 3.32. Code for Liquefied Petroleum Gas and Anhydrous Ammonia 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; or
- (f) mass flow meters. (Also see Section 3.37. Code for Mass Flow Meters.)
(Added 1994)

A.3. Additional Code Requirements. – In addition to the requirements of this code, liquid-measuring devices shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1. Indicating and Recording Elements and Recorded Representations.

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

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

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

(Amended 1987, 1994, and 2006)

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

(Added 1979)

S.1.2.2. Agri-Chemical Liquid Devices.

S.1.2.2.1. Liquid Measure. – Deliveries shall be indicated and recorded in liters or gallons and decimal subdivisions or fractional equivalents thereof.

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

- (a) 0.5 L (0.1 gal) on devices with a maximum rated flow rate of 750 L/min (200 gal/min) or less;
 - (b) 5 L (1 gal) on devices with a maximum rated flow of more than 750 L/min (200 gal/min); or
 - (c) 5 L (1 gal) on meters with a rated maximum flow rate of 375 L/min (100 gal/min) or more used for jet fuel aviation refueling systems.
- (Added 2007)

This requirement does not apply to manually operated devices equipped with stops or stroke-limiting means.
(Amended 1983, 1986, and 2007)

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

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

S.1.4. Graduations.

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

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

- (a) every graduation shall be at least 0.2 mm (0.008 in) but not greater than the minimum clear interval between graduations; and
- (b) main graduations shall be not more than 50 % greater than the width of subordinate graduations.

S.1.4.3. Clear Interval Between Graduations. – The clear interval between graduations shall be not less than 1.0 mm (0.04 in). If the graduations are not parallel, the measurement shall be made:

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

S.1.5. Indicators.

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

S.1.5.2. Length.

- (a) If the indicator and the graduations are in different planes, the index of the indicator shall extend to each graduation with which it is to be used.
- (b) If the indicator is in the same plane as the graduations, the distance between the index of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 1.0 mm (0.04 in).

S.1.5.3. Width.

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

S.1.5.4. Clearance. – If the indicator and the graduations are in different planes, the clearance between the index of an indicator and the plane of the graduations shall be no greater than 1.5 mm (0.06 in).

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

S.1.6. Additional Operating Requirements, Retail Devices (Except Slow-flow Meters).

S.1.6.1. Indication of Delivery. – The device shall automatically show on its face the initial zero condition and the quantity delivered (up to the nominal capacity). However, the following requirements shall apply:

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

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

[Nonretroactive as of January 1, 2006]

(Added 2005)

(Amended 1982 and 2005)

S.1.6.2. Provisions for Power Loss.

S.1.6.2.1. Transaction Information. – *In the event of a power loss, the information needed to complete any transaction in progress at the time of the power loss (such as the quantity and unit price, or sales price) shall be determinable for at least 15 minutes at the dispenser or at the console if the console is accessible to the customer.*

[Nonretroactive as of January 1, 1983]

S.1.6.2.2. User Information. – *The device memory shall retain information on the quantity of fuel dispensed and the sales price totals during power loss.*

[Nonretroactive as of January 1, 1983]

S.1.6.3. Return to Zero.

- (a) The primary indicating elements, and primary recording elements if the device is equipped to record, shall be readily returnable to a definite zero indication. However, a key-lock operated or other

self-operated device may be equipped with cumulative indicating or recording elements, provided that it is also equipped with a zero-return indicating element.

- (b) It shall not be possible to return primary indicating elements, or primary recording elements beyond the correct zero position.

- (c) Primary indicating elements shall not be resettable to zero during a delivery.

(Amended 1972 and 2016)

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

S.1.6.4.1. Unit Price.

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

- (b) *Except for dispensers used exclusively for fleet sales, other price contract sales, and truck refueling (e.g., truck stop dispensers used only to refuel trucks), whenever a grade, brand, blend, or mixture is offered for sale from a device at more than one unit price, then all of the unit prices at which that product is offered for sale shall meet the following conditions:*

- (1) *For a system that applies a discount prior to the delivery, all unit prices shall be displayed or shall be capable of being displayed on the dispenser through a deliberate action of the customer prior to the delivery of the product. It is not necessary that all of the unit prices for all grades, brands, blends, or mixtures be simultaneously displayed prior to the delivery of the product.*

[Nonretroactive as of January 1, 1991]

- (2) For a system that offers post-delivery discounts on fuel sales, display of pre-delivery unit price information is exempt from (b)(1), provided the system complies with S.1.6.8. Recorded Representations for Transactions Where a Post-Delivery Discount(s) is Provided.

(Added 2012)

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

(Added 2012)

(Amended 1989, 1997, and 2012)

S.1.6.4.2. Product Identity.

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

S.1.6.5. Money-Value Computations.

- (a) *A computing device shall compute the total sales price at any single-purchase unit price (i.e., excluding fleet sales, other price contract sales, and truck stop dispensers used only to refuel trucks) for which*

the product being measured is offered for sale at any delivery possible within either the measurement range of the device or the range of the computing elements, whichever is less.

[Nonretroactive as of January 1, 1991]

- (b) The analog sales price indicated for any delivered quantity shall not differ from a mathematically computed price (quantity × unit price = total sales price) by an amount greater than the value in Table 1. Money-Value Divisions and Maximum Allowable Variations for Money-Value Computations on Mechanical Analog Computers.

(Amended 1984, 1989, and 1993)

S.1.6.5.1. Money-Value Divisions, Analog. – The values of the graduated intervals representing money values on a computing type device shall be no greater than those in Table 1. Money-Value Divisions and Maximum Allowable Variations for Money-Value Computations on Mechanical Analog Computers.

(Amended 1991)

Table 1. Money-Value Divisions and Maximum Allowable Variations for Money-Value Computations on Mechanical Analog Computers				
Unit Price		Money-Value Division	Maximum Allowable Variation	
From	To and Including		Design Test	Field Test
0	\$0.25/liter or \$1.00/gallon	1¢	± 1¢	± 1¢
\$0.25/liter or \$1.00/gallon	\$0.75/liter or \$3.00/gallon	1¢ or 2¢	± 1¢	± 2¢
\$0.75/liter or \$3.00/gallon	\$2.50/liter or \$10.00/gallon	1¢ or 2¢	± 1¢	± 2¢
		5¢	± 2½¢	± 5¢

S.1.6.5.2. Money-Value Divisions, Digital. – A computing type device with digital indications shall comply with the requirements of paragraph G.S.5.5. Money-Values, Mathematical Agreement, and the total price computation shall be based on quantities not exceeding 0.05 L for devices indicating in metric units and 0.01 gal intervals for devices indicating in U.S. customary units.

(Added 1980)

S.1.6.5.3. Auxiliary Elements. – *If a system is equipped with auxiliary indications, all indicated money-value divisions of the auxiliary element shall be identical with those of the primary element.*

[Nonretroactive as of January 1, 1985]

S.1.6.5.4. Selection of Unit Price. – A system shall not permit a change to the unit price during delivery of product. When a product or grade is offered for sale at more than one unit price through a computing device, the following conditions shall be met:

- (a) *Except for a system only capable of applying a post-delivery discount(s), the selection of the unit price shall be made prior to delivery through a deliberate action of the customer to select the unit price for the fuel delivery.*

[Nonretroactive as of January 1, 1991]

- (b) For a system only capable of applying a post-delivery discount(s), the selection of the unit price shall be made through a deliberate action of the customer to select the unit price for the fuel delivery.

(Added 2012)

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

(Added 2012)

The provisions in (a) and (b) do not apply to dispensers used exclusively for fleet sales, other price contract sales, and truck refueling (e.g., truck stop dispensers used only to refuel trucks).

(Added 1989) (Amended 1991, 1992, 1993, 1996, and 2012)

S.1.6.5.5. Display of Quantity and Total Price. – *Except for aviation refueling applications, when a delivery is completed, the total price and quantity for that transaction shall be displayed on the face of the dispenser for at least five minutes or until the next transaction is initiated by using controls on the device or other customer-activated controls.*

[Nonretroactive as of January 1, 1994]

(Added 1992) (Amended 1996 and 2007)

S.1.6.5.6. Display of Quantity and Total Price, Aviation Refueling

(a) *The quantity shall be displayed throughout the transaction.*

(b) *The total price shall also be displayed under one of the following conditions:*

- (1) The total price can appear on the face of the dispenser or through a controller adjacent to the device.
- (2) If a device is designed to continuously compute and display the total price, then the total price shall be computed and displayed throughout the transaction for the quantity delivered.

(c) *The total price and quantity shall be displayed for at least five minutes or until the next transaction is initiated by using controls on the device or other customer-activated controls.*

(d) *A receipt shall be available and shall include, at a minimum, the total price, quantity, and unit price.*

[Nonretroactive as of January 1, 2008]

(Added 2007) (Amended 2023)

S.1.6.6. Agreement Between Indications.

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

- (1) all total money-values for an individual sale that are indicated or recorded by the system agree; and
- (2) *within each element, the values indicated or recorded meet the formula (quantity × unit price = total sales price) to the closest cent.*

[Nonretroactive as of January 1, 1988]

- (b) When a system applies a post-delivery discount(s) to a fuel's unit price through an auxiliary element, the following conditions shall apply for computed values:

- (1) the total volume of the delivery shall be in agreement between all elements in the system.

(Added 2012)

(Added 1985) (Amended 1987, 1988, and 2012)

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

- (a) *the total volume of the delivery;**
- (b) *the unit price;**
- (c) *the total computed price;**
- (d) *the product identity by name, symbol, abbreviation, or code number;* and*
- (e) *the dispenser designation by either an alphabetical or numerical description.***

[Nonretroactive as of January 1, 1986][Nonretroactive as of January 1, 2021]*

(Added 1985) (Amended 1997, 2012, 2014, 2018 and 2023)

S.1.6.8. Recorded Representations for Transactions Where a Post-Delivery Discount(s) is Provided. – Except for fleet sales and other price contract sales, a receipt providing the following information shall be available through a built-in or separate recording element that is part of the system for transactions involving a post-delivery discount:

- (a) the product identity by name, symbol, abbreviation, or code number;
- (b) transaction information as shown on the dispenser at the end of the delivery and prior to any post-delivery discount(s), including the:
 - (1) total volume of the delivery;
 - (2) unit price; and
 - (3) total computed price of the fuel sale.
- (c) an itemization of the post-delivery discounts to the unit price; and
- (d) the final total price of the fuel sale after all post-delivery discounts are applied.
- (e) *the dispenser designation by either an alphabetical or numerical description.*

[Nonretroactive as of January 1, 2021]

(Added 2012) (Amended 2014, 2018, and 2023)

S.1.6.9. Lubricant Devices, Travel of Indicator. – The indicator shall move at least 2.5 cm (1 in) in relation to the graduations, if provided, for a delivery of 0.5 L (1 pt).

S.1.6.10. Automatic Timeout – Pay-At-Pump for Retail Devices. – *Once a device has been authorized, it must deauthorize within three minutes if not activated. Reauthorization of the device must be performed*

before any product can be dispensed. If the time limit to deauthorize the device is programmable, it shall not accept an entry greater than three minutes.

[Nonretroactive as of January 1, 2017]

(Added 2016) (Amended 2019 and 2021)

S.1.7. Additional Operating Requirements, Wholesale Devices Only.

S.1.7.1. Travel of Indicator. – A wholesale device shall be readily operable to deliver accurately any quantity from 200 L (50 gal) 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 4 L (1 gal) shall be not less than 5 mm (0.20 in).

(Amended 1987)

S.1.7.2. Money-Values, Mathematical Agreement. – Any digital money-value indication and any recorded money-value on a computing-type device shall be in mathematical agreement with its associated quantity indication or representation to within 1 cent of money-value.

S.2. Measuring Elements.

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

(Amended 1975 and 2017)

S.2.1.1. Air/Vapor Elimination on Loading Rack Measuring Systems.

(a) A loading rack measuring system shall be equipped with an effective air/vapor eliminator or other automatic means to prevent the passage of air/vapor through the meter unless the system is designed or operationally controlled by a means such that air/vapor cannot enter the system.

(b) Vent lines from the air/vapor eliminator shall be made of appropriate non-collapsible material.

(Added 1994) (Amended 2017)

S.2.2. Provision for Sealing. – For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices. For parameters adjusted using other means, the following applies.

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

(a) any measuring or indicating element;

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

(c) any metrological parameter that will affect the metrological integrity of the device or system.

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

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

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

(Amended 1991, 1993, 1995, 2006, and 2019)

S.2.3. Directional Flow Valves. – Valves intended to prevent reversal of flow shall be automatic in operation.

Table S.2.2. Categories of Device and Methods of Sealing	
Categories of Device	Methods of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. <i>The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.</i>	<i>[The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.]*</i> <i>[*Nonretroactive as of January 1, 1996]</i>
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). <i>[Nonretroactive as of January 1, 1995]</i> <i>The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.</i> <i>[Nonretroactive as of January 1, 2001]</i>	<i>An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. The event logger information shall be available at the time of inspection either as a printed copy or in electronic format. The information may be printed by the device, printed by another on-site device, or transmitted electronically. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: Does not require 1000 changes to be stored for each parameter.)</i>

[Nonretroactive as of January 1, 1995]

(Table Added 1993) (Amended 1995, 1998, 1999, 2006, 2015, and 2022)

S.2.4. Stop Mechanism.

S.2.4.1. Indication. – The delivery for which the device is set shall be conspicuously indicated.

(Amended 1983)

S.2.4.2. Stroke Limiting Elements. – Stops or other stroke limiting elements subject to direct pressure or impact shall be:

- (a) made secure by positive, nonfrictional engagement of these elements; and

- (b) adjustable to provide for deliveries within tolerances.

(Amended 1983)

S.2.4.3. Setting. – If two or more stops or other elements may be selectively brought into operation to permit predetermined quantities of deliveries:

- (a) the position for the proper setting of each such element shall be accurately defined; and
- (b) any inadvertent displacement from the proper setting shall be obstructed.

(Amended 1983)

S.2.5. Zero-Set-Back Interlock for Retail Devices. – A device shall be constructed so that:

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

(Amended 1981, 1985, and 2019)

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

- (a) *in the liquid chamber of the meter; or*
- (b) *in the meter inlet or discharge line immediately adjacent to the meter.*

[Nonretroactive as of January 1, 1985]

(Added 1984) (Amended 1986)

S.2.7. Wholesale Devices Equipped with Automatic Temperature Compensators.

S.2.7.1. Automatic Temperature Compensation. – A device may be equipped with an automatic means for adjusting the indication and registration of the measured volume of product to the volume at 15 °C (60 °F).

S.2.7.2. Provision for Deactivating. – On a device equipped with an automatic temperature-compensating mechanism that will indicate or record only in terms of gallons compensated to 15 °C (60 °F), provision shall be made for deactivating the automatic temperature-compensating mechanism so that the meter can indicate and record, if it is equipped to record, in terms of the uncompensated volume.

(Amended 1972)

S.2.7.3. Provision for Sealing Automatic Temperature-Compensating Systems. – 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 without breaking the seal.

S.2.7.4. Temperature Determination with Automatic Temperature-Compensation. – For test purposes, means shall be provided (e.g., thermometer well) to determine the temperature of the liquid either:

- (a) in the liquid chamber of the meter; or
 - (b) immediately adjacent to the meter in the meter inlet or discharge line.
- (Amended 1987)

S.2.8. Exhaustion of Supply, Lubricant Devices Other than Meter Types. – When the level of the supply of lubricant becomes so low as to compromise the accuracy of measurement, the device shall:

- (a) automatically become inoperable; or
- (b) give a conspicuous and distinct warning.

S.3. Discharge Lines and Valves.

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

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

An outlet that may be opened for purging or draining the measuring system or for recirculating, if recirculation is required in order to maintain the product in a deliverable state, shall be permitted only when the system is measuring food products, agri-chemicals, biodiesel, or biodiesel blends. Effective automatic means shall be provided to prevent passage of liquid through any such outlet during normal operation of the measuring system and to inhibit meter indications (or advancement of indications) and recorded representations while the outlet is in operation.

(Amended 1991, 1995, 1996, and 2007)

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

(Amended 1982, 1990, 1991, and 2002)

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

S.3.4. Gravity-Discharge Unit. – On a gravity-discharge unit:

- (a) the discharge hose or equivalent pipe shall be of the dry-hose type with no shutoff valve at its outlet end unless the hose or pipe drains to the same level under all conditions of use;
- (b) the dry-hose shall be sufficiently stiff and only as long as necessary to facilitate drainage;
- (c) an automatic vacuum breaker, or equivalent mechanism, shall be incorporated to prevent siphoning and to ensure rapid and complete drainage; and
- (d) the inlet end of the hose or outlet pipe shall be high enough to ensure complete drainage.

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

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

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

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

(Amended 1990)

S.4. Marking Requirements.

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

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

S.4.2. Air Pressure. – If a device is operated by air pressure, the air pressure gauge shall show, by special graduations or other means, the maximum and minimum working pressures recommended by the manufacturer.

S.4.3. Wholesale Devices.

S.4.3.1. Discharge Rates. – A wholesale device shall be marked to show its designed maximum and minimum discharge rates. However, the minimum discharge rate shall not exceed 20 % of the maximum discharge rate.

S.4.3.2. Temperature Compensation. – If a device is equipped with an automatic temperature compensation, the primary indicating elements, recording elements, and recorded representation shall be clearly and conspicuously marked to show that the volume delivered has been adjusted to the volume at 15 °C (60 °F).

S.4.4. Retail Devices.

S.4.4.1. Discharge Rates. – *On a retail device with a designed maximum discharge rate of 115 L (30 gal) per minute or greater, the maximum and minimum discharge rates shall be marked in accordance with S.4.4.2. Location of Marking Information; Retail Dispensers. The marked minimum discharge rate shall not exceed 20 % of the marked maximum discharge rate.*

[Nonretroactive as of January 1, 1985]

(Added 1984) (Amended 2003 and 2019)

Example: With a marked maximum discharge rate of 230 L/min (60 gpm), the marked minimum discharge rate shall be 45 L/min (12 gpm) or less (e.g., 40 L/min [10 gpm] is acceptable). A marked minimum discharge rate greater than 45 L/min (12 gpm) (e.g., 60 L/min [15 gpm]) is not acceptable.

S.4.4.2. Location of Marking Information for Retail Dispensers. – *The marking information required in the General Code, paragraph G-S.1. Identification shall appear as follows:*

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

- (b) *either internally and/or externally, provided the information is permanent and easily read; and*
- (c) *on a portion of the device that cannot be readily removed or interchanged (i.e., not on a service access panel).*

The use of a dispenser key or tool to access internal marking information is permitted for retail liquid-measuring devices.

[Nonretroactive as of January 1, 2003]

(Added 2002) (Amended 2004 and 2019)

S.5. Totalizers for Retail Dispensers. – *Retail dispensers shall be equipped with a non-resettable totalizer for the quantity delivered through the metering device.*

[Nonretroactive as of January 1, 1995]

(Added 1993) (Amended 1994 and 2019)

N. Notes

N.1. Test Liquid.

N.1.1. Type of Liquid. – The liquid used for testing a liquid-measuring device shall be the type the device is used to measure, or another liquid with the same general physical characteristics.

N.1.2. Labeling. – Following the completion of a successful examination of a wholesale device, the weights and measures official should attach a label or tag indicating the type of liquid used during the test.

N.2. Volume Change. – Care shall be taken to minimize changes in volume of the test liquid due to temperature changes and evaporation losses.

N.3. Test Drafts.

N.3.1. 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. Slow-flow Meters. – Test drafts shall be equal to at least four times the minimum volume that can be measured and indicated through either a visible indication or an audible signal.

N.3.3. Lubricant Devices. – Test drafts shall be 1 L (1 qt). Additional test drafts may include 0.5 L (1 pt), 4 L (4 qt), and 6 L (6 qt).

N.3.4. Other Retail Devices. – On devices with a designed maximum discharge rate of:

- (a) less than 80 L (20 gal) per minute, tests shall include drafts of one or more amounts, including a draft of at least 19 L (5 gal).
- (b) 80 L (20 gal) per minute or greater, tests shall include drafts of one or more amounts, including a draft of at least the amount delivered by the device in one minute at the maximum flow rate of the installation.

(Amended 1984)

N.3.5. Wholesale Devices.

N.3.5.1. Test Drafts. – The delivered quantity shall be equal to at least the amount delivered by the device in one minute at its maximum discharge rate.

(Amended 1987, 1996, and 2023)

N.3.5.2. Small Volume Prover Test. – The total delivered quantity for any required accuracy test shall be representative of at least the amount delivered by the device in one minute of continuous flow at its maximum discharge rate.

(Added 2023)

N.3.5.3. Transfer Standard Meter Test. – When comparing a meter with a calibrated transfer standard meter, the minimum quantity for any test draft shall be equal to or greater than the amount delivered in one minute at the flow rate being tested.

(Added 2023) (Amended 2024)

N.4. Testing Procedures.

N.4.1. Normal Tests. – The “normal” test of a device shall be made at the maximum discharge flow rate developed under the conditions of installation. Any additional tests conducted at flow rates down to and including one-half of the sum of the maximum discharge flow rate (MDFR) and the rated minimum discharge flow rate (RMDFR) shall be considered normal tests. As a formula, this is stated as:

$$\frac{MDFR + RMDFR}{2} = \text{minimum discharge flow rate for additional tests}$$

(Amended 1991 and 2023)

N.4.1.1. Wholesale Devices Equipped with Automatic Temperature-Compensating Systems. – On wholesale devices equipped with automatic temperature-compensating systems, normal tests shall be conducted:

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

The first test shall be performed with the automatic temperature-compensating system operating in the “as found” condition.

On devices that indicate or record both the compensated and uncompensated volume for each delivery, the tests in (a) and (b) may be performed as a single test.

(Amended 1987)

N.4.2. Special Tests. – “Special” tests shall be made to develop the operating characteristics of a device and any special elements and accessories attached to or associated with the device. Any test except as set forth in N.4.1. Normal Tests shall be considered a special test.

N.4.2.1. Slow-Flow Meters. – A “special” test shall be made at a flow rate:

- (a) not larger than twice the actual minimum flow rate; and
- (b) not smaller than the actual minimum flow rate of the installation.

N.4.2.2. Retail Motor-Fuel Devices and DEF Devices

- (a) Devices without a marked minimum flow rate shall have a “special” test performed at the slower of the following rates:

- (1) 19 L (5 gal) per minute; or

- (2) the minimum discharge rate at which the device will deliver when equipped with an automatic discharge nozzle set at its slowest setting.

- (b) Devices with a marked minimum flow rate shall have a “special” test performed at or near the marked minimum flow rate.

(Added 1984) (Amended 2005 and 2019)

N.4.2.3. Other Retail Devices. – “Special” tests of other retail devices shall be made at the slower of the following rates:

- (a) 50 % of the maximum discharge rate developed under the conditions of installation; or
- (b) the minimum discharge rate marked on the device.

N.4.2.4. Wholesale Devices. – “Special” tests shall be made to develop the operating characteristics of a measuring system and any special associated or attached elements and accessories. “Special” tests shall include a test at or slightly above the slower of the following rates:

- (a) 20 % of the marked maximum discharge rate; or
- (b) the minimum discharge rate marked on the device.

In no case shall the test be performed at a flow rate less than the minimum discharge rate marked on the device.

(Amended 2014)

N.4.3. Money-Value Computation Tests.

N.4.3.1. Laboratory Tests. – When testing the device in the laboratory:

- (a) compliance with paragraph S.1.6.5. Money-Value Computations shall be determined by using the cone gear as a reference for the total quantity delivered;
- (b) the indicated quantity shall agree with the cone gear representation with the index of the indicator within the width of the graduation; and
- (c) the maximum allowable variation of the indicated sales price shall be as shown in Table 1. Money-Value Divisions and Maximum Allowable Variations for Money-Value Computations on Mechanical Analog Computers.

(Amended 1984)

N.4.3.2. Field Tests. – In the conduct of field tests to determine compliance with paragraph S.1.6.5. Money-Value Computations, the maximum allowable variation in the indicated sales price shall be as shown in Table 1. Money-Value Divisions and Maximum Allowable Variations for Money-Value Computations on Mechanical Analog Computers.

(Added 1982) (Amended 1984)

N.4.4. Pour and Drain Times.

N.4.4.1. Pour and Drain Times for Hand-held Test Measures. – Hand-held test measures require a 30-second (± 5 seconds) pour followed by a 10-second drain with the measure held at a 10-degree to 15-degree angle from vertical.

N.4.4.2. Drain Times for Bottom Drain Test Measures or Provers. – Bottom drain field standard provers require a 30-second drain time after main flow cessation.

(Added 2009)

N.4.5. Verification of Linearization Factors. – All enabled linearization factors shall be verified. The verification of enabled linearization factors shall be done through physical testing, or a combination of physical testing and empirical analysis at the discretion of the official with statutory authority.

(Added 2016)

N.4.6. Repeatability Tests. – Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors such as temperature, pressure, and flow rate are reduced to the extent that they will not affect the results obtained. When conducting the tests, the flow rates shall be within the minimum and maximum discharge rates as marked by the manufacturer. For devices with no marked minimum and maximum flow rates, the minimum discharge rates shall be as specified in N.4.2.1. Slow-Flow Meters or N.4.2.2. Retail Motor-Fuel Devices and DEF Devices and the maximum discharge rates shall be the maximum discharge rate developed under the conditions of the installation. For devices equipped with an automatic temperature compensator, the results shall be based on the uncompensated (gross) volume (e.g., with the temperature compensator deactivated).

(Amended 2019)

N.5. Temperature Correction on Wholesale Devices. – 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 prover. When adjustments are necessary, appropriate petroleum measurement tables should be used.

(Amended 1974)

T. Tolerances

T.1. Application 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. – Maintenance, acceptance, and special test tolerances shall be as shown in Table T.2. Accuracy Classes and Tolerances for Liquid Measuring Devices Covered in NIST Handbook 44, Section 3.30.

Table T.2. Accuracy Classes and Tolerances for Liquid Measuring Devices Covered in NIST Handbook 44, Section 3.30.				
Accuracy Class	Application	Acceptance Tolerance	Maintenance Tolerance	Special Test Tolerance¹
0.3	- Petroleum products delivered from large capacity (flow rates greater than 115 L/min or 30 gpm)** devices, including motor-fuel devices - Heated products (other than asphalt) at temperatures greater than 50 °C (122 °F) - Asphalt at temperatures equal to or below 50 °C (122 °F) - All other liquids not shown in the table where the typical delivery is over 200 L (50 gal)	0.2 %	0.3 %	0.5 %
0.3A	- Asphalt at temperatures greater than 50 °C (122 °F)	0.3 %	0.3 %	0.5 %
0.5*	- Petroleum products delivered from small capacity (at 4 L/min (1 gpm) through 115 L/min or 30 gpm)** motor-fuel devices - Agri-chemical liquids - All other applications not shown in the table where the typical delivery is ≤ 200 L (50 gal)	0.3 %	0.5 %	0.5 %
1.1	- Petroleum products and other normal liquids from devices with flow rates** less than 1 gpm. - Devices designed to deliver less than 1 gal	0.75 %	1.0 %	1.25 %
* For test drafts ≤ 40 L or 10 gal, the tolerances specified for Accuracy Class 0.5 in the table above do not apply. For these test drafts, the following applies: (a) Maintenance tolerances on normal and special tests shall be 20 mL plus 4 mL per indicated liter or 1 in ³ plus 1 in ³ per indicated gallon. (b) Acceptance tolerances on normal and special tests shall be one-half the maintenance tolerance values. ¹ Special test tolerances are not applicable to retail motor fuel and retail Diesel Exhaust Fluid (DEF) dispensers. ** Flow rate refers to designed or marked maximum flow rate.				

(Added 2002) (Amended 2006, 2013, and 2022)

T.3. Repeatability. – When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 % of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. This tolerance does not apply to the test of the automatic temperature-compensating system. (Also see N.4.6. Repeatability Tests.)

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

T.4. Automatic Temperature-Compensating Systems. – The difference between the meter errors (expressed as a percentage) determined with and without the automatic temperature-compensating system activated shall not exceed:

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

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

[Nonretroactive as of January 1, 1988]

(Added 1987) (Amended 1992, 1996, and 2002)

UR. User Requirements

UR.1. Selection Requirements.

UR.1.1. Discharge Hose.

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

- (a) shall be measured from its housing or outlet of the discharge line to the inlet of the discharge nozzle;
- (b) shall be measured with the hose fully extended if it is coiled or otherwise retained or connected inside a housing; and
- (c) shall not exceed 5.5 m (18 ft) unless it can be demonstrated that a longer hose is essential to permit deliveries to be made to receiving vehicles or vessels.

An unnecessarily remote location of a device shall not be accepted as justification for an abnormally long hose.
(Amended 1972 and 1987)

UR.1.1.2. Marinas and Airports.

UR.1.1.2.1. Length. – The length of the discharge hose shall be as short as practicable, and shall not exceed 15 m (50 ft) unless it can be demonstrated that a longer hose is essential.

UR.1.1.2.2. Protection. – Discharge hoses exceeding 8 m (26 ft) in length shall be adequately protected from weather and other environmental factors when not in use.

(Made retroactive 1974 and Amended 1984)

UR.2. Installation Requirements.

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

(Added 1987)

UR.2.2. Discharge Rate. – A device shall be installed so that the actual maximum discharge rate will not exceed the rated maximum discharge rate. Automatic means for flow regulation shall be incorporated in the installation if necessary.

UR.2.3. Suction Head. – A piston-type device shall be installed so 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.2.4. Diversion of Liquid Flow. – A device equipped with two delivery outlets used exclusively in the fueling of trucks shall be so installed that any diversion of flow to other than the receiving vehicle cannot be readily accomplished and is readily apparent. Allowable deterrents include, but are not limited to, physical barriers to adjacent driveways, visible valves, or lighting systems that indicate which outlets are in operation, and explanatory signs.

(Amended 1991 and 2019)

UR.2.5. Product Storage Identification.

- (a) The fill connection for any petroleum product or other product storage tank or vessel supplying petroleum product or other products shall be permanently, plainly, and visibly marked as to the product contained.
- (b) When the fill connection device is marked by means of a color code, the color code key shall be conspicuously displayed at the place of business.

(Added 1975) (Amended 1976 and 2019)

UR.3. Use of Device.

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

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

UR.3.2. Unit Price and Product Identity.

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

Provided that the dispenser complies with S.1.6.4.1. Display of Unit Price, it is not necessary that all the unit prices for all grades, brands, blends, or mixtures be simultaneously displayed or posted.

- (b) The following information shall be conspicuously displayed or posted on each side of a retail dispenser used in direct sale:
 - (1) the identity of the product in descriptive commercial terms; and
 - (2) the identity of the grade, brand, blend, or mixture that a multi-product dispenser is set to deliver.

(Amended 1972, 1983, 1987, 1989, 1992, 1993, and 2012)

UR.3.3. Computing Device. – Any computing device used in an application where a product or grade is offered for sale at one or more unit prices shall be used only for sales for which the device computes and displays the sales price for the selected transaction.

(Became retroactive 1999)

(Added 1989) (Amended 1992)

The following exceptions apply:

- (a) Fleet sales and other price contract sales are exempt from this requirement.
- (b) A truck stop dispenser used exclusively for refueling trucks is exempt from this requirement provided that:

- (1) all purchases of fuel are accompanied by a receipt of the transaction containing the applicable price per gallon, the total gallons delivered, and the total price of the sale; and
(Added 1993) (Amended 2023)
- (2) unless a dispenser complies with S.1.6.4.1. Display of Unit Price, the price posted on the dispenser and the price at which the dispenser is set to compute shall be the highest price for any transaction which may be conducted.
(Added 1993)
- (c) A dispenser used in an application where a price per unit discount is offered following the delivery is exempt from this requirement, provided the following conditions are satisfied:
 - (1) the unit price posted on the dispenser and the unit price at which the dispenser is set to compute prior to the application of any discount shall be the highest unit price for any transaction;
(Amended 2014)
 - (2) all purchases of fuel are accompanied by a receipt recorded by the system. The receipt shall contain:
 - a. the product identity by name, symbol, abbreviation, or code number;
 - b. transaction information as shown on the dispenser at the end of the delivery and prior to any post-delivery discount including the:
 - 1. total volume of the delivery;
 - 2. unit price; and
 - 3. total computed price of the fuel sale prior to post-delivery discounts being applied.
 - c. an itemization of the post-delivery discounts to the unit price; and
 - d. the final total price of the fuel sale.

(Added 2012) (Amended 2014)

(Added 1989) (Amended 1992, 1993, 2012, 2014, and 2023)

UR.3.4. Recorded Representations. – The total price; the total volume of the delivery; the price per liter or gallon; and a corresponding alpha or numeric dispenser designation* shall be recorded by the device on any recorded representation containing any one of these values and shall comply with G-S.5.6. Recorded Representations. Establishments where no product grades are repeated are exempt from the dispenser designation requirement.

*[Nonretroactive as of January 1, 2021]

(Amended 2001, 2018, 2019, and 2023)

UR.3.5. Steps after Dispensing. – After delivery to a customer from a retail motor-fuel device:

- (a) the starting lever shall be returned to its shutoff position and the zero-set-back interlock engaged; and
- (b) the discharge nozzle shall be returned to its designed hanging position unless the primary indicating elements, and recording elements, if the device is equipped and activated to record, have been returned to a definite zero indication.

UR.3.6. Temperature Compensation, Wholesale.

UR.3.6.1. Automatic.

UR.3.6.1.1. When to be Used. – If a device is equipped with a mechanical automatic temperature compensator, it shall be connected, operable, and in use at all times. An electronic or mechanical automatic temperature-compensating system may not be removed, nor may a compensated device be replaced with an uncompensated device, without the written approval of the responsible weights and measures jurisdiction.

Note: This requirement does not specify the method of sale for product measured through a meter.

(Amended 1989)

UR.3.6.1.2. Invoices.

- (a) A written invoice based on a reading of a device that is equipped with an automatic temperature compensator shall show that the volume delivered has been adjusted to the volume at 15 °C (60 °F).
- (b) The invoice issued from an electronic wholesale device equipped with an automatic temperature-compensating system shall also indicate:
 - (1) the API gravity, specific gravity or coefficient of expansion for the product;
 - (2) product temperature; and
 - (3) gross reading.

(Amended 1987)

UR.3.6.2. Nonautomatic.

UR.3.6.2.1. Temperature Determination. – If the volume of the product delivered is adjusted to the volume at 15 °C (60 °F), the product temperature shall be taken during the delivery in:

- (a) the liquid chamber of the meter; or
- (b) the meter inlet or discharge line adjacent to the meter; or
- (c) the compartment of the receiving vehicle at the time it is loaded.

UR.3.6.2.2. Invoices. – The accompanying invoice shall indicate that the volume of the product has been adjusted for temperature variations to a volume at 15 °C (60 °F) and shall also state the product temperature used in making the adjustment.

UR.3.6.3. Period of Use. – When fuel is bought or sold on an automatic or non-automatic temperature-compensated basis, it shall be bought or sold using this method over at least a consecutive 12-month period, unless otherwise agreed to by both the buyer and seller in writing.

(Added 2003)

UR.4. Maintenance Requirements.

UR.4.1. Use of Adjustments. – Whenever a device is adjusted, all enabled linearization factors shall be verified to determine that the errors are in tolerance and any adjustments which are made shall be made so as to bring performance errors as close as practicable to zero value. The verification of enabled linearization factors shall be done through physical testing or a combination of testing and empirical analysis.

(Added 2016)

UR.4.2. Security for Retail Motor-Fuel Devices (RMFD). – Any retail motor fuel device capable of conducting customer-initiated electronic financial transactions must be secured to substantially restrict the ability of unauthorized persons to manipulate it to obtain payment information that could be used to commit fraud. The following is a non-exhaustive list of ways that restriction of such manipulation may be accomplished:

- (a) A physical lock, locking device, or a physical securing device that will restrict access to the electronic financial transaction compartment of the RMFD. A lock, locking device, or securing device shall not be manipulated with commonly available tools. A lock shall not allow the use of a universal key. A universal key is a key that is readily available in the market or can be easily purchased in a hardware or common retail store. A single non-universal key for all of the like devices at a retail facility or for all of the like devices at a chain of retail facilities is acceptable; or
- (b) Electronic alarming or disabling of the equipment if unauthorized access is attempted; or
- (c) Advanced payment acceptance technologies that increase protections against the theft of payment information itself or do not allow access to such information in a form that may be used to commit fraud; or
- (d) Another security solution that has been approved by the local or state weights and measures jurisdiction with authority.

(Added 2021)

Liquid-Measuring Device Code Index

Acceptance	20, 21, 22	Money value divisions.....	9
Adjustable element	12	Money values - mathematical agreement	12
Advancement	6	Money-value computation	8, 19
Agreement	9, 10, 12	Money-value divisions	9
Agri-chemical	5, 6, 21	Motor-fuel device	21, 22
Antidrain means.....	16	Nonautomatic	25
Automatic 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 25		Normal tests.....	18
Automatic temperature compensation	14	Operating requirements	7, 12
Automatic temperature compensators	14, 16, 24	Parallax	7
Automatic temperature-compensating systems	14, 18, 21	Power loss.....	7
<i>Automatic Timeout – Pay-At-Pump for Retail</i>		Price contract sales	8, 10, 11, 23
<i>Device</i>	11	Primary indicating element.....	5, 7, 8, 16, 23, 24
Auxiliary elements.....	9	Product identity	8, 11, 23
Blend	8, 23	Pump-discharge unit.....	15
Clear interval	6	Quantity	7, 9, 10, 12, 17, 19
Clearance	7	Recording element.....	5, 6, 7, 8, 11, 14, 16, 23, 24
Computing device.....	8, 9, 23	Repeatability	20, 21
Directional flow valves.....	13	Retail devices.....	7, 16, 17, 19
Discharge hose.....	15, 16, 22	Retail motor-fuel device	5, 14, 18, 22, 24, 26
Discharge lines	15	Retail motor-fuel dispensers	17
Discharge rate	16, 17, 19, 22	Seal	12, 13, 14, 16
Diversion	22	Sealing	12, 13, 14
Dry-hose	15	Security.....	12, 14, 16
Fleet sales	8, 10, 11, 23	Slow-flow meters.....	7, 17, 18
Grade	8, 9, 23	Special tests	18
Graduations.....	6, 7, 11, 12, 16	Stop mechanism.....	13
Gravity-discharge unit	15	Temperature compensation.....	14, 16
Index of an indicator.....	6, 7	Temperature compensators.....	14, 16, 24
Indicating element	6, 8, 14	Temperature correction.....	20
Indicators	6	Temperature determination.....	14, 25
Installation requirements	22	Temperature-compensating systems.....	14, 18, 21
Interlock.....	14	Test drafts	17, 21
Invoices.....	25	Tolerances.....	13, 20
Key-lock	7, 23	Total price.....	9, 24
Lubricant devices.....	11, 15, 17	Totalizers	17, 23
Maintenance	20, 21, 22	Truck refueling	10, 15, 23
Maintenance Requirements	25	Unit price	7, 8, 9, 10, 11, 23, 24
Marking requirements.....	16	User information.....	7
Mass.....	5	Valves.....	13, 15, 22
Mass flow meters.....	5	Vapor elimination	12
Measuring element	12	Wet-hose.....	15, 16
Money value computation	19	Wholesale devices 5, 12, 14, 16, 17, 18, 19, 20, 24	
		Zero-set-back interlock.....	14, 24

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Table of Contents

	Page
Table of Contents	29
Section 3.31. Vehicle-Tank Meters.....	31
A. Application.....	31
A.1. General.....	31
A.2. Exceptions.....	31
A.3. Additional Code Requirements.....	31
S. Specifications	31
S.1. Design of Indicating and Recording Elements and of Recorded Representations.....	31
S.1.1. Primary Elements.....	31
S.1.2. Graduations.....	32
S.1.3. Indicators.....	32
S.1.4. Computing-Type Device.....	33
S.2. Design of Measuring Elements.....	34
S.2.1. Air/Vapor Elimination.....	34
S.2.2. Provision for Sealing.....	34
S.2.3. Directional Flow Valves.....	35
S.2.4. <i>Zero-Set-Back Interlock, Vehicle-Tank Meters, Electronic</i>	35
S.2.5. Automatic Temperature Compensation for Refined Petroleum Products.....	35
S.2.6. <i>Thermometer Well, Temperature Determination</i>	36
S.3. Design of Discharge Lines and Discharge Line Valves.....	36
S.3.1. Diversion of Measured Liquid.....	36
S.3.2. Pump-Discharge Unit.....	37
S.3.3. Gravity-Discharge Unit.....	37
S.3.4. Discharge Hose.....	37
S.3.5. Discharge Valve.....	37
S.3.6. Antidrain Valve.....	37
S.4. Design of Intake Lines (for Milk-Metering Systems).....	37
S.4.1. Diversion of Liquid to be Measured.....	37
S.4.2. Intake Hose.....	37
S.5. Marking Requirements.....	38
S.5.1. Limitation of Use.....	38
S.5.2. Discharge Rates.....	38
S.5.3. Measuring Components, Milk-Metering System.....	38
S.5.4. Flood Volume, Milk-Metering System.....	38
S.5.5. Conversion Factor.....	38
S.5.6. Temperature Compensation for Refined Petroleum Products.....	38
N. Notes.....	38
N.1. Test Liquid.....	38
N.2. Evaporation and Volume Change.....	39
N.3. Test Drafts.....	39
N.3.1. Transfer Standard Meter Test.....	39
N.4. Testing Procedures.....	39
N.4.1. Normal Tests.....	39
N.4.2. Special Tests (Except Milk-Measuring Systems).....	39

N.4.3.	Antidrain Valve Test.....	39
N.4.4.	System Capacity.....	39
N.4.5.	Product Depletion Test.....	39
N.4.6.	Verification of Linearization Factors.....	40
N.4.7.	Repeatability Tests.....	40
N.5.	Temperature Correction for Refined Petroleum Products.....	40
T.	Tolerances	40
T.1.	Application.....	40
T.1.1.	To Underregistration and to Overregistration.....	40
T.2.	Tolerance Values.....	40
T.2.1.	Automatic Temperature-Compensating Systems.....	42
T.3.	Repeatability.....	42
T.4.	Product Depletion Test.....	42
UR.	User Requirements.....	42
UR.1.	Installation Requirements.....	42
UR.1.1.	Discharge Rate.....	42
UR.1.2.	Unit Price.....	42
UR.1.3.	Intake Hose.....	42
UR.1.4.	Liquid Measured.....	42
UR.2.	Use Requirements.....	42
UR.2.1.	Return of Indicating and Recording Elements to Zero.....	42
UR.2.2.	Recording Element.....	43
UR.2.3.	Ticket in Printing Device.....	43
UR.2.4.	Credit for Flood Volume.....	43
UR.2.5.	Automatic Temperature Compensation for Refined Petroleum Products.....	43
UR.2.6.	Clearing the Discharge Hose.....	43
UR.3.	Maintenance Requirements.....	44
UR.3.1.	Use of Adjustments.....	44

Section 3.31. Vehicle-Tank Meters

A. Application

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

(Amended 1985 and 1995)

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

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

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

S. Specifications

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

S.1.1. Primary Elements.

S.1.1.1. General. – A meter shall be equipped with a primary indicating element. Except for systems used solely for the sale of aviation fuel into aircraft-related operations, a meter shall be equipped with a primary recording element.

(Amended 1993 and 2023)

S.1.1.2. Units.

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

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

- (a) 0.5 L (0.1 gal) or 0.5 kg (1 lb) on milk-metering systems;
- (b) 0.5 L (0.1 gal) on meters with a rated maximum flow rate of 750 L/min (200 gal/min) or less;
- (c) 5 L (1 gal) on meters with a rated maximum flow of 375 L/min (100 gal/min) or more used for jet fuel aviation refueling systems; or
(Added 2006)
- (d) 5 L (1 gal) on other meters.

(Amended 1989, 1994, and 2006)

S.1.1.4. Advancement of Indicating and Recording Elements. – Primary indicating and recording elements shall be susceptible to advancement only by the mechanical operation of the meter. However, a meter may be cleared by advancing its elements to zero, but only if:

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

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

(Amended 2016)

S.1.2. Graduations.

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

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

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

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

(Amended 1986)

S.1.3. Indicators.

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

S.1.3.2. Length. – The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case the distance between the end of

the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 1.0 mm (0.04 in).

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

(a) *the width of the narrowest graduation;* and*
*[*Nonretroactive as of January 1, 2002]*
(Amended 2001)

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

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

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

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

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

S.1.4. Computing-Type Device.

S.1.4.1. Display of Unit Price. – In a device of the computing type, means shall be provided for displaying, in a manner clear to the operator and an observer, the unit price at which the device is set to compute. The unit price is not required to be displayed continuously.
(Amended 1983 and 2005)

S.1.4.2. Recorded Representations. – If a computing-type device issues a recorded representation which displays the total computed price, the recorded representation shall record the total quantity of the delivery, the appropriate fraction of the quantity, and the price per unit of quantity.
(Amended 1989 and 2023)

S.1.4.3. Money-Value Computations. – Money-value computations shall be of the full-computing type in which the money-value at a single unit price, or at each of a series of unit prices, shall be computed for every delivery within either the range of measurement of the device or the range of the computing elements, whichever is less. Value graduations shall be supplied and shall be accurately positioned. The value of each graduated interval shall be one cent. On electronic devices with digital indications, the total price may be computed on the basis of the quantity indicated when the value of the smallest division indicated is equal to or less than 0.2 L (0.1 gal) or 0.2 kg (1 lb).
(Amended 1979 and 1989)

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

S.2. Design of Measuring Elements.

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

(Amended 1993 and 2017)

S.2.2. Provision for Sealing. – For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices. For parameters adjusted using other means, the following applies.

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

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

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

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

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

(Amended 2006 and 2019)

Table S.2.2. Categories of Device and Methods of Sealing	
Categories of Device	Methods of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. <i>The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.</i>	<i>The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.</i>
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).	<i>An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be</i>

<p align="center">Table S.2.2. Categories of Device and Methods of Sealing</p>	
Categories of Device	Methods of Sealing
<i>The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.</i>	<i>available on demand through the device or through another on-site device. The information may also be available electronically. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1 000 records are required. (Note: Does not require 1 000 changes to be stored for each parameter.)</i>

[Nonretroactive as of January 1, 1995]

(Table Added 2006) (Amended 2016)

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

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

[Nonretroactive as of January 1, 2006]

(Added 2005)

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

S.2.5.1. Automatic Temperature Compensation for Refined Petroleum Products. – A device may be equipped with an automatic means for adjusting the indication and registration of the measured volume of product to the volume at 15 °C for liters or the volume at 60 °F for gallons and decimal subdivisions or fractional equivalents thereof where not prohibited by state law.

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

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

S.2.5.4. Provision for Sealing Automatic Temperature-Compensating Systems. – Adequate provision shall be made for an approved means of security (e.g., data change audit trail) or physically applying security seals in such a manner that an automatic temperature-compensating system cannot be disconnected and no adjustment may be made to the system.

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

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

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

(Added 2007)

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

- (a) liquid chamber of the meter; or
- (b) meter inlet or discharge line immediately adjacent to the meter.

[Nonretroactive as of January 1, 2012]

(Added 2011)

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

(Not applicable to milk-metering systems.)

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

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

This paragraph does not apply to the following:

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

(Amended 2018 and 2023)

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

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

- (f) clear means, such as an indicator light or audible alarm, is used to identify when the valve is in use; and *on both quantity indications and any associated recorded representations* (e.g., using such terms as “flushing mode” or “not for commercial use”);
[Nonretroactive as of January 1, 2024]
(Amended 2023)

- (g) *effective, automatic means shall be provided to prevent passage of liquid through any such flush system during normal operation of the measuring system; and*
[Nonretroactive as of January 1, 2024]
(Amended 2023)

- (h) no hoses or piping are connected to the inlet when it is not in use.
(Added 2018) (Amended 2023)

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

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

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

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

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

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

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

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

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

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

- (a) of the dry-hose type;

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

S.5. Marking Requirements.

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

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

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

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

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

S.5.5. Conversion Factor. – When the conversion factor of 1.03 kg/L (8.6 lb/gal) is used to convert the volume of milk to weight, the conversion factor shall be clearly marked on the primary indicating element and recorded on the delivery ticket.
(Added 1989)

S.5.6. Temperature Compensation for Refined Petroleum Products. – If a device is equipped with an automatic temperature compensator, the primary indicating elements, recording elements, and recorded representations shall be clearly and conspicuously marked to show the volume delivered has been adjusted to the volume at 15 °C for liters or the volume at 60 °F for gallons and decimal subdivisions or fractional equivalents thereof.
(Added 2007)

N. Notes

N.1. Test Liquid.

- (a) A measuring system shall be tested with the liquid to be commercially measured or with a liquid of the same general physical characteristics. Following a satisfactory examination, the weights and measures official should attach a seal or tag indicating the product used during the test.
(Amended 1975)
- (b) A milk-measuring system shall be tested with the type of milk to be measured when the accuracy of the system is affected by the characteristics of milk (e.g., positive displacement meters).
(Added 1989)

(Amended 1975 and 1989)

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

N.3. Test Drafts. – Test drafts shall be equal to at least the amount delivered by the device in 1 minute at its maximum discharge rate.

(Amended 1989 and 2023)

N.3.1. Transfer Standard Meter Test. – When comparing a meter with a calibrated transfer standard meter, the minimum quantity for any test draft shall be equal to or greater than the amount delivered in one minute at the flow rate being tested.

(Added 2023) (Amended 2024)

N.4. Testing Procedures.

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

(Amended 1992)

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

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

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

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

(Added 2007)

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

(Amended 1978 and 2005)

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

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

N.4.5. Product Depletion Test. – Except for vehicle-mounted metering systems used solely for the delivery of aviation fuel, the effectiveness of the vapor eliminator or vapor elimination means shall be tested by dispensing product at the normal flow rate until the product supply is depleted and continuing until the lack of fluid causes

the meter indication to stop completely for at least 10 seconds. If the meter indication fails to stop completely for at least 10 seconds, continue to operate the system for 3 minutes. Finish the test by switching to another compartment with sufficient product to complete the test on a multi-compartment vehicle or by adding sufficient product to complete the test to a single compartment vehicle. When adding product to a single compartment vehicle, allow appropriate time for any entrapped vapor to disperse before continuing the test. Test drafts shall be of the same size and run at approximately the same flow rate.

(Added 2005)

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

(Added 2016)

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

(Amended 2019)

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

(Added 2007)

T. Tolerances

T.1. Application.

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

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

(Amended 1995)

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

* For 5 gal and 10 gal test drafts, the tolerances specified for Accuracy Class 0.5 in the table above do not apply. For these test drafts, the maintenance tolerances on normal and special tests for 5 gal and 10 gal test drafts are 6 in³ and 11 in³, respectively. Acceptance tolerances on normal and special tests are 3 in³ and 5.5 in³.

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

(Added 2002) (Amended 2013)

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

(Added 1989)

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

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

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

(Added 2007) (Amended 2010)

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

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

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

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

(Amended 2013)

UR. User Requirements

UR.1. Installation Requirements.

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

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

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

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

(Added 2003)

UR.2. Use Requirements.

UR.2.1. Return of Indicating and Recording Elements to Zero. – The primary indicating elements (visual), and the primary recording elements, when these are returnable to zero, shall be returned to zero immediately

before each delivery is begun and after the pump has been activated and the product to be measured has been supplied to the measuring system.

(Amended 1981)

UR.2.2. Recording Element. – Vehicle-Mounted metering systems shall be equipped with a means to record all sales where product is delivered through the meter and shall comply with G-S.5.6. Recorded Representations. A copy of the ticket issued by the device shall be provided to the customer at the time of delivery or as otherwise specified by the customer.

(Added 1993) (Amended 1994 and 2023)

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

(Added 1999)

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

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

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

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

Note: This requirement does not specify the method of sale for products measured through a meter.

(Amended 2009)

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

(Added 2009)

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

(Added 2007)

UR.2.6. Clearing the Discharge Hose.

UR.2.6.1. Clearing the Discharge Hose, General. – A manifold flush or similar system designed to accommodate the flushing of product on single-hose, multiple-product system is not to be used during a commercial transaction. The following restrictions apply:

- (a) The inlet valves for the system are not to be connected to any hose or piping (dust covers are permitted) when not in use.

- (b) When the flushing system is in operation, the discharge hose is only to be connected to the port for the product type being flushed from the discharge line.
- (c) Following the flushing process, indications and recording elements must be reset to zero prior to beginning a commercial delivery.

(Added 2023)

UR.2.6.2. Minimizing Cross Contamination. – When dissimilar products are dispensed through a single meter, the user shall take steps to ensure the system is properly flushed to minimize the potential for cross contamination of product in receiving tanks on subsequent deliveries. Dispensing products having radically different characteristics (e.g., gasoline and diesel fuel) through a single meter delivery system is not recommended.

(Added 2023)

UR.2.6.3. Records. – Whenever, prior to delivery, a different product is pumped through the discharge hose to avoid contamination, a record including the date, time, original product, new product, and gallons pumped shall be maintained. These records shall be kept for a period of 12 months and available for inspection by the weights and measures authority having jurisdiction over the system.

(Amended 2023)

(Added 2018) (Amended 2023)

UR.3. Maintenance Requirements.

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

(Added 2016)

Table of Contents

	Page
Section 3.32. Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices.....	3-47
A. Application.....	3-47
A.1. General.....	3-47
A.2. Devices Used to Measure Other Liquid Products not Covered in Specific Codes.....	3-47
A.3. Exceptions.....	3-47
A.4. Additional Code Requirements.	3-47
S. Specifications.....	3-47
S.1. Design of Indicating and Recording Elements and of Recorded Representations.	3-47
S.1.1. Primary Elements.	3-47
S.1.2. Graduations.....	3-48
S.1.3. Indicators.	3-48
S.1.4. For Retail Devices Only.	3-49
S.1.5. For Stationary Retail Devices Only.....	3-49
S.1.6. For Wholesale Devices Only.	3-52
S.2. Design of Measuring Elements.....	3-52
S.2.1. Air/Vapor Elimination.....	3-52
S.2.2. Provision for Sealing.	3-52
S.2.3. Directional Flow Valves.	3-53
S.2.4. Maintenance of Liquid State.	3-53
S.2.5. <i>Zero-Set-Back Interlock</i>	3-53
S.2.6. Automatic Timeout.	3-54
S.2.7. Thermometer Well.	3-54
S.2.8. Automatic Temperature Compensation.	3-54
S.3. Design of Discharge Lines and Discharge Line Valves.	3-55
S.3.1. Diversion of Measured Liquid.	3-55
S.3.2. Delivery Hose.	3-55
S.4. Marking Requirements.....	3-55
S.4.1. Limitation of Use.	3-55
S.4.2. Discharge Rates.....	3-55
S.4.3. <i>Location of Marking Information; Retail Motor-Fuel Dispensers.</i>	3-55
S.4.4. Temperature Compensation.	3-56
N. Notes.....	3-56
N.1. Test Liquid.	3-56
N.2. Vaporization and Volume Change.....	3-56
N.3. Test Drafts.....	3-56
N.3.1. Minimum Test.....	3-56
N.3.2. Transfer Standard Meter Test.....	3-56
N.4. Testing Procedures.	3-56
N.4.1. Normal Tests.....	3-56
N.4.2. Special Tests.	3-57
N.4.3. Money-Value Computation Tests.....	3-57
N.4.4. Repeatability Tests.	3-57
N.5. Temperature Correction.	3-57
T. Tolerances	3-58
T.1. Application.....	3-58

T.1.1. To Underregistration and to Overregistration.	3-58
T.2. Tolerance Values.	3-58
T.3. Repeatability.	3-58
T.4. Automatic Temperature-Compensating Systems.....	3-58
UR. User Requirements.....	3-58
UR.1. Installation Requirements.....	3-58
UR.1.1. Discharge Rate.	3-58
UR.1.2. Length of Discharge Hose.	3-58
UR.2. Use Requirements.....	3-59
UR.2.1. Return of Indication and Recording Elements to Zero.	3-59
UR.2.2. Condition of Fill of Discharge Hose.....	3-59
UR.2.3. Vapor-Return Line.	3-59
UR.2.4. Temperature Compensation.	3-59
UR.2.5. Ticket in Printing Device.....	3-59
UR.2.6. Recorded Representations.....	3-59
UR.2.7. For Stationary Retail Computing-Type Systems Only, Installed After January 1, 2017.	3-60

Section 3.32. Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices

A. Application

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

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

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

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

S. Specifications

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

S.1.1. Primary Elements.

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

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

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

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

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

(Amended 1987)

S.1.1.4. Advancement of Indicating and Recording Elements. – Primary indicating and recording elements shall be susceptible to advancement only by the mechanical operation of the device. However, a device may be cleared by advancing its elements to zero, but only if:

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

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

S.1.1.5. Money-Values, Mathematical Agreement. – Any digital money-value indication and any recorded money-value on a computing-type device shall be in mathematical agreement with its associated quantity indication or representation to within 1 cent of money-value; except that a stationary retail computing-type device must compute and indicate to the nearest 1 cent of money-value. (Also see Section 1.10. General Code, G-S.5.5. Money-Values, Mathematical Agreement.)

(Amended 1984 and 1988)

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

(Added 1979) (Amended 1987 and 2023)

S.1.2. Graduations.

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

S.1.2.2. Width. – In any series of graduations:

- (a) the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations;
- (b) the width of main graduations shall be not more than 50 % greater than the width of subordinate graduations; and
- (c) graduations shall in no case be less than 0.2 mm (0.008 in) in width.

S.1.2.3. Clear Interval between Graduations. – The clear interval shall be not less than 1.0 mm (0.04 in). If the graduations are not parallel, the measurement shall be made:

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

S.1.3. Indicators.

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

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

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

- (a) *the width of the narrowest graduation*;* and
[*Nonretroactive as of January 1, 2002]
(Amended 2001)

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

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

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

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

S.1.4. For Retail Devices Only.

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

- (a) For electronic devices manufactured prior to January 1, 2006, the first 0.03 L (or 0.009 gal) of a delivery and its associated total sales price need not be indicated.
- (b) *For electronic devices manufactured on or after January 1, 2006, the measurement, indication of delivered quantity, and the indication of total sales price shall be inhibited until the fueling position reaches conditions necessary to ensure that the delivery starts at zero.*

[Nonretroactive as of January 1, 2006]

(Amended 2016)

S.1.4.2. Return to Zero.

- (a) Primary indicating elements shall be readily returnable to a definite zero indication.
- (b) Primary recording elements on a stationary retail device shall be readily returnable to a definite zero indication if the device is equipped to record.
- (c) Means shall be provided to prevent the return of primary indicating elements and of primary recording elements if these are returnable to zero, beyond their correct zero position.
- (d) Primary indicating elements shall not be resettable to zero during a delivery.

(Amended 1990 and 2016)

S.1.5. For Stationary Retail Devices Only.

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

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

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

[Nonretroactive as of January 1, 2016]

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

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

(Amended 2016)

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

(Amended 1995)

Table 1. Money-Value Divisions and Maximum Allowable Variations for Money-Value Computations on Mechanical Analog Computers				
Unit Price		Money- Value Division	Maximum Allowable Variation	
From	To and Including		Design Test	Field Test
0	\$0.25/liter or \$1.00/gallon	1¢	± 1¢	± 1¢
\$0.25/liter or \$1.00/gallon	\$0.75/liter or \$3.00/gallon	1¢ or 2¢	± 1¢	± 2¢
\$0.75/liter or \$3.00/gallon	\$2.50/liter or \$10.00/gallon	1¢ or 2¢	± 1¢	± 2¢
		5¢	± 2½¢	± 5¢

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

- (a) Not more than 1 cent at all unit prices up to and including \$0.25 per liter or \$1.00 per gallon.
- (b) Not more than 2 cents at unit prices greater than \$0.25 per liter or \$1.00 per gallon up to and including \$0.75 per liter or \$3.00 per gallon.
- (c) Not more than 5 cents at all unit prices greater than \$0.75 per liter or \$3.00 per gallon.

(Amended 1984)

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

S.1.5.2.3. Money-Value Divisions, Auxiliary Indications. – *In a system equipped with auxiliary indications, all indicated money-value divisions shall be identical.*

[Nonretroactive as of January 1, 1985.]

S.1.5.3. Agreement Between Indications.

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

- (1) *All total values for an individual sale that are indicated or recorded by the system agree, and*
- (2) *Within each element, the values indicated or recorded meet the formula (quantity × unit price = total sale price) to the closest cent.*

(b) *When a system applies a post-delivery discount(s) to a fuel's unit price through an auxiliary element, the total volume of the delivery shall be in agreement between all elements in the system.*

[Nonretroactive as of January 1, 2016]

(Added 2016)

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

- (a) the total volume of the delivery;
- (b) the unit price;
- (c) the total computed price; and
- (d) the product identity by name, symbol, abbreviation, or code number.

(Added 2014) (Amended 2016)

S.1.5.5. Recorded Representations for Transactions Where a Post-Delivery Discount(s) is Provided.

– Except for fleet sales and other price contract sales, a recorded representation providing the following information shall be available through a built-in or separate recording element that is part of the system for transactions involving a post-delivery discount:

- (a) the product identity by name, symbol, abbreviation, or code number;
- (b) transaction information as shown on the dispenser at the end of the delivery and prior to any post-delivery discount(s), including the:
 - (1) total volume of the delivery;
 - (2) unit price; and
 - (3) total computed price of the fuel sale.
- (c) an itemization of the post-delivery discounts to the unit price; and
- (d) the final total price of the fuel sale after all post-delivery discounts are applied.

(Added 2016) (Amended 2023)

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

sales price) shall be determinable for at least 15 minutes at the device or another on-site device accessible to the customer.

[Nonretroactive as of January 1, 2017]

(Added 2016)

S.1.5.7. Totalizers for Retail Motor-Fuel Dispensers. – *Retail motor-fuel dispensers shall be equipped with a nonresettable totalizer for the quantity delivered through the metering device.*

[Nonretroactive as of January 1, 2017]

(Added 2016)

S.1.6. For Wholesale Devices Only.

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

(Amended 1987)

S.2. Design of Measuring Elements.

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

(Amended 2016 and 2018)

S.2.2. Provision for Sealing. – For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices. For parameters adjusted using other means, the following applies.

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

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

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

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

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

(Amended 2006 and 2019)

Table S.2.2. Categories of Device and Methods of Sealing	
Categories of Device	Methods of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. <i>The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.</i>	<i>The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.</i>
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). <i>The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.</i>	<i>An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available on demand through the device or through another on-site device. The information may also be available electronically. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1 000 records are required. (Note: Does not require 1 000 changes to be stored for each parameter.)</i>

[Nonretroactive as of January 1, 1995]

(Table Added 2006) (Amended 2016)

S.2.3. Directional Flow Valves. – A measuring system shall be equipped with a valve or other effective means, automatic in operation and installed in or adjacent to the measuring element, to prevent reversal of flow of the product being measured.

(Amended 1982)

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

S.2.5. Zero-Set-Back Interlock.

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

[Nonretroactive as January 1, 2021]

(Added 2019) (Amended 2021 and 2024)

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

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

[Nonretroactive as of January 1, 2017]

(Added 2016) (Amended 2024)

S.2.6. Automatic Timeout.

S.2.6.1. Electronic Stationary (Other than Stationary Retail Motor-Fuel Dispensers). – For individual deliveries, if there is no product flow for three minutes the transaction must be completed before additional product flow is allowed. The three-minute timeout shall be a sealable feature on an indicator.

[Nonretroactive as of January 1, 2021]

(Added 2021) (Amended 2023)

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

[Nonretroactive as of January 1, 2022]

(Added 2021)

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

(Added 2023)

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

- (a) in the liquid chamber of the meter; or
- (b) in the meter inlet or discharge line and immediately adjacent to the meter.

(Amended 1987)

S.2.8. Automatic Temperature Compensation. – A device may be equipped with an adjustable automatic means for adjusting the indication and registration of the measured volume of product to the volume at 15 °C (60 °F).

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

shall be made to facilitate the deactivation of the automatic temperature-compensating mechanism so that the meter may indicate, and record if it is equipped to record, in terms of the uncompensated volume.

(Amended 1972)

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

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

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

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

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

(Amended 1975)

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

S.4. Marking Requirements.

S.4.1. Limitation of Use. – If a device is intended to measure accurately only products having particular properties, or to measure accurately only under specific installation or operating conditions, or to measure accurately only when used in conjunction with specific accessory equipment, these limitations shall be clearly and permanently stated on the device.

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

- (a) 20 L (5 gal) per minute for stationary retail devices; or
- (b) 20 % of the marked maximum discharge rate for other retail devices and for wholesale devices.

(Amended 1987)

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

(Added 2003)

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

- (a) *within 60 cm (24 in) to 150 cm (60 in) from the base of the dispenser;*
- (b) *either internally and/or externally provided the information is permanent and easily read; and*

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

The use of a dispenser key or tool to access internal marking information is permitted for retail motor-fuel dispensers.

[Nonretroactive as of January 1, 2003]

(Added 2006)

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

N. Notes

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

N.2. Vaporization and Volume Change. – Care shall be exercised to reduce to a minimum, vaporization and volume changes.

N.3. Test Drafts.

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

(Amended 2023)

N.3.2. Transfer Standard Meter Test. – When comparing a meter with a calibrated transfer standard meter, the minimum quantity for any test draft shall be equal to or greater than the amount delivered in one minute at the flow rate being tested.

(Added 2023) (Amended 2024)

(Amended 1982, 2023, and 2024)

N.4. Testing Procedures.

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

(Amended 1998)

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

- (a) by comparing the compensated volume indicated or recorded to the actual delivered volume adjusted to 15 °C (60 °F); and
- (b) with the temperature-compensating system deactivated, comparing the uncompensated volume indicated or recorded to the actual delivered volume.

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

(Amended 1987)

N.4.2. Special Tests. – “Special” tests shall be made to develop the operating characteristics of a device and any special elements and accessories attached to or associated with the device. Any test except as set forth in N.4.1. Normal Tests shall be considered a special test.

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

- (a) 20 L (5 gal) per minute; or
- (b) the minimum discharge rate marked on the device, whichever is less.

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

- (a) minimum discharge rate that can be developed under the conditions of installation; or
- (b) minimum discharge rate marked on the device, whichever is greater.

(Amended 1973)

N.4.2.3. For Wholesale Devices. – “Special” tests on a wholesale device shall include a test at, or slightly above, the minimum discharge rate marked on the device. In no case shall the test be performed at a flow rate less than the minimum discharge rate marked on the device.

(Amended 1987 and 2017)

N.4.3. Money-Value Computation Tests.

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

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

(Added 1984)

N.4.4. Repeatability Tests. – Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors such as temperature, pressure, and flow rate are reduced to the extent that they will not affect the results obtained. When conducting the tests, the discharge rates shall be within the minimum and maximum discharge rates as marked by the manufacturer. For devices equipped with an automatic temperature compensator, results shall be based on the uncompensated (gross) volume (e.g., with the temperature compensator deactivated).

(Amended 2019)

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

T. Tolerances

T.1. Application.

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

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

Table T.2. Accuracy Classes and Tolerances for LPG and Anhydrous Ammonia Liquid-Measuring Devices				
Accuracy Class	Application	Acceptance Tolerance	Maintenance Tolerance	Special Test Tolerance
1.0	Anhydrous ammonia, LPG (including vehicle-mounted meters)	0.6 %	1.0 %	1.0 %

(Added 2003)

T.3. Repeatability. – When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 % of the absolute value of the maintenance tolerance and the results of each test shall be within applicable tolerance. (Also see N.4.4. Repeatability Tests)
(Added 1992) (Amended 1997, 2001, and 2019)

T.4. Automatic Temperature-Compensating Systems. – The difference between the meter errors (expressed as a percentage) determined with and without the automatic temperature-compensating system activated shall not exceed:

- (a) 1.0 % for mechanical automatic temperature-compensating systems; and
- (b) 0.5 % for electronic automatic temperature-compensating systems.

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

(Added 1991) (Amended 1992, 1996, and 1997)

UR. User Requirements

UR.1. Installation Requirements.

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

UR.1.2. Length of Discharge Hose. – The length of the discharge hose on a stationary motor-fuel device shall not exceed 5.5 m (18 ft), measured from the outside of the housing of the device to the inlet end of the discharge nozzle, unless it can be demonstrated that a longer hose is essential to permit deliveries to be made to receiving vehicles or vessels. Unnecessarily remote location of a device shall not be accepted as justification for an abnormally long hose.

(Amended 1991)

UR.2. Use Requirements.

UR.2.1. Return of Indication and Recording Elements to Zero. – The primary indicating elements (visual), and the primary recording elements when these are returnable to zero, shall be returned to zero before each delivery.

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

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

- (a) in the case of any receiving container to which normal deliveries cannot be made without the use of such vapor-return line; or
- (b) in the case of any top spray-fill receiving container when the ambient temperature is at or above 32 °C (90 °F).

(Amended 2016)

UR.2.4. Temperature Compensation.

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

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

(Added 1984)

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

(Amended 1984)

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

(Added 1987)

UR.2.5. Ticket in Printing Device. – A ticket shall not be inserted into a device equipped with a ticket printer until immediately before a delivery is begun, and in no case shall a ticket be in the device when the vehicle is in motion while on a public street, highway, or thoroughfare.

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

Representations. A copy of the recorded representation issued by the device shall be provided to the customer at the time of delivery or as otherwise specified by the customer.

(Added 1992) (Amended 2023)

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

UR.2.7.1. Unit Price and Product Identity.

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

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

- (b) The following information shall be conspicuously displayed or posted on each side of a retail dispenser used in a direct sale:
 - (1) The identity of the product in descriptive commercial terms; and
 - (2) The identity of the grade, brand, blend, or mixture that a multi-product dispenser is set to deliver.

(Added 2016)

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

- (a) Fleet sales and other price contract sales are exempt from this requirement.
- (b) A truck stop dispenser used exclusively for refueling trucks is exempt from this requirement, provided that:
 - (1) all purchases of fuel are accompanied by a recorded representation of the transaction containing the applicable price per unit of measure, the total quantity delivered, and the total price of the sale; and
 - (2) unless a dispenser complies with S.1.5.1. Display of Unit Price, the price posted on the dispenser and the price at which the dispenser is set to compute shall be the highest price for any transaction which may be conducted.
- (c) A dispenser used in an application where a price per unit discount is offered following the delivery is exempt from this requirement, provided the following conditions are satisfied:
 - (1) the unit price posted on the dispenser and the unit price at which the dispenser is set to compute shall be the highest unit price for any transaction;
 - (2) all purchases of fuel are accompanied by a receipt recorded by the system for the transaction containing:

- a. the product identity by name, symbol, abbreviation, or code number;
 - b. transaction information as shown on the dispenser at the end of the delivery and prior to any post-delivery discount including the:
 - 1. total volume of the delivery;
 - 2. unit price; and
 - 3. total computed price of the fuel sale prior to post-delivery discounts being applied.
 - c. an itemization of the post-delivery discounts to the unit price; and
 - d. the final total price of the fuel sale after all post-delivery discounts are applied.
- (Added 2016) (Amended 2023)

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Table of Contents

	Page
Section 3.33. Hydrocarbon Gas Vapor-Measuring Devices.....	3-65
A. Application	3-65
A.1. General.....	3-65
A.2. Exceptions.....	3-65
A.3. Additional Code Requirements.	3-65
S. Specifications.....	3-65
S.1. Design of Indicating and Recording Elements and of Recorded Representations.	3-65
S.1.1. Primary Elements.....	3-65
S.1.2. Graduations.....	3-66
S.1.3. Indicators.	3-66
S.2. Design of Measuring Elements.	3-67
S.2.1. Pressure Regulation.	3-67
S.2.2. Provision for Sealing.....	3-67
S.2.3. Maintenance of Vapor State.....	3-67
S.2.4. Automatic Temperature Compensation.	3-67
S.3. Design of Discharge Lines.....	3-67
S.3.1. Diversion of Measured Vapor.....	3-67
S.4. Marking Requirements.....	3-68
S.4.1. Limitations of Use.	3-68
S.4.2. Discharge Rates.	3-68
S.4.3. Temperature Compensation.	3-68
S.4.4. Badge.	3-68
N. Notes.....	3-68
N.1. Test Medium.	3-68
N.2. Temperature and Volume Change.	3-68
N.3. Test Drafts.....	3-68
N.4. Test Procedures.....	3-68
N.4.1. Normal Tests.....	3-68
N.4.2. Special Tests.	3-69
N.4.3. Repeatability Tests.....	3-69
N.5. Temperature Correction.	3-69
N.6. Frequency of Test.	3-69
T. Tolerances.....	3-69
T.1. Tolerance Values on Normal Tests and on Special Tests Other Than Low-Flame Tests.	3-69
T.2. Repeatability.	3-70
UR. User Requirements	3-70
UR.1. Installation Requirements.	3-70
UR.1.1. Capacity Rate.....	3-70
UR.1.2. Leakage.....	3-70
UR.2. Use Requirements.	3-70
UR.2.1. Automatic Temperature Compensation.	3-70
UR.2.2. Invoices.....	3-70
UR.2.3. Correction for Elevation.	3-71
UR.2.4. Valves and Test Tee.	3-71
UR.2.5. Use of Auxiliary Heated Vaporizer Systems.	3-71

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Section 3.33. Hydrocarbon Gas Vapor-Measuring Devices

A. Application

A.1. General. – This code applies to devices used for the measurement of hydrocarbon gas in the vapor state, such as propane, propylene, butanes, butylenes, ethane, methane, natural gas, and any other hydrocarbon gas/air mix. (Amended 1984, 1986, 1988, and 1991)

A.2. Exceptions. – This code does not apply to:

- (a) Liquid-measuring devices used for dispensing liquefied petroleum gases in liquid form. (Also see Section 3.32. Code for Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices.)
- (b) Natural, liquefied petroleum, and manufactured-gas-vapor meters when these are operated in a public utility system.
- (c) Mass flow meters. (Also see Section 3.37. Code for Mass Flow Meters.)
(Added 1994)

A.3. Additional Code Requirements. – In addition to the requirements of this code, Hydrocarbon Gas Vapor-Measuring Devices shall meet the requirements of Section 1.10. General Code.

S. Specifications

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

S.1.1. Primary Elements.

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

S.1.1.2. Units. – A volume-measuring device shall indicate, and record if equipped to record, its deliveries in terms of cubic meters or cubic feet, or multiple or decimal subdivisions of cubic meters or cubic feet. (Amended 1972 and 1991)

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:

- (a) 1 m^3 ($1\,000 \text{ dm}^3$) (100 ft^3) when the maximum rated gas capacity is less than $280 \text{ m}^3/\text{h}$ ($10\,000 \text{ ft}^3/\text{h}$);
- (b) 10 m^3 ($1\,000 \text{ ft}^3$) when the maximum rated gas capacity is $280 \text{ m}^3/\text{h}$ ($10\,000 \text{ ft}^3/\text{h}$) up to, but not including, $1\,700 \text{ m}^3/\text{h}$ ($60\,000 \text{ ft}^3/\text{h}$); and
- (c) 100 m^3 ($10\,000 \text{ ft}^3$) when the maximum rated gas capacity is $1\,700 \text{ m}^3/\text{h}$ ($60\,000 \text{ ft}^3/\text{h}$) or more.

(Amended 1972, 1988, and 1991)

S.1.1.4. Advancement of Indicating and Recording Elements. – Primary indicating and recording elements shall advance digitally or continuously and be susceptible to advancement only by the mechanical operation of the device.

S.1.1.5. Proving Indicator. – Devices rated less than $280 \text{ m}^3/\text{h}$ ($10\,000 \text{ ft}^3/\text{h}$) gas capacity shall be equipped with a proving indicator measuring 0.025 m^3 , 0.05 m^3 , 0.1 m^3 , 0.2 m^3 , or 0.25 m^3 per revolution,

(1 ft³, 2 ft³, 5 ft³, or 10 ft³ per revolution) for testing the meter. Devices with larger capacities shall be equipped as follows:

- (a) Devices rated 280 m³ (10 000 ft³) up to but not including 1 700 m³/h (60 000 ft³/h) gas capacity shall be equipped with a proving indicator measuring not greater than 1 m³ (100 ft³) per revolution.
- (b) Devices rated 1 700 m³/h (60 000 ft³/h) gas capacity or more shall be equipped with a proving indicator measuring not more than 10 m³ (1 000 ft³) per revolution.

The test circle of the proving indicator shall be divided into ten equal parts. Additional subdivisions of one or more of such equal parts may be made.

(Amended 1973 and 1988)

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 in no case should it exceed 1.0 mm (0.04 in) for indicating elements and 0.5 mm (0.02 in) for proving circles.

S.1.2.3. Clear Interval Between Graduations. – The clear interval shall be not less than 1.0 mm (0.04 in). If the graduations are not parallel, the measurement shall be made:

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

S.1.3. Indicators.

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

S.1.3.2. Length. – The index of an indicator shall reach to the finest graduations with which it is used.

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 the:

- (a) *width of the narrowest graduation;* and*
*[*Nonretroactive as of January 1, 2002]*
(Amended 2001)

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

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

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

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

S.2. Design of Measuring Elements.

S.2.1. Pressure Regulation. – The vapor should be measured at a normal gauge pressure (psig) of:
(Amended 1991)

- (a) 2 740 Pa ± 685 Pa (11 in of water column [0.40 psig] ± 2.75 in of water column [0.10 psig]) for liquefied petroleum gas vapor; or
- (b) 1 744 Pa ± 436 Pa (7 in of water column [0.25 psig] ± 1.75 in of water column [0.06 psig]) for natural and manufactured gas.

When vapor is measured at a pressure other than what is specified above for the specific product, a volume multiplier shall be applied within the meter or to the billing invoice based on the following equation:

$$VPM = \frac{AAP + GP}{AAP + NGP}$$

Where:

- VPM = Volume pressure multiplier
- AAP = Assumed atmospheric pressure in Pa or psia
- GP = Gauge pressure in Pa or psig
- NGP = Normal gauge pressure in Pa or psig

The assumed atmospheric pressure is to be taken from Table 2. Corrections for Altitude, U.S. Customary Units and Table 2M. Corrections for Altitude, Metric Units.

When liquefied petroleum gas vapor is measured at a pressure of 6 900 Pa (1 psig) or more, the delivery pressure shall be maintained within ± 1 725 Pa (± 0.25 psig).

Pressure variations due to regulator lock off shall not increase the operating pressure by more than 25 %.
(Amended 1980, 1984, and 1991)

S.2.2. Provision for Sealing. – For devices or systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices. For parameters adjusted using other means, the following applies.

Adequate provision shall be made for applying security seals in such a manner that no adjustment or interchange can be made of any measurement element.

(Amended 2019)

S.2.3. Maintenance of Vapor State. – A device shall be so designed and installed that the product being measured will remain in a vapor state during passage through the meter.

S.2.4. Automatic Temperature Compensation. – A device may be equipped with an adjustable automatic means for adjusting the indication and registration of the measured volume of vapor product to the volume at 15 °C (60 °F).

S.3. Design of Discharge Lines.

S.3.1. Diversion of Measured Vapor. – No means shall be provided by which any measured vapor can be diverted from the measuring chamber of the meter or the discharge line therefrom.

S.4. Marking Requirements.

S.4.1. Limitations 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 rated gas capacity in cubic meters per hour or cubic feet per hour.

S.4.3. Temperature Compensation. – If a device is equipped with an automatic temperature compensator, this shall be indicated on the badge or immediately adjacent to the badge of the device and on the register.

S.4.4. Badge. – A badge affixed in a prominent position on the front of the device shall show the manufacturer's name, serial number and model number of the device, and capacity rate of the device for the particular products that it was designed to meter as recommended by the manufacturer.

N. Notes

N.1. Test Medium. – The device shall be tested with air or the product to be measured.

(Amended 1991)

N.2. Temperature and Volume Change. – Care should be exercised to reduce to a minimum any volume changes. The temperature of the air, bell-prover oil, and the meters under test should be within 1 °C (2 °F) of one another. The devices should remain in the proving room for at least 16 hours before starting any proving operations to allow the device temperature to approximate the temperature of the proving device.

N.3. Test Drafts. – Except for low-flame tests, test drafts shall be at least equal to one complete revolution of the largest capacity proving indicator and shall in no case be less than 0.05 m³ or 2 ft³. All flow rates shall be controlled by suitable outlet orifices.

(Amended 1973 and 1991)

Table 1. Capacity of Low-Flow Test Rate Orifices with Respect to Device Capacity			
Metric Units		U.S. Customary Units	
Rated Capacity	Low-Flow Test Rate	Rated Capacity	Low-Flow Test Rate
Up to and including 7 m ³ /h	0.007 m ³ /h	Up to and including 250 ft ³ /h	0.25 ft ³ /h
Over 7 m ³ /h up to and including 14 m ³ /h	0.014 m ³ /h	Over 250 ft ³ /h up to and including 500 ft ³ /h	0.50 ft ³ /h
Over 14 m ³ /h	0.1 % of capacity rate	Over 500 ft ³ /h	0.1 % of capacity rate

N.4. Test Procedures. – If a device is equipped with an automatic temperature compensator, the proving device reading shall be corrected to 15 °C (60 °F), using an approved table.

(Amended 1972)

N.4.1. Normal Tests. – The normal test of a device shall be made at a rate not to exceed the capacity rate given on the badge of the meter.

(Amended 1988)

N.4.1.1. Automatic Temperature Compensation. – If a device is equipped with an automatic temperature compensator, the quantity of the test draft indication of the standard shall be corrected to 15 °C (60 °F).

N.4.2. Special Tests. – “Special” tests shall be made to develop the operating characteristics of a device and any special elements and accessories attached to or associated with the device. Any test except as set forth in N.4.1. Normal Tests shall be considered a special test.

N.4.2.1. Slow Test. – The device shall be tested at a rate not less than 20 % of the marked capacity rate, or (at the check rate) not less than the minimum flow rate if marked on the device, whichever is less.
(Amended 1988)

N.4.2.2. Low-Flame Test. – The device shall be tested at an extremely low-flow rate as given in Table 1. Capacity of Low-Flow Test Rate Orifices with Respect to Device Capacity. The test shall consist of passing air at a pressure of 375 Pa (1.5 in water column) through the meter for not less than 60 minutes. The meter shall continue to advance at the conclusion of the test period.
(Amended 1990 and 1991)

N.4.2.3. Pressure Regulation Test. – On devices operating at a pressure of 6 900 Pa (1 psig) or more, a pressure regulation test shall be made at both the minimum and maximum use load to determine the proper operation of the regulator and the proper sizing of the piping and dispensing equipment. These tests may include a test of 24 hours during which the pressure is recorded.
(Added 1984)

N.4.3. Repeatability Tests. – Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors such as temperature, pressure, and flow rate are reduced to the extent that they will not affect the results obtained. When conducting the tests, the minimum discharge rate shall be the minimum flow rate marked on the device or at least 20% of the marked capacity rate, whichever is less, and the maximum discharge rates shall not exceed the capacity rate as marked by the manufacturer.

Note: The repeatability test will not be performed at the low-flame flow rate for these devices as the time required would be unrealistic.
(Amended 2019)

N.5. Temperature Correction. – Corrections shall be made for any changes in volume resulting from the difference in air temperatures between time of passage through the device and time of volumetric determination in the proving device.

N.6. Frequency of Test. – A hydrocarbon gas vapor-measuring device shall be tested before installation and allowed to remain in service for 10 years from the time last tested without being retested, unless a test is requested by:

- (a) the purchaser of the product being metered;
- (b) the seller of the product being metered; or
- (c) the weights and measures official.

T. Tolerances

T.1. Tolerance Values on Normal Tests and on Special Tests Other Than Low-Flame Tests. – Maintenance and acceptance tolerances for normal and special tests for hydrocarbon gas vapor-measuring devices shall be as shown in Table T.1. Accuracy Classes and Tolerances for Hydrocarbon Gas Vapor-Measuring Devices.
(Amended 1981 and 2003)

Table T.1. Accuracy Classes and Tolerances for Hydrocarbon Gas Vapor-Measuring Devices				
Accuracy Class	Application		Acceptance Tolerance	Maintenance Tolerance
3.0	Gases at low pressure (for example, LPG vapor)	Overregistration	1.5 %	1.5 %
		Underregistration	3.0 %	3.0 %

(Added 2003)

T.2. Repeatability. – When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 0.9 % and the results of each test shall be within the applicable tolerance. Also see N.4.3. Repeatability Tests.

(Added 2002) (Amended 2019)

UR. User Requirements

UR.1. Installation Requirements.

UR.1.1. Capacity Rate. – A device shall be so installed that the actual maximum flow rate will not exceed the capacity rate except for short durations. 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. Leakage. – The metering system shall be installed and maintained as a pressure-tight and leak-free system.

UR.2. Use Requirements.

UR.2.1. Automatic Temperature Compensation. – A compensated device may not be replaced with an uncompensated device without the written approval of the weights and measures authority having jurisdiction over the device.

UR.2.2. Invoices. – A customer purchasing hydrocarbon gas measured by a vapor meter shall receive from the seller an invoice for each billing period. The invoice shall clearly and separately show the following:

- (a) The opening and closing meter readings and the dates of those readings.
- (b) The altitude correction factor.
- (c) The total cubic meters (cubic feet) billed, corrected for elevation.
- (d) The charge per cubic meter (cubic foot) after correction for elevation.
- (e) All periodic charges independent of the measured gas, such as meter charges, meter reading fees, service charges or a minimum charge for a minimum number of cubic meters (cubic feet).
- (f) The total charge for the billing period.

If the vapor meter is equipped with an automatic temperature compensator, or any other means are used to compensate for temperature, the invoice shall show that the volume has been adjusted to the volume at 15 °C (60 °F).

(Amended 1988 and 1991)

UR.2.3. Correction for Elevation. – The metered volume of gas shall be corrected for changes in the atmospheric pressure with respect to elevation to the standard pressure of 101.56 kPa (14.73 psia). The appropriate altitude correction factor from Table 2M. Corrections for Altitude, Metric Units or Table 2. Corrections for Altitude, U.S. Customary Units shall be used. (The table is modified from NBS Handbook 117, Examination of Vapor-Measuring Devices for Liquefied Petroleum Gas.)

Elevation correction factors (ACF) were obtained by using the following equation:

$$ACF = \frac{GP \text{ of gas} + AAP}{\text{base pressure}}$$

Where:

GP	=	gauge pressure
AAP	=	assumed atmospheric pressure
base pressure	=	101.560 kPa = 14.73 psia
2740 Pa	=	11 in of water column = 0.397 psig
1744 Pa	=	7 in of water column = 0.253 psig

(Amended 1988)

UR.2.4. Valves and Test Tee. – *All gas meter installations shall be provided with a shut-off valve located adjacent to and on the inlet side of the meter. In the case of a single meter installation utilizing a liquefied petroleum gas tank, the tank service valve may be used in lieu of the shut-off valve. All gas meter installations shall be provided with a test tee located adjacent to and on the outlet side of the meter.*

[Nonretroactive as of January 1, 1990]

(Added 1989)

UR.2.5. Use of Auxiliary Heated Vaporizer Systems. – Automatic temperature compensation shall be used on hydrocarbon gas vapor meters equipped with an auxiliary heated vaporizer system unless there is sufficient length of underground piping to provide gas at a uniform temperature to the meter inlet. When required by weights and measures officials, a thermometer well (appropriately protected against freezing) shall be installed immediately up-stream of the meter.

(Added 1990)

Table 2M. Corrections for Altitude, Metric Units							
Elevation (meters)			Altitude Correction Factor		Assumed Atmospheric Pressure	Assumed Atmospheric Pressure Plus Gauge Pressure	
			2.74 kPa Gauge Pressure	1.74 kPa Gauge Pressure	(kPa)	2.74 kPa Gauge Pressure	1.74 kPa Gauge Pressure
	– 50 to	120	1.02	1.01	100.85	103.59	102.58
above	120 to	300	1.00	0.99	98.82	101.56	100.54
above	300 to	470	0.98	0.97	96.79	99.53	98.51
above	470 to	650	0.96	0.95	94.76	97.50	96.48
above	650 to	830	0.94	0.93	92.73	95.47	94.45
above	830 to	1 020	0.92	0.91	90.70	93.44	92.42
above	1 020 to	1 210	0.90	0.89	88.66	91.40	90.39
above	1 210 to	1 400	0.88	0.87	86.63	89.37	88.36
above	1 400 to	1 590	0.86	0.85	84.60	87.34	86.33
above	1 590 to	1 790	0.84	0.83	82.57	85.31	84.29
above	1 790 to	2 000	0.82	0.81	80.54	83.28	82.26
above	2 000 to	2 210	0.80	0.79	78.51	81.25	80.23
above	2 210 to	2 420	0.78	0.77	76.48	79.22	78.20
above	2 420 to	2 640	0.76	0.75	74.45	77.19	76.17
above	2 640 to	2 860	0.74	0.73	72.41	75.15	74.15
above	2 860 to	3 080	0.72	0.71	70.38	73.12	72.12
above	3 080 to	3 320	0.70	0.69	68.35	71.09	70.08
above	3 320 to	3 560	0.68	0.67	66.32	69.06	68.05
above	3 560 to	3 800	0.66	0.65	64.29	67.03	66.01
above	3 800 to	4 050	0.64	0.63	62.26	65.00	63.98
above	4 050 to	4 310	0.62	0.61	60.23	62.97	61.95
above	4 310 to	4 580	0.60	0.59	58.20	60.94	59.92

Table 2. Corrections for Altitude, U.S. Customary Units							
Elevation (feet)			Altitude Correction Factor		Assumed Atmospheric Pressure	Assumed Atmospheric Pressure Plus Gauge Pressure	
			11 inch WC	7 inch WC	(psia)	11 inch WC (psia)	7 inch WC (psia)
above	– 150 to	400	1.02	1.01	14.64	15.04	14.89
above	400 to	950	1.00	0.99	14.35	14.74	14.60
above	950 to	1 550	0.98	0.97	14.05	14.45	14.30
above	1 550 to	2 100	0.96	0.95	13.76	14.15	14.01
above	2 100 to	2 700	0.94	0.93	13.46	13.86	13.71
above	2 700 to	3 300	0.92	0.91	13.17	13.56	13.42
above	3 300 to	3 950	0.90	0.89	12.87	13.27	13.12
above	3 950 to	4 550	0.88	0.87	12.58	12.97	12.83
above	4 550 to	5 200	0.86	0.85	12.28	12.68	12.53
above	5 200 to	5 850	0.84	0.83	11.99	12.38	12.24
above	5 850 to	6 500	0.82	0.81	11.69	12.09	11.94
above	6 500 to	7 200	0.80	0.79	11.40	11.79	11.65
above	7 200 to	7 900	0.78	0.77	11.10	11.50	11.35
above	7 900 to	8 600	0.76	0.75	10.81	11.20	11.06
above	8 600 to	9 350	0.74	0.73	10.51	10.91	10.76
above	9 350 to	10 100	0.72	0.71	10.22	10.61	10.47
above	10 100 to	10 850	0.70	0.69	9.92	10.32	10.17
above	10 850 to	11 650	0.68	0.67	9.63	10.03	9.88
above	11 650 to	12 450	0.66	0.65	9.33	9.73	9.58
above	12 450 to	13 250	0.64	0.63	9.04	9.44	9.29
above	13 250 to	14 100	0.62	0.61	8.75	9.14	9.00
above	14 100 to	14 950	0.60	0.59	8.45	8.85	8.70

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Table of Contents

	Page
Section 3.34. Cryogenic Liquid-Measuring Devices	3-77
A. Application.....	3-77
A.1. General.....	3-77
A.2. Exceptions.....	3-77
A.3. Additional Code Requirements.	3-77
S. Specifications.....	3-77
S.1. Design of Indicating and Recording Elements and of Recorded Representations.	3-77
S.1.1. Primary Elements.....	3-77
S.1.2. Graduations.....	3-78
S.1.3. Indicators.....	3-78
S.1.4. Computing-Type Device.	3-79
S.2. Design of Measuring Elements.....	3-79
S.2.1. Air/Vapor Elimination.....	3-79
S.2.2. Directional Flow Valves.....	3-80
S.2.3. Maintenance of Liquid State.....	3-80
S.2.4. Automatic Temperature or Density Compensation.	3-80
S.2.5. Provision for Sealing.....	3-80
S.3. Design of Discharge Lines and Discharge Line Valves.	3-81
S.3.1. Diversion of Measured Liquid.	3-81
S.3.2. Discharge Hose.....	3-81
S.4. Marking Requirements.....	3-81
S.4.1. Limitation of Use.....	3-81
S.4.2. Discharge Rates.....	3-82
S.4.3. Temperature or Density Compensation.	3-82
N. Notes.....	3-82
N.1. Test Liquid.....	3-82
N.2. Vaporization and Volume Change.....	3-82
N.3. Test Drafts.....	3-82
N.3.1. Gravimetric Test.	3-82
N.3.2. Transfer Standard Test.....	3-82
N.4. Density.....	3-82
N.5. Testing Procedures.....	3-83
N.5.1. Normal Tests.....	3-83
N.5.2. Special Tests.....	3-83
N.5.3. Repeatability Tests.....	3-83
N.6. Temperature Correction.....	3-84
N.7. Automatic Temperature or Density Compensation.....	3-84
T. Tolerances.....	3-84
T.1. Application.....	3-84
T.1.1. To Underregistration and to Overregistration.	3-84

T.2. Tolerance Values.....	3-84
T.3. On Tests Using Type 2 Transfer Standards.....	3-84
T.4. Repeatability.....	3-84
UR. User Requirements.....	3-84
UR.1. Installation Requirements.....	3-84
UR.1.1. Discharge Rate.....	3-84
UR.1.2. Length of Discharge Hose.....	3-84
UR.1.3. Maintenance of Liquid State.....	3-85
UR.2. Use Requirements.....	3-85
UR.2.1. Return of Indicating and Recording Elements to Zero.....	3-85
UR.2.2. Condition of Discharge System.....	3-85
UR.2.3. Vapor Return Line.....	3-85
UR.2.4. Drainage of Discharge Line.....	3-85
UR.2.5. Conversion Factors.....	3-85
UR.2.6. Temperature or Density Compensation.....	3-85
UR.2.7. Pressure of Tanks with Volumetric Metering Systems without Temperature Compensation.....	3-86

Section 3.34. Cryogenic Liquid-Measuring Devices

A. Application

A.1. General. – This code applies to devices used for the measurement of cryogenic liquids such as, but not limited to oxygen, nitrogen, hydrogen, and argon.

(Amended 1986 and 1995)

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

- (a) Devices used for dispensing liquefied petroleum gases (for which see Section 3.32. Code for Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices).
- (b) Devices used solely for dispensing a product in connection with operations in which the amount dispensed does not affect customer charges.
- (c) Devices used solely for dispensing liquefied natural gas.
- (d) Mass flow meters. (Also see Section 3.37. Code for Mass Flow Meters.)

(Added 1994)

A.3. Additional Code Requirements. – In addition to the requirements of this code, Cryogenic Liquid- Measuring Devices shall meet the requirements of Section 1.10. General Code.

S. Specifications

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

S.1.1. Primary Elements.

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

S.1.1.2. Units. – A device shall indicate and record, if equipped to record, its deliveries in terms of: kilograms or pounds; liters or gallons of liquid at the normal boiling point of the specific cryogenic product; cubic meters (cubic feet) of gas at a normal temperature of 21 °C (70 °F) and an absolute pressure of 101.325 kPa (14.696 psia); or decimal subdivisions or multiples of the measured units cited above.

(Amended 2002)

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) for small delivery devices:

- (1) 1 L;
- (2) 0.1 gal;
- (3) 1 kg;
- (4) 1 lb;

(5) 0.1 m³ of gas; or

(6) 10 ft³ of gas.

(b) for large delivery devices:

(1) 10 L;

(2) 1 gal;

(3) 10 kg;

(4) 10 lb;

(5) 1 m³ of gas; or

(6) 100 ft³ of gas.

(Amended 2002)

S.1.1.4. Advancement of Indicating and Recording Elements. – Primary indicating and recording elements shall be susceptible to advancement only by the normal operation of the device. However, a device may be cleared by advancing its elements to zero, but only if:

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

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

S.1.1.5. Return to Zero. – Primary indicating and recording 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 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 % greater than the width of subordinate graduations. Graduations shall in no case be less than 0.2 mm (0.008 in) in width.

S.1.2.3. Clear Interval Between Graduations. – The clear interval shall be no less than 1.0 mm (0.04 in). If the graduations are not parallel, the measurement shall be made:

(a) along the line of relative movement between the graduations at the end of the indicator; or

(b) if the indicator is continuous, at the point of widest separation of the graduations.

(Also see S.1.3.6. Travel of Indicator.)

S.1.3. Indicators.

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

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

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

- (a) *width of the narrowest graduation; and*

[Nonretroactive as of January 1, 2002]

(Amended 2001)

- (b) 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.

(Amended 2001)

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

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

S.1.3.6. Travel of Indicator. – If the most sensitive element of the primary indicating element uses an indicator and graduations, the relative movement of these parts corresponding to the smallest indicated value shall be not less than 0.5 mm (0.20 in).

S.1.4. Computing-Type Device.

S.1.4.1. Recorded Representations. – Any recorded representation issued by a device of the computing type which includes the total computed price shall also include the total quantity of the delivery and the price per unit.

(Amended 2023)

S.1.4.2. 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 total price shall be computed on the basis of the quantity indicated when the value of the smallest division indicated is equal to or less than the values specified in S.1.1.3. Value of Smallest Unit.

S.1.4.3. Money-Values, Mathematical Agreement. – Any digital money-value indication and any recorded money-value on a computing type device shall be in mathematical agreement with its associated quantity indication or representation to within 1 cent of money-value.

S.2. Design of Measuring Elements.

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

(Amended 2018)

S.2.2. Directional Flow Valves. – A valve or valves or other effective means, automatic in operation, to prevent the reversal of flow shall be installed in or adjacent to the measuring device.

(Amended 1978)

S.2.3. Maintenance of Liquid State. – A device shall be so designed that the product being measured will remain in a liquid state during passage through the device.

S.2.4. Automatic Temperature or Density Compensation. – A device shall be equipped with automatic means for adjusting the indication and/or recorded representation of the measured quantity of the product, to indicate and/or record in terms of: kilograms or pounds; or liters or gallons of liquid at the normal boiling point of the specific cryogenic product; or the equivalent cubic meters (cubic feet) of gas at a normal temperature of 21 °C (70 °F) and an absolute pressure of 101.325 kPa (14.696 lb/in² absolute). *When a compensator system malfunctions, the indicating and recording elements may indicate and record in uncompensated volume if the mode of operation is clearly indicated, e.g., by a marked annunciator, recorded statement, or other obvious means.**

*[*Nonretroactive as of January 1, 1992]*

(Amended 1991 and 2002)

S.2.5. Provision for Sealing. – For devices or systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices. For parameters adjusted using other means, the following applies.

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

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

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

*Audit trails shall use the format set forth in Table S.2.5. Categories of Device and Methods of Sealing.**

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

(Amended 2006 and 2019)

Table S.2.5. Categories of Device and Methods of Sealing	
Categories of Device	Methods of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.	The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.	An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available on demand through the device or through another on-site device. The information may also be available electronically. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1 000 records are required. (Note: Does not require 1 000 changes to be stored for each parameter.)

[Nonretroactive as of January 1, 1995]

(Table Added 2006) (Amended 2016)

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 device or the discharge line therefrom, except that a manually controlled outlet that may be opened for purging or draining the measuring system 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.

S.3.2. Discharge Hose. – The discharge hose of a measuring system shall be of the completely draining dry-hose type.

S.4. Marking Requirements.

S.4.1. Limitation of Use. – If a measuring system 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 marked on the device.

S.4.2. Discharge Rates. – A meter shall be marked to show its designed maximum and minimum discharge rates.

S.4.3. Temperature or Density Compensation. – Devices equipped with an automatic temperature or density compensator, shall be clearly and conspicuously marked on the primary indicating elements, recording elements, and recorded representations to show that the quantity delivered has been adjusted to the conditions specified in S.2.4. Automatic Temperature or Density Compensation.

N. Notes

N.1. Test Liquid. – A meter shall be tested with the liquid to be commercially measured except that, in a type evaluation examination, nitrogen may be used.

N.2. Vaporization and Volume Change. – Care shall be exercised to reduce to a minimum vaporization and volume changes. When testing by weight, the weigh tank and transfer systems shall be pre-cooled to liquid temperature prior to the start of the test to avoid the venting of vapor from the vessel being weighed.

N.3. Test Drafts.

N.3.1. Gravimetric Test. – Weight test drafts shall be equal to at least the amount delivered by the device in 2 minutes at its maximum discharge rate, and shall in no case be less than 907 kg (2 000 lb).

N.3.2. Transfer Standard Test. – When comparing a meter with a calibrated transfer standard, the test draft shall be equal to at least the amount delivered by the device in two minutes at its maximum discharge rate, and shall in no case be less than 180 L (50 gal) or equivalent thereof. When testing uncompensated volumetric meters in a continuous recycle mode, appropriate corrections shall be applied if product conditions are abnormally affected by this test mode.

(Amended 1976)

N.4. Density. – Temperature and pressure of the metered test liquid shall be measured during the test for the determination of density or volume correction factors when applicable. For Liquid Density and Volume Correction Factors (with respect to temperature and pressure) the publications shown in Table N.4. Density or Volume Correction Factors shall apply.

(Amended 1986 and 2004)

Table N.4. Density or Volume Correction Factors	
Cryogenic Liquid	Publication
Argon	Tegeler, Ch., Span, R., Wagner, W. "A New Equation of State for Argon Covering the Fluid Region for Temperatures from the Melting Line to 700 K at Pressures up to 1000 Mpa." <i>J. Phys. Chem. Ref. Data</i> , 28(3):779-850, 1999.
Ethylene	Smukala, J., Span, R., Wagner, W. "New Equation of State for Ethylene Covering the Fluid Region for Temperatures from the Melting Line to 450 k at Pressures up to 300 Mpa." <i>J. Phys. Chem. Ref. Data</i> , 29(5):1053-1122, 2000.
Nitrogen	Span, R., Lemmon, E.W., Jacobsen, R.T, Wagner, W., and Yokozeki, A. "A Reference Thermodynamic Property Formulation for Nitrogen." <i>J. Phys. Chem. Ref. Data</i> , Volume 29, Number 6, pp. 1361-1433, 2000.
Oxygen	Schmidt, R., Wagner, W. "A New Form of the Equation of State for Pure Substances and its Application to Oxygen." <i>Fluid Phase Equilib.</i> , 19:175-200, 1985.
Hydrogen	Leachman, J. W., Jacobsen, R. T., Lemmon, E.W., and Penoncello, S.G. "Fundamental Equations of State for Parahydrogen, Normal Hydrogen, and Orthohydrogen" <i>J. Phys. Chem. Ref. Data</i> , Volume 38, Number 3, pp. 565, 2009.
Note: A complete database program containing all of the most recent equations for calculating density for various cryogenic liquids is available in "NIST Reference Fluid Thermodynamic and Transport Properties Database (REFPROP)" at www.nist.gov/srd . There is a fee for download of this database.	

(Added 2004)

N.5. Testing Procedures.

N.5.1. Normal Tests. – The "normal" tests of a device shall be made over a range of discharge rates that may be anticipated under the conditions of installation.

N.5.2. Special Tests. – Any test except as set forth in N.5.1. Normal Tests shall be considered a "special" test. Tests shall be conducted, if possible, to evaluate any special elements or accessories attached to or associated with the device. A device shall be tested at a minimum discharge rate of:

- (a) 50 % of the maximum discharge rate developed under the conditions of installation, or the minimum discharge rate marked on the device, whichever is less; or
- (b) the lowest discharge rate practicable under conditions of installation.

Special tests may be conducted to develop any characteristics of the device that are not normally anticipated under the conditions of installation.

N.5.3. Repeatability Tests. – Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors such as temperature, pressure, and flow rate are reduced to the extent that they will not affect the results obtained. When conducting the tests, the discharge rates shall be within the minimum and maximum discharge rates as marked by the manufacturer. For devices equipped with an automatic temperature or density compensator, results shall be based on either:

- (1) all runs conducted with the compensated (net) volume (e.g., with the temperature or density compensator activated); or

- (2) all runs conducted with the uncompensated (gross) volume (e.g., with the temperature or density compensator deactivated).

(Amended 2019)

N.6. Temperature Correction. – Corrections shall be made for any changes in volume resulting from the differences in liquid temperature between time of passage through the meter and time of volumetric determination of test draft.

N.7. Automatic Temperature or Density Compensation. – When a device is equipped with an automatic temperature or density compensator, the compensator shall be tested by comparing the quantity indicated or recorded by the device (with the compensator connected and operating) with the actual delivered quantity corrected to the normal boiling point of the cryogenic product being measured or to the normal temperature and pressure as applicable.

T. Tolerances

T.1. Application.

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

T.2. Tolerance Values. – The maintenance and acceptance tolerances for normal and special tests shall be as shown in Table T.2. Accuracy Classes and Tolerances for Cryogenic Liquid-Measuring Devices.

(Amended 2003)

Table T.2. Accuracy Classes and Tolerances for Cryogenic Liquid-Measuring Devices				
Accuracy Class	Application	Acceptance Tolerance	Maintenance Tolerance	Special Test Tolerance
2.5	Cryogenic products; liquefied compressed gases other than liquid carbon dioxide	1.5 %	2.5 %	2.5 %

(Added 2003)

T.3. On Tests Using Type 2 Transfer Standards. – When commercial meters are tested using a Type 2 transfer standard, the tolerance applied to the meter under test shall be calculated using the formula specified Section 1.10. General Code, paragraph G-T.5. Tolerances on Tests When Type 2 Transfer Standards Are Used.

(Added 1976) (Amended 2023)

T.4. Repeatability. – When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 % of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. Also see N.5.3. Repeatability Tests.

(Added 2001) (Amended 2019)

UR. User Requirements

UR.1. Installation Requirements.

UR.1.1. Discharge Rate. – A device shall be so installed that the actual maximum discharge rate will not exceed the rated maximum discharge rate. If necessary, means for flow regulation shall be incorporated in the installation.

UR.1.2. Length of Discharge Hose. – The discharge hose shall be of such a length and design as to keep vaporization of the liquid to a minimum.

UR.1.3. Maintenance of Liquid State. – A device shall be so installed and operated that the product being measured shall remain in the liquid state during passage through the meter.

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 shall be returned to zero immediately before each delivery.

UR.2.2. Condition of Discharge System. – The discharge system, up to the measuring element, shall be precooled to liquid temperatures before a “zero” condition is established prior to the start of a commercial delivery.

UR.2.3. Vapor Return Line. – A vapor return line shall not be used during a metered delivery.
(Amended 1976)

UR.2.4. Drainage of Discharge Line. – On a dry-hose system, upon completion of a delivery, the vendor shall leave the discharge line connected to the receiving container with the valve adjacent to the meter in the closed position and the valve at the discharge line outlet in the open position for a period of at least:

- (a) 1 minute for small delivery devices; and
- (b) 3 minutes for large delivery devices

to allow vaporization of some product in the discharge line to force the remainder of the product in the line to flow into the receiving container.

(Amended 1976)

UR.2.5. Conversion Factors. – Established conversion values (Also see references in Table N.4. Density or Volume Correction Factors.) shall be used whenever metered liquids are to be billed in terms of:

- (a) kilograms or pounds based on a meter indication of liters, gallons, cubic meters of gas, or cubic feet of gas;
- (b) cubic meters or cubic feet of gas based on a meter indication of liters or gallons, kilograms, or pounds;
or
- (c) liters or gallons based on a meter indication of kilograms or pounds, cubic meters of gas or cubic feet of gas.

All sales of cryogenics shall be based on either kilograms or pounds, liters or gallons of liquid at Normal Boiling Point (NBP),¹ cubic meters of gas or cubic feet of gas at Normal Temperature and Pressure (NTP)¹.

(Amended 1986)

UR.2.6. Temperature or Density Compensation.

UR.2.6.1. Use of Automatic Temperature or Density Compensators. – If a device is equipped with an automatic temperature or density compensator, this shall be connected, operable, and in use at all times. Such automatic temperature or density 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.

¹ See Appendix D, Definitions.

UR.2.6.2. Recorded Representations. – Any recorded representation based on a reading of a device that is equipped with an automatic temperature or density compensator shall have shown thereon that the quantity delivered has been adjusted to the quantity at the NBP of the specific cryogenic product or the equivalent volume of gas at NTP.

(Amended 2023)

UR.2.6.3. Recorded Representation. – Any recorded representation provided by a device of the computing type which includes the total computed price, the total quantity of the delivery, or the price per unit, shall also include the other two values and shall comply with G-S.5.6. Recorded Representations.

(Amended 2023)

UR.2.6.4. Ticket in Printing Device. – A ticket shall not be inserted into a device equipped with a ticket printer until immediately before a delivery is begun, and in no case shall a ticket be in the device when the vehicle is in motion while on a public street, highway, or thoroughfare.

UR.2.7. Pressure of Tanks with Volumetric Metering Systems without Temperature Compensation. – When the saturation pressure of the product in the vendor's tank exceeds 240 kPa (35 psia), a correction shall be applied to the written invoice or printed ticket using the appropriate tables as listed in Table N.4. Density or Volume Correction Factors; or the saturation pressure shall be reduced to 207 kPa (30 psia) (if this can be safely accomplished) prior to making a delivery.

(Added 1976)

Table of Contents

	Page
Section 3.35. Milk Meters	3-89
A. Application.....	3-89
A.1. General.....	3-89
A.2. Exceptions.....	3-89
A.3. Additional Code Requirements.	3-89
S. Specifications.....	3-89
S.1. Design of Indicating and Recording Elements and of Recorded Representations.	3-89
S.1.1. Primary Elements.....	3-89
S.1.2. Graduations.....	3-90
S.1.3. Indicators.....	3-90
S.1.4. Computing-Type Devices.....	3-91
S.2. Design of Measuring Elements.....	3-91
S.2.1. Air/Vapor Elimination.....	3-91
S.2.2. Maintaining Flooded Condition.	3-91
S.2.3. Provision for Sealing.....	3-91
S.2.4. Directional Flow Valves.....	3-92
S.3. Design of Intake Lines.....	3-92
S.3.1. Diversion of Liquid to be Measured.....	3-92
S.3.2. Intake Hose.....	3-92
S.4. Marking Requirements.....	3-93
S.4.1. Limitation of Use.....	3-93
S.4.2. Discharge Rates.....	3-93
S.4.3. Measuring Components.....	3-93
S.4.4. Flood Volume.....	3-93
S.4.5. Conversion Factor.....	3-93
N. Notes.....	3-93
N.1. Test Liquid.....	3-93
N.2. Evaporation and Volume Change.....	3-93
N.2.1. Temperature Correction.....	3-93
N.3. Test Drafts.....	3-93
N.3.1. Test Drafts.....	3-93
N.3.2. Transfer Standard Meter Test.....	3-94
N.4. Testing Procedures.....	3-94
N.4.1. Normal Tests.....	3-94
N.4.2. Special Tests.....	3-94
N.4.3. System Capacity.....	3-94
N.4.4. Repeatability Tests.....	3-94
T. Tolerances	3-94
T.1. Application.....	3-94
T.1.1. To Underregistration and to Overregistration.....	3-94
T.2. Tolerance Values.....	3-94
T.3. Repeatability.....	3-95
UR. User Requirements.....	3-95
UR.1. Installation Requirements.....	3-95
UR.1.1. Plumb and Level Condition.....	3-95
UR.1.2. Discharge Rate.....	3-95
UR.1.3. Unit Price.....	3-95

UR.1.4. Intake Hose.....	3-95
UR.2. Use Requirements.....	3-95
UR.2.1. Return of Indicating and Recording Elements to Zero.	3-95
UR.2.2. Recorded Representations.....	3-95
UR.2.3. Ticket in Printing Device.....	3-95
UR.2.4. Credit for Flood Volume.	3-95

Section 3.35. Milk Meters

A. Application

A.1. General. – This code applies to devices used for the measurement of milk; generally applicable to, but not limited to, meters used in dairies, milk processing plants, and cheese factories, to measure incoming bulk milk.

A.2. Exceptions. – This code does not apply to mass flow meters. (Also see Section 3.37. Code for Mass Flow Meters.)

(Added 1994)

A.3. Additional Code Requirements. – In addition to the requirements of this code, Milk Meters shall meet the requirements of Section 1.10. General Code.

S. Specifications

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

S.1.1. Primary Elements.

S.1.1.1. General. – A 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) A meter shall indicate, and record if the meter is equipped to record, its deliveries in terms of liters or gallons. Fractional parts of the liter shall be in terms of decimal subdivisions. Fractional parts of the gallon shall be in terms of either decimal or binary subdivisions.
- (b) When it is an industry practice to purchase and sell milk by weight based upon 1.03 kg/L (8.6 lb/gal), the primary indicating element may indicate in kilograms or pounds. The weight value division shall be a decimal multiple or submultiple of 1, 2, or 5. Fractional parts of the kilogram or pound shall be in decimal subdivisions. (Also see S.4.5. Conversion Factor.)

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

- (a) 0.5 L or 0.5 kg (1 pt or 1 lb) when measuring quantities less than or equal to 4 000 L or 4 000 kg (1 000 gal or 8 600 lb); or
- (b) 5 L or 5 kg (1 gal or 10 lb) when measuring quantities in excess of 4 000 L or 4 000 kg (1 000 gal or 8 600 lb).

(Amended 1989)

S.1.1.4. Advancement of Indicating and Recording Elements. – Primary indicating and recording elements shall be susceptible to advancement only by the mechanical operation of the meter. However, a meter may be cleared by advancing its elements to zero, but only if:

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

S.1.1.5. Return to Zero. – Primary indicating elements 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 the primary indicating elements and the primary recording elements, if the device is so equipped, beyond their correct zero position.

S.1.1.6. Indication of Measurement. – A meter shall be constructed to show automatically its initial zero condition and the volume measured up to the nominal capacity of the device.

S.1.2. Graduations.

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

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

S.1.2.3. Clear Interval between Graduations. – The clear interval shall be not less than 1.0 mm (0.04 in). If the graduations are not parallel, the measurement shall be made:

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

S.1.3. Indicators.

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

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

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

- (a) *the width of the narrowest graduation; and*
[Nonretroactive as of January 1, 2002]
(Amended 2001)
- (b) the width of the minimum clear interval between graduations.

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

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

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

S.1.3.6. 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 5 mm (0.20 in).

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 unit at which the device is set to compute.

S.1.4.2. Recorded Representations. – If a computing-type device issues a recorded representation which includes the total computed price, the recorded representation shall include the total quantity of the delivery, the appropriate fraction of the quantity, and the price per unit of quantity.
(Amended 1989 and 2023)

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.1.4.4. Money-Values, Mathematical Agreement. – Any digital money-value indication and any recorded money-value on a computing-type device shall be in mathematical agreement with its associated quantity indicating or representation to within 1 cent of money-value.

S.2. Design of Measuring Elements.

S.2.1. Air/Vapor Elimination. – A measuring system shall be equipped with an effective air/vapor eliminator or other automatic means to prevent the passage of air/vapor through the meter. Vent lines from the air/vapor eliminator shall be made of appropriate non-collapsible material.
(Amended 2017)

S.2.2. Maintaining Flooded Condition. – The vent on the vapor eliminator shall be positioned or installed in such a manner that the vapor eliminator cannot easily be emptied between uses.

S.2.3. Provision for Sealing. – For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices. For parameters adjusted using other means, the following applies.

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

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

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

*Audit trails shall use the format set forth in Table S.2.3. Categories of Device and Methods of Sealing.**
[*Nonretroactive as of January 1, 1995]

(Amended 2006 and 2019)

Table S.2.3. Categories of Device and Methods of Sealing	
Categories of Device	Methods of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.	The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.	An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available on demand through the device or through another on-site device. The information may also be available electronically. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1 000 records are required. (Note: Does not require 1 000 changes to be stored for each parameter.)

[Nonretroactive as of January 1, 1995]

(Table Added 2006) (Amended 2016)

S.2.4. Directional Flow Valves. – Valves intended to prevent reversal of flow shall be automatic in operation.

S.3. Design of Intake Lines.

S.3.1. Diversion of Liquid to be Measured. – No means shall be provided by which any liquid can be diverted from the supply tank to the receiving tank without being measured by the device. A manually controlled outlet that may be opened for purging or draining the measuring system shall be permitted. Effective means shall be provided to prevent passage of liquid through any such outlet during normal operation of the measuring system. (Amended 1994)

S.3.2. Intake Hose. – The intake hose shall be:

- (a) of the dry-hose type;
- (b) adequately reinforced;
- (c) not more than 6 m (20 ft) in length unless it can be demonstrated that a longer hose is essential to permit transfer from a supply tank; and

- (d) connected to the pump at horizontal or above to permit complete drainage of the hose.
(Amended 1991)

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. The marked minimum discharge rate shall not exceed 20 % of the marked maximum discharge rate.

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

S.4.3. Measuring Components. – All components that affect the measurement of milk that are disassembled for cleaning purposes shall be clearly and permanently identified with a common serial number.

S.4.4. Flood Volume. – When applicable, the volume of product (to the nearest minimum division of the meter) necessary to flood the system when dry shall be clearly, conspicuously, and permanently marked on the air eliminator.

S.4.5. Conversion Factor. – When the conversion factor of 1.03 kg/L (8.6 lb/gal) is used to convert the volume of milk to weight, the conversion factor shall be clearly marked on the primary indicating element and recorded on the delivery ticket.

N. Notes

N.1. Test Liquid.

- (a) A meter shall be tested with the liquid to be commercially measured or with a liquid of the same general physical characteristics. Following a satisfactory examination, the weights and measures official should attach a seal or tag indicating the product used during the test.
(Amended 1989)

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

(Added 1989)

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.2.1. 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. When adjustments are necessary, appropriate tables should be used.

N.3. Test Drafts.

N.3.1. Test Drafts. – The delivered quantity shall be equal to at least the amount delivered by the device in one minute at its maximum discharge rate.

(Amended 2023)

N.3.2. Transfer Standard Meter Test. – When comparing a meter with a calibrated transfer standard meter, the minimum quantity for any test draft shall be equal to or greater than the amount delivered in one minute at the flow rate being tested.

(Added 2023) (Amended 2024)

(Amended 1989, 2023, and 2024)

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. The “normal” test shall include a determination of the effectiveness of the air elimination system.

N.4.2. Special Tests. – “Special” tests shall be made to develop the operating characteristics of a device and any special elements and accessories attached to or associated with the device. Any test except as set forth in N.4.1. Normal Tests shall be considered a special test.

N.4.3. System Capacity. – The test of a milk-metering system shall include the verification of the volume of product necessary to flood the system as marked on the air eliminator.

N.4.4. Repeatability Tests. – Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors such as temperature, pressure, and flow rate are reduced to the extent that they will not affect the results obtained. When conducting the tests, the discharge rates shall be within the minimum and maximum discharge rates as marked by the manufacturer.

(Amended 2019)

T. Tolerances

T.1. Application.

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

T.2. Tolerance Values. – Maintenance and acceptance tolerances shall be as shown in Table 1. Tolerances for Milk Meters.

(Amended 1989)

Table 1. Tolerances for Milk Meters		
Indication	Maintenance	Acceptance
gallons	gallons	gallons
100	0.5	0.3
200	0.7	0.4
300	0.9	0.5
400	1.1	0.6
500	1.3	0.7
Over 500	Add 0.002 gallon per indicated gallon over 500	Add 0.001 gallon per indicated gallon over 500

(Added 1989)

T.3. Repeatability. – When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 % of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. Also see N.4.4. Repeatability Tests.

(Added 2002) (Amended 2019)

UR. User Requirements

UR.1. Installation Requirements.

UR.1.1. 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.1.2. Discharge Rate. – A meter shall be so installed that the actual maximum discharge rate will not exceed the rated maximum discharge rate. If necessary, means for flow regulation shall be incorporated in the installation, in which case this shall be fully effective and automatic in operation.

UR.1.3. Unit Price. – There shall be displayed on the face of a device of the computing type the unit price at which the device is set to compute.

UR.1.4. Intake Hose. – The intake hose shall be so installed as to permit complete drainage and that all available product is measured following each transfer.

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 transfer.

UR.2.2. Recorded Representations. – Any recorded representation issued by a device of the computing type which includes the total computed price, the total quantity, or the price per unit of quantity, shall also include the other two values and shall comply with G-S.5.6. Recorded Representations.

(Amended 1989 and 2023)

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

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

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Table of Contents

	Page
Section 3.36. Water Meters	3-99
A. Application.....	3-99
A.1. General.....	3-99
A.2. Exceptions.....	3-99
A.3. Additional Code Requirements	3-99
S. Specifications.....	3-99
S.1. Design of Indicating and Recording Elements and of Recorded Representations.	3-99
S.1.1. Primary Elements.....	3-99
S.1.2. Graduations.....	3-100
S.1.3. Indicators.....	3-100
S.2. Design of Measuring Elements.....	3-101
S.2.1. Provision for Sealing.....	3-101
S.2.2. Batching Measuring Systems Only.	3-102
S.2.3. Multi-Jet Meter Identification.....	3-102
S.3. Markings.....	3-102
S.3.1. <i>Location of Marking Information; Utility Type Meters.</i>	3-102
S.3.2. <i>Meter Size and Directional Flow Marking Information.</i>	3-102
N. Notes.....	3-102
N.1. Test Liquid.....	3-102
N.2. Evaporation and Volume Change.....	3-102
N.3. Test Drafts.....	3-102
N.4. Testing Procedures.....	3-102
N.4.1. Normal Tests.....	3-102
N.4.2. Special Tests.....	3-103
N.4.3. Batching Meter Tests.....	3-104
N.4.4. Repeatability Tests.....	3-104
T. Tolerances	3-104
T.1. Tolerance Values.....	3-104
T.1.1. Repeatability.....	3-105
UR. User Requirements.....	3-105
UR.1. Batching Meters Only.....	3-105
UR.1.1. Strainer.....	3-105
UR.1.2. Siphon Breaker.....	3-105
UR.1.3. Provision for Testing.....	3-105
UR.2. Accessibility of Customer Indication.....	3-105

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Section 3.36. Water Meters

A. Application

A.1. General. – This code applies to devices used for the measurement of water; generally applicable to, but not limited to, utilities type meters installed in residences or business establishments and meters installed in batching systems.

(Amended 2002)

A.2. Exceptions. – This code does not apply to:

- (a) water meters mounted on vehicle tanks (for which see Section 3.31. Vehicle-Tank Meters); or
 - (b) mass flow meters. (Also see Section 3.37. Mass Flow Meters.)
- (Added 1994)

A.3. Additional Code Requirements. – In addition to the requirements of this code, Water Meters shall meet the requirements of Section 1.10. General Code.

S. Specifications

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

S.1.1. Primary Elements.

S.1.1.1. General. – A water meter shall be equipped with a primary indicating element and may also be equipped with a primary recording element. Such elements shall be visible at the point of measurement or be stored in non-volatile and non-resettable memory. The display may be remotely located provided it is readily accessible to the customer.

(Amended 2002)

S.1.1.2. Units. – A water meter shall indicate and record, if the device is equipped to record, its deliveries in terms of liters, gallons or cubic feet or binary or decimal subdivisions thereof except batch plant meters, which shall indicate deliveries in terms of liters, gallons or decimal subdivisions of the liter or gallon only.

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) 50 L (10 gal or 1 ft³) on utility type meters, sizes 1 in and smaller; or
 - (b) 500 L (100 gal or 10 ft³) on utility-type meters, sizes 1½ in and 2 in; or
 - (c) 0.2 L ($\frac{1}{10}$ gal or $\frac{1}{100}$ ft³) on batching meters delivering less than 375 L/min (100 gal/min or 13 ft³/min); or
 - (d) 5 L (1 gal or $\frac{1}{10}$ ft³) on batching meters delivering 375 L/min (100 gal/min or 13 ft³/min) or more.
- (Amended 2009)

S.1.1.4. Advancement of Indicating and Recording Elements. – Primary indicating and recording elements shall advance only by the designed operation of the device, as intended by the manufacturer.

(Amended 2021)

S.1.1.5. Return to Zero. – If the meter is so designed that the primary indicating elements are readily returnable to a definite zero indication, means shall be provided to prevent the return of these elements beyond their correct zero position.

S.1.1.6. Proving Indicator. – Utility-type meters shall be equipped with a proving indicator. The individual graduations on a mechanical (analog) proving indicator shall indicate volumes no larger than $\frac{1}{100}$ of the value of the smallest unit of indicated delivery required in S.1.1.3. Value of Smallest Unit. For electronic (digital) proving indications, the smallest unit of volume displayed shall be no larger than $\frac{1}{1000}$ of the value of the smallest unit of indicated delivery required in S.1.1.3. Value of Smallest Unit.

(Added 2009)

S.1.2. Graduations.

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

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

S.1.2.3. Clear Interval Between Graduations. – The clear interval shall not be less than 1.0 mm (0.04 in). If the graduations are not parallel, the measurement shall be made:

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

S.1.3. Indicators.

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

S.1.3.2. Length. – The index of an indicator shall reach to the finest graduations with which it is used, the width of the minimum clear interval between graduations, and the width of main graduations shall be not more than 50 % greater than the width of subordinate graduations. Graduations shall in no case be less than 0.2 mm (0.008 in) in width.

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 not be greater than:

- (a) *the width of the narrowest graduation; and*
[Nonretroactive as of January 1, 2002]
(Amended 2001)

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

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

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

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

S.2. Design of Measuring Elements.

S.2.1. Provision for Sealing. – For devices or systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices. For parameters adjusted using other means, the following applies.

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

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

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

*Audit trails shall use the format set forth in Table S.2.1. Categories of Device and Methods of Sealing.**

**[Nonretroactive as of January 1, 2019]*

(Amended 2018 and 2019)

Table S.2.1. Categories of Device and Methods of Sealing	
Categories of Device	Method of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.	The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.	An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available on demand through the device or through another on-site device. The information may also be available electronically. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1 000 records are required. (Note: Does not require 1 000 changes to be stored for each parameter.)

[Nonretroactive as of January 1, 2019]

(Table Added 2018)

S.2.2. Batching Measuring Systems Only.

S.2.2.1. Air/Vapor Elimination, Batching Measuring Systems. – Batching measuring systems shall be equipped with an effective air/vapor eliminator or other automatic means to prevent the passage of air/vapor through the meter. Vent lines from the air/vapor eliminator shall be made of appropriate non-collapsible material.

(Amended 2017)

S.2.2.2. Directional Flow Valves. – Valves intended to prevent reversal of flow shall be automatic in operation.

S.2.3. Multi-Jet Meter Identification. – Multi-Jet water meters shall be clearly and permanently marked as such on the device or identified on the Certificate of Conformance.

(Added 2003)

S.3. Markings

S.3.1. Location of Marking Information; Utility Type Meters. – All required markings, including those required by G-S.1. Identification, shall be either on the meter body or primary indicator.

[Nonretroactive as of January 1, 2013]

(Added 2012)

S.3.2. Meter Size and Directional Flow Marking Information. – A water meter shall be clearly and indelibly marked with the following information:

(a) meter size on the indicator face plate; and

(b) water flow direction.

[Nonretroactive as of January 1, 2022]

(Added 2021)

N. Notes

N.1. Test Liquid. – A meter shall be tested with water.

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

N.3. Test Drafts. – Test drafts should be equal to at least the amount delivered by the device in two minutes and in no case less than the amount delivered by the device in one minute at the actual maximum flow rate developed by the installation. The test draft sizes shown in Table N.4.1. Flow Rate and Draft Size for Water Meters Normal Tests, shall be followed as closely as possible.

(Amended 2003)

N.4. Testing Procedures.

N.4.1. Normal Tests. – The normal test of a meter shall be made at the maximum discharge rate developed by the installation. Meters with maximum gallon per minute ratings higher than the values specified in Table N.4.1. Flow Rate and Draft Size for Water Meters Normal Tests may be tested up to the meter rating, with meter indications no less than those shown.

(Amended 1990, 2002, and 2003)

Table N.4.1. Flow Rate and Draft Size for Water Meters Normal Tests			
Meter Size (inches)	Rate of Flow (gal/min)	Maximum Rate	
		Meter Indication/Test Draft	
		gal	ft ³
Less than $\frac{5}{8}$	8	50	5
$\frac{5}{8}$	15	50	5
$\frac{3}{4}$	25	50	5
1	40	100	10
$1\frac{1}{2}$	80	300	40
2	120	500	40
3	250	500	50
4	350	1 000	100
6	700	1 000	100

(Table Added 2003)

N.4.2. Special Tests. – Special tests to develop the operating characteristics of meters may be made according to the rates and quantities shown in Table N.4.2.a. Flow Rate and Draft Size for Water Meters Special Tests and Table N.4.2.b. Flow Rate and Draft Size for Utility Type Water Meters Special Tests.

(Amended 2003 and 2010)

Table N.4.2.a. Flow Rate and Draft Size for Batching Water Meters Special Tests						
Meter Size (inches)	Intermediate Rate			Minimum Rate		
	Rate of Flow (gal/min)	Meter Indication/Test Draft		Rate of Flow (gal/min)	Meter Indication/Test Draft	
		gal	ft ³		gal	ft ³
Less than or equal to $\frac{5}{8}$	2	10	1	$\frac{1}{4}$	5	1
$\frac{3}{4}$	3	10	1	$\frac{1}{2}$	5	1
1	4	10	1	$\frac{3}{4}$	5	1
$1\frac{1}{2}$	8	50	5	$1\frac{1}{2}$	10	1
2	15	50	5	2	10	1
3	20	50	5	4	10	1
4	40	100	10	7	50	5
6	60	100	10	12	50	5

(Table Added 2003) (Table Amended 2010)

Table N.4.2.b. Flow Rate and Draft Size for Utility Type Water Meters Special Tests						
Meter Size (inches)	Intermediate Rate			Minimum Rate		
	Rate of Flow (gal/min)	Meter Indication/Test Draft		Rate of Flow (gal/min)	Meter Indication/Test Draft	
		gal	ft ³		gal	ft ³
Less than $\frac{5}{8}$	2	10	1	$\frac{1}{4}$	5	1
$\frac{5}{8}$	2	10	1	$\frac{1}{4}$	5	1
$\frac{5}{8} \times \frac{3}{4}$	2	10	1	$\frac{1}{4}$	5	1
$\frac{3}{4}$	3	10	1	$\frac{1}{2}$	5	1
1	4	10	1	$\frac{3}{4}$	5	1
1½	8	100	10	1½	100	10
2	15	100	10	2	100	10

(Table Added 2010)

N.4.3. Batching Meter Tests. – Tests on batching meters should be conducted at the maximum and intermediate rates only.

N.4.4. Repeatability Tests. – Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors such as temperature, pressure, and flow rate are reduced to the extent that they will not affect the results obtained. When conducting the tests, the minimum flow rate shall be at least the minimum rate specified in Table N.4.2.a. Flow Rate and Draft Size for Batching Water Meters Special Tests, and the maximum discharge rates shall not exceed the maximum discharge rate developed under the conditions of the installation.

(Amended 2019)

T. Tolerances

T.1. Tolerance Values. – Maintenance and acceptance tolerances shall be as shown in Table T.1. Accuracy Classes and Tolerances for Water Meters.

Table T.1. Accuracy Classes and Tolerances for Water Meters					
Accuracy Class	Application		Acceptance Tolerance	Maintenance Tolerance	Tolerance for Special Tests Conducted at the Minimum Flow Rate
1.5	Water, Other Than Multi-Jet Water Meters	Overregistration	1.5 %	1.5 %	1.5 %
		Underregistration	1.5 %	1.5 %	5.0 %
1.5	Water, Multi-Jet Water Meters	Overregistration	1.5 %	1.5 %	3.0 %
		Underregistration	1.5 %	1.5 %	3.0 %

(Table Added 2003)

(Amended 2003)

T.1.1. Repeatability. – When multiple tests are conducted at approximately the same flow rate, each test shall be within the applicable tolerances and the range of test results shall not exceed the values shown in Table T.1.1. Repeatability. Also see N.4.4. Repeatability Tests.

(Added 2002) (Amended 2010)

Table T.1.1. Repeatability		
	Batching Meters	Utility-Type Meters
Normal Flow Rates	0.6 %	0.6 %
Intermediate Flow Rates	0.6 %	2.0 %
Minimum Flow Rate	1.3 %	4.0 %

(Table Added 2010)

UR. User Requirements

UR.1. Batching Meters Only.

UR.1.1. Strainer. – A filter or strainer shall be provided if it is determined that the water contains excessive amounts of foreign material.

UR.1.2. Siphon Breaker. – An automatic siphon breaker or other effective means shall be installed in the discharge piping at the highest point of outlet, in no case below the top of the meter, to prevent siphoning of the meter and permit rapid drainage of the pipe or hose.

UR.1.3. Provision for Testing. – Acceptable provisions for testing shall be incorporated into all meter systems. Such provisions shall include a two-way valve, or manifold valving, and a pipe or hose installed in the discharge line accessible to the proper positioning of the test measure.

UR.2. Accessibility of Customer Indication. – An unobstructed standing space of at least 76 cm (30 in) wide, 91 cm (36 in) deep, and 198 cm (78 in) high shall be maintained in front of an indication intended for use by the customer to allow for reading the indicator. The customer indication shall be readily observable to a person located within the standing space without necessity of a separate tool or device.

(Added 2008)

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Table of Contents

	Page
Section 3.37. Mass Flow Meters.....	3-109
A. Application.....	3-109
A.1. Liquids.....	3-109
A.2. Vapor (Gases).....	3-109
A.3. Additional Code Requirements.	3-109
S. Specifications.....	3-109
S.1. Indicating and Recording Elements.	3-109
S.1.1. Indicating Elements.....	3-109
S.1.2. Compressed Natural Gas and Liquefied Natural Gas Dispensers.....	3-109
S.1.3. Units.....	3-109
S.2. Operating Requirements.	3-110
S.2.1. Return to Zero.....	3-110
S.2.2. Indicator Reset Mechanism.....	3-110
S.2.3. Non-resettable Indicator.	3-110
S.2.4. Provisions for Power Loss.	3-110
S.2.5. Display of Unit Price and Product Identity.	3-111
S.2.6. Money-Value Computations.	3-111
S.2.7. <i>Recorded Representations, Point-of-Sale Systems.</i>	3-111
S.2.8. <i>Indication of Delivery.</i>	3-112
S.2.9. <i>Automatic Timeout – Pay-At-Retail Motor-Fuel Devices.</i>	3-112
S.3. Measuring Elements and Measuring Systems.	3-112
S.3.1. Maximum and Minimum Flow-Rates.....	3-112
S.3.2. Adjustment Means.....	3-112
S.3.3. Air/Vapor Elimination.....	3-112
S.3.4. Maintenance of Liquid State.	3-113
S.3.5. Provision for Sealing.	3-113
S.3.6. Automatic Density Correction.	3-114
S.3.7. Pressurizing the Discharge Hose.....	3-114
S.3.8. Zero-Set-Back Interlock, Retail Motor-Fuel Devices.....	3-114
S.4. Discharge Lines and Valves.	3-115
S.4.1. Diversion of Measured Product.....	3-115
S.4.2. Pump-Discharge Unit.	3-115
S.4.3. Directional Flow Valves.	3-115
S.4.4. Discharge Valves.	3-115
S.4.5. Antidrain Means.....	3-115
S.4.6. Other Valves.	3-115
S.5. Markings.....	3-116
S.5.1. <i>Location of Marking Information; Retail Motor-Fuel Dispensers.</i>	3-116
S.5.2. Marking of Equivalent Conversion Factors for Compressed Natural Gas.....	3-116
S.5.3. Marking of Equivalent Conversion Factor for Liquefied Natural Gas.	3-116
S.6. Recording Element.	3-117
S.6.1. Recorded Representations.....	3-117
S.7. <i>Totalizers for Retail Motor-Fuel Devices.</i>	3-117
N. Notes.....	3-117
N.1. Minimum Measured Quantity.	3-117

N.2.	Test Medium.....	3-117
N.2.1.	Liquid-Measuring Devices.....	3-117
N.2.2.	Vapor-Measuring Devices.....	3-117
N.3.	Test Drafts.....	3-117
N.3.1.	Minimum Test.....	3-117
N.3.2.	Transfer Standard Meter Test.....	3-117
N.4.	Minimum Measured Quantity.....	3-118
N.5.	Motor-Fuel Dispenser.....	3-118
N.6.	Testing Procedures.....	3-118
N.6.1.	Normal Tests.....	3-118
N.6.2.	Special Tests.....	3-118
N.6.3.	Repeatability Tests.....	3-118
T.	Tolerances.....	3-118
T.1.	Tolerances, General.....	3-118
T.2.	Tolerances.....	3-118
T.3.	Repeatability.....	3-119
T.4.	Type Evaluation Examinations for Liquid-Measuring Devices.....	3-119
UR.	User Requirements.....	3-120
UR.1.	Selection Requirements.....	3-120
UR.1.1.	<i>Discharge Hose-Length</i>	3-120
UR.1.2.	Minimum Measured Quantity.....	3-120
UR.2.	Installation Requirements.....	3-120
UR.2.1.	Manufacturer's Instructions.....	3-120
UR.2.2.	Discharge Rate.....	3-120
UR.2.3.	Low-Flow Cut-Off Valve.....	3-120
UR.3.	Use of Device.....	3-120
UR.3.1.	Unit Price and Product Identity for Retail Dispensers.....	3-120
UR.3.2.	Vapor-Return Line.....	3-121
UR.3.3.	Recorded Representations for Vehicle Mounted Metering Systems.....	3-121
UR.3.4.	Recorded Representation.....	3-121
UR.3.5.	Ticket in Printing Device.....	3-121
UR.3.6.	Steps After Dispensing.....	3-121
UR.3.7.	Return of Indicating and Recording Elements to Zero.....	3-121
UR.3.8.	Return of Product to Storage, Retail Compressed and Liquefied Natural Gas Dispensers.....	3-122

Section 3.37. Mass Flow Meters

A. Application

A.1. Liquids. – This code applies to devices that are designed to dynamically measure the mass, or the mass and density of liquids. It also specifies the relevant examinations and tests that are to be conducted.

(Amended 1997)

A.2. Vapor (Gases). – This code applies to devices that are designed to dynamically measure the mass of hydrocarbon gas in the vapor state. Examples of these products are propane, propylene, butanes, butylenes, ethane, methane, natural gas and any other hydrocarbon gas/air mix.

A.3. Additional Code Requirements. – In addition to the requirements of this code, Mass Flow Meters shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1. Indicating and Recording Elements.

S.1.1. Indicating Elements. – A measuring assembly shall include an indicating element. Indications shall be clear, definite, accurate, and easily read under normal conditions of operation of the instrument.

S.1.2. Compressed Natural Gas and Liquefied Natural Gas Dispensers. – Except for fleet sales and other price contract sales, a compressed or liquefied natural gas dispenser used to refuel vehicles shall be of the computing type and shall indicate the quantity, the unit price, and the total price of each delivery. The dispenser shall display the mass measured for each transaction either continuously on an external or internal display accessible during the inspection and test of the dispenser, or display the quantity in mass units by using controls on the device.

(Added 1994) (Amended 2016)

S.1.3. Units.

S.1.3.1. Units of Measurement. – Deliveries shall be indicated and recorded in grams, kilograms, metric tons, pounds, tons, and/or liters, gallons, quarts, pints and decimal subdivisions thereof. The indication of a delivery shall be on the basis of apparent mass versus a density of 8.0 g/cm³. The volume indication shall be based on the mass measurement and an automatic means to determine and correct for changes in product density.

(Amended 1993 and 1997)

S.1.3.1.1. Compressed Natural Gas Used as an Engine Fuel. – When compressed natural gas is dispensed as an engine fuel, the delivered quantity shall be indicated in “gasoline gallon equivalent units (GGE)” or “diesel gallon equivalent units (DGE),” or in mass. (Also see Appendix D. Definitions.)

(Added 1994) (Amended 2016)

S.1.3.1.2. Liquefied Natural Gas Used as an Engine Fuel. – When liquefied natural gas is dispensed as an engine fuel, the delivered quantity shall be indicated in diesel gallon equivalent units (DGE) or in mass. (Also see Appendix D. Definitions.)

(Added 2016)

S.1.3.2. Numerical Value of Quantity-Value Divisions. – The value of a scale interval shall be equal to:

- (a) 1, 2, or 5; or
- (b) a decimal multiple or submultiple of 1, 2, or 5.

S.1.3.3. Maximum Value of Quantity-Value Divisions. –The maximum value of the quantity-value division shall not exceed the following:

- (a) For compressed natural gas dispensed as an engine fuel:
 - (1) 0.001 for gasoline gallon equivalent (GGE) units; or
 - (2) 0.001 diesel gallon equivalent (DGE) units; or
 - (3) 0.001 kg or 0.001 lb for mass units.
- (b) For liquefied natural gas dispensed as an engine fuel:
 - (1) 0.001 for diesel gallon equivalent (DGE) units; or
 - (2) 0.001 kg or 0.001 lb for mass units.
- (c) For all other gases or liquids, a maximum value not greater than 0.2 % of the minimum measured quantity.

(Amended 1994, 2019, and 2021)

S.1.3.4. Values Defined. – Indicated values shall be adequately defined by a sufficient number of figures, words, symbols, or combinations thereof. A display of “zero” shall be a zero digit for all displayed digits to the right of the decimal mark and at least one to the left.

S.2. Operating Requirements.

S.2.1. Return to Zero. – Except for measuring assemblies in a pipeline:

- (a) One indicator and the primary recording elements, if the device is equipped to record, shall be provided with a means for readily returning the indication to zero either automatically or manually.
- (b) It shall not be possible to return primary indicating elements, or primary recording elements, beyond the correct zero position.

(Amended 1993)

S.2.2. Indicator Reset Mechanism. – The reset mechanism for the indicating element shall not be operable during a delivery. Once the zeroing operation has begun, it shall not be possible to indicate a value other than the latest measurement, or “zeros” when the zeroing operation has been completed.

S.2.3. Non-resettable Indicator. – An instrument may also be equipped with a non-resettable indicator if the indicated values cannot be construed to be the indicated values of the resettable indicator for a delivered quantity.

S.2.4. Provisions for Power Loss.

S.2.4.1. Transaction Information. – In the event of a power loss, the information needed to complete any transaction in progress at the time of the power loss (such as the quantity and unit price, or sales price) shall be determinable for at least 15 minutes at the dispenser or at the console if the console is accessible to the customer.

(Added 1993)

S.2.4.2. User Information. – The device memory shall retain information on the quantity of fuel dispensed and the sales price totals during power loss.

(Added 1993)

S.2.5. Display of Unit Price and Product Identity.

S.2.5.1. Unit Price. – A computing or money-operated device shall be able to display on each face the unit price at which the device is set to compute or to dispense.

(Added 1993)

S.2.5.2. Product Identity. – A device shall be able to conspicuously display on each side the identity of the product being dispensed.

(Added 1993)

S.2.5.3. Selection of Unit Price. – *Except for dispensers used exclusively for fleet sales, other price contract sales, and truck refueling (e.g., truck stop dispensers used only to refuel trucks), when a product or grade is offered for sale at more than one unit price through a computing device, the selection of the unit price shall be made prior to delivery using controls on the device or other customer-activated controls. A system shall not permit a change to the unit price during delivery of a product.*

[Nonretroactive as of January 1, 1998]

(Added 1997)

S.2.5.4. Agreement Between Indications. – *When a quantity value indicated or recorded by an auxiliary element is a derived or computed value based on data received from a retail motor-fuel dispenser, the value may differ from the quantity value displayed on the dispenser, provided the following conditions are met:*

- (a) all total money-values for an individual sale that are indicated or recorded by the system agree; and*
- (b) within each element the values indicated or recorded meet the formula (quantity x unit price = total sales price) to the closest cent.*

[Nonretroactive as of January 1, 1998]

(Added 1997)

S.2.6. Money-Value Computations. – A computing device shall compute the total sales price at any single-purchase unit price (i.e., excluding fleet sales, other price contract sales, and truck stop dispensers used only to refuel trucks) for which the product being measured is offered for sale at any delivery possible within either the measurement range of the device or the range of the computing elements, whichever is less.

(Added 1993)

S.2.6.1. Auxiliary Elements. – If a system is equipped with auxiliary indications, all indicated money-value and quantity divisions of the auxiliary element shall be identical with those of the primary element.

(Added 1993)

S.2.6.2. Display of Quantity and Total Price. – When a delivery is completed, the total price and quantity for that transaction shall be displayed on the face of the dispenser for at least 5 minutes or until the next transaction is initiated by using controls on the device or other user-activated controls.

(Added 1993)

S.2.7. Recorded Representations, Point-of-Sale Systems. – *The sales information recorded by cash registers when interfaced with a retail motor-fuel dispenser shall contain the following information for products delivered by the dispenser:*

- (a) *the total volume of the delivery;*
- (b) *the unit price;*
- (c) *the total computed price; and*
- (d) *the product identity by name, symbol, abbreviation, or code number.*

[Nonretroactive as of January 1, 1986]

(Added 1993)

S.2.8. Indication of Delivery. – *The device shall automatically show on its face the initial zero condition and the quantity delivered (up to the nominal capacity). However, the first 0.03 L (0.009 gal) of a delivery and its associated total sales price need not be indicated.*

[Nonretroactive as of January 1, 1998]

(Added 1997)

S.2.9. Automatic Timeout – Pay-At-Retail Motor-Fuel Devices. – *Once a retail motor-fuel device has been authorized, it must deauthorize within two minutes if not activated. Reauthorization of the retail motor-fuel device must be performed before product is delivered. If the time limit to deauthorize the retail motor-fuel device is programmable, it shall not accept an entry greater than two minutes.*

[Nonretroactive as of January 1, 2020]

(Added 2019)

S.3. Measuring Elements and Measuring Systems.

S.3.1. Maximum and Minimum Flow-Rates.

- (a) The ratio of the maximum to minimum flow-rates specified by the manufacturer for devices measuring liquefied gases shall be 5:1 or greater.
- (b) The ratio of the maximum to minimum flow-rates specified by the manufacturer for devices measuring other than liquefied gases shall be 10:1 or greater.

S.3.2. Adjustment Means. – An assembly shall be provided with the means to change the ratio between the indicated quantity and the quantity of liquid measured by the assembly. A bypass on the measuring assembly shall not be used for these means.

S.3.2.1. Discontinuous Adjusting Means. – When the adjusting means changes the ratio between the indicated quantity and the quantity of measured liquid in a discontinuous manner, the consecutive values of the ratio shall not differ by more than 0.1 %.

S.3.3. Air/Vapor Elimination. – A measuring system shall be equipped with an effective air/vapor eliminator or other automatic means to prevent the measurement of air/vapor. Vent lines from the air/vapor eliminator shall be made of appropriate non-collapsible material.

(Amended 1999 and 2017)

S.3.3.1. Air/Vapor Elimination on Loading Rack Liquid Measuring Systems.

- (a) A loading rack measuring system shall be equipped with an effective air/vapor eliminator or other automatic means to prevent the passage of air/vapor through the meter unless the system is designed or operationally controlled by a means such that neither air nor vapor can enter the system.

- (b) Vent lines from the air/vapor eliminator shall be made of appropriate non-collapsible material.

(Added 1995) (Amended 2017)

S.3.4. Maintenance of Liquid State. – A liquid-measuring device shall be installed so that the measured product remains in a liquid state during passage through the instrument.

S.3.5. Provision for Sealing. – For devices or systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices. For parameters adjusted using other means, the following applies.

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

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

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

*Audit trails shall use the format set forth in Table S.3.5. Categories of Device and Methods of Sealing.**

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

(Amended 1992, 1995, 2006, and 2019)

Table S.3.5. Categories of Device and Methods of Sealing	
Categories of Device	Methods of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. <i>The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.</i>	<i>[The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.]*</i> <i>[*Nonretroactive as of January 1, 1996]</i>
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). <i>[Nonretroactive as of January 1, 1995]</i> <i>The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.</i> <i>[Nonretroactive as of January 1, 2001]</i>	<i>An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available on demand through the device or through another on-site device. The information may also be available electronically. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1 000 records are required. (Note: Does not require 1 000 changes to be stored for each parameter.)</i>

[Nonretroactive as of January 1, 1995]

(Table Added 1995) (Amended 1995, 1998, 1999, 2006, and 2016)

S.3.6. Automatic Density Correction.

- (a) An automatic means to determine and correct for changes in product density shall be incorporated in any mass flow metering system that is affected by changes in the density of the product being measured.
- (b) Volume-measuring devices with automatic temperature compensation used to measure natural gas as a motor vehicle engine fuel shall be equipped with an automatic means to determine and correct for changes in product density due to changes in the temperature, pressure, and composition of the product.

(Amended 1994 and 1997)

S.3.7. Pressurizing the Discharge Hose. – The discharge hose for compressed natural gas shall automatically pressurize prior to the device beginning to register the delivery.

(Added 1993)

S.3.8. Zero-Set-Back Interlock, Retail Motor-Fuel Devices. – A device shall be constructed so that:

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

(Added 1993)

S.4. Discharge Lines and Valves.

S.4.1. Diversion of Measured Product. – No means shall be provided by which any measured product can be diverted from the measuring instrument. However, two or more delivery outlets may be permanently installed and operated simultaneously, provided that any diversion of flow to other than the intended receiving receptacle cannot be readily accomplished or is readily apparent. Such means include physical barriers, visible valves, or indications that make it clear which outlets are in operation, and explanatory signs if deemed necessary.

An outlet that may be opened for purging or draining the measuring system, or for recirculating product if recirculation is required in order to maintain the product in a deliverable state shall be permitted. Effective automatic means shall be provided to prevent the passage of liquid through any such outlet during normal operation of the measuring system and to inhibit meter indications (or advancement of indications) and recorded representations while the outlet is in operation.

(Amended 2002 and 2006)

S.4.2. Pump-Discharge Unit. – A pump-discharge unit for liquids equipped with a flexible discharge hose shall be of the wet-hose type.

(Added 1993)

S.4.3. Directional Flow Valves. – If a reversal of flow could result in errors that exceed the tolerance for the minimum measured quantity, a valve or valves or other effective means, automatic in operation (and equipped with a pressure limiting device, if necessary) to prevent the reversal of flow shall be properly installed in the system. (Also see N.1. Minimum Measured Quantity.)

S.4.4. Discharge Valves. – A discharge valve may be installed on a discharge line only if the system is a wet-hose type. Any other shutoff valve on the discharge side of the instrument 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 means of a security seal with which the valve is sealed open.

S.4.5. Antidrain Means. – In a wet-hose type device, effective means shall be provided to prevent the drainage of the hose between transactions.

S.4.6. Other Valves. – Check valves and closing mechanisms that are not used to define the measured quantity shall have relief valves (if necessary) to dissipate any abnormally high pressure that may arise in the measuring assembly.

S.5. Markings. – A measuring system shall be legibly and indelibly marked with the following information:

- (a) pattern approval mark (i.e., type approval number);
- (b) name and address of the manufacturer or his trademark and, if required by the weights and measures authority, the manufacturer's identification mark in addition to the trademark;
- (c) model identifier or product name selected by the manufacturer;
- (d) nonrepetitive serial number;
- (e) *the accuracy class of the meter as specified by the manufacturer consistent with Table T.2. Accuracy Classes for Mass Flow Meter Applications Covered in NIST Handbook 44, Section 3.37 Mass Flow Meters;**
[*Nonretroactive as of January 1, 1995]
(Added 1994)
- (f) maximum and minimum flow rates in pounds per unit of time;
- (g) maximum working pressure;
- (h) applicable range of temperature if other than $-10\text{ }^{\circ}\text{C}$ to $+50\text{ }^{\circ}\text{C}$;
- (i) minimum measured quantity; and
- (j) product limitations, if applicable.

S.5.1. Location of Marking Information; Retail Motor-Fuel Dispensers. – *The marking information required in General Code, paragraph G-S.1. Identification shall appear as follows:*

- (a) *within 60 cm (24 in) to 150 cm (60 in) from the base of the dispenser;*
- (b) *either internally and/or externally provided the information is permanent and easily read; and*
- (c) *on a portion of the device that cannot be readily removed or interchanged (i.e., not on a service access panel).*

[Nonretroactive as of January 1, 2003]

The use of a dispenser key or tool to access internal marking information is permitted for retail liquid and compressed gas-measuring devices.

(Added 2006) (Amended 2019)

S.5.2. Marking of Equivalent Conversion Factors for Compressed Natural Gas. – A device dispensing compressed natural gas shall have either the statement “1 Gasoline Gallon Equivalent (GGE) means 5.660 lb of Compressed Natural Gas” or “1 Diesel Gallon Equivalent (DGE) means 6.384 lb of Compressed Natural Gas” permanently and conspicuously marked on the face of the dispenser according to the method of sale used.

(Added 1994) (Amended 2016)

S.5.3. Marking of Equivalent Conversion Factor for Liquefied Natural Gas. – A device dispensing liquefied natural gas shall have the statement “1 Diesel Gallon Equivalent (DGE) means 6.059 lb of Liquefied Natural Gas” permanently and conspicuously marked on the face of the dispenser according to the method of sale used.

(Added 2016)

S.6. Recording Element. – When an assembly is equipped with means for recording the measured quantity, the following conditions apply:

- (a) the scale interval shall be the same as that of the indicator;
- (b) the value of the recorded quantity shall be the same value as the indicated quantity;
- (c) *the recorded quantity shall also include the mass value if the mass is not the indicated quantity;*
[Nonretroactive as of January 1, 2021]
- (d) a quantity for a delivery (other than an initial reference value) cannot be recorded until the measurement and delivery has been completed;
- (e) the recording element is returned to zero when the resettable indicator is returned to zero; and
- (f) the recorded values shall meet the requirements applicable to the indicated values.

(Amended 2016 and 2023)

S.6.1. Recorded Representations. – When a quantity is delivered, the recorded representation shall include an identification number, the time and date, and the name of the seller. This information may be printed by the device or pre-printed on the ticket.

(Amended 2023)

S.7. Totalizers for Retail Motor-Fuel Devices. – *Retail motor-fuel dispensers shall be equipped with a nonresettable totalizer for the quantity delivered through the metering device.*

[Nonretroactive as of January 1, 1998]

(Added 1997)

N. Notes

N.1. Minimum Measured Quantity. – The minimum measured quantity shall be specified by the manufacturer.

N.2. Test Medium.

N.2.1. Liquid-Measuring Devices. – The device shall be tested with the liquid that the device is intended to measure or another liquid with the same general physical characteristics.

N.2.2. Vapor-Measuring Devices. – The device shall be tested with air or the product to be measured.

N.3. Test Drafts

N.3.1. Minimum Test. – The minimum test shall be one test draft at the maximum flow rate of the installation and one test draft at the minimum flow rate. More tests may be performed at these or other flow rates. (Also see T.3. Repeatability.)

(Amended 2023)

N.3.2. Transfer Standard Meter Test. – When comparing a meter with a calibrated transfer standard meter, the minimum quantity for any test draft shall be equal to or greater than the amount delivered in one minute at the flow rate being tested except for tests of the minimum measured quantity specified for the meter.

(Added 2023) (Amended 2024)

N.4. Minimum Measured Quantity. – The device shall be tested for a delivery equal to the declared minimum measured quantity when the device is likely to be used to make deliveries on the order of the minimum measured quantity.

N.5. Motor-Fuel Dispenser. – When a device is intended for use as a liquid motor-fuel dispenser, the type evaluation test shall include a test for accuracy using five starts and stops during a delivery to simulate the operation of the automatic shut-off nozzle. This test may be conducted as part of the normal inspection and test of the meter.

N.6. Testing Procedures.

N.6.1. Normal Tests. – The normal test of a meter shall be made at the maximum discharge rate developed by the installation. Any additional tests conducted at flow rates down to and including the rated minimum discharge flow rate shall be considered normal tests.

(Added 1999)

N.6.2. Special Tests. – “Special” tests shall be made to develop the operating characteristics of a device and any special elements and accessories attached to or associated with the device. Any test except as set forth in N.6.1. Normal Tests shall be considered a special test. Special tests of a measuring system shall be made to develop operating characteristics of the measuring systems during a split compartment delivery. Also see Table T.2. Accuracy Classes and Tolerances for Mass Flow Meters.

(Added 1999)

N.6.3. Repeatability Tests. – Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors such as temperature, pressure, and flow rate are reduced to the extent that they will not affect the results obtained. When conducting the tests, the discharge rates shall be within the minimum and maximum discharge rates as marked by the manufacturer.

(Amended 2019)

T. Tolerances

T.1. Tolerances, General.

- (a) The tolerances apply equally to errors of underregistration and errors of overregistration.
- (b) The tolerances apply to all products at all temperatures measured at any flow rate within the rated measuring range of the meter.

(Amended 1999)

T.2. Tolerances. – The tolerances for mass flow meters for specific liquids, gases, and applications are listed in Table T.2. Accuracy Classes and Tolerances for Mass Flow Meters.

(Amended 1994 and 1999)

Table T.2. Accuracy Classes and Tolerances for Mass Flow Meters				
Accuracy Class	Application or Commodity Being Measured	Acceptance Tolerance	Maintenance Tolerance	Special Tolerance
0.3	<ul style="list-style-type: none"> - Large capacity motor-fuel dispensers (maximum discharge flow rates greater than 100 L/min or 25 gal/min) - Heated products (other than asphalt) at temperatures greater than 50 °C (122 °F) - Asphalt at temperatures equal to or below 50 °C (122 °F) - Loading rack meters - Vehicle-tank meters - Home heating oil - Milk and other food products - All other liquid applications not shown in the table where the minimum delivery is at least 700 kg (1 500 lb) 	0.2 %	0.3 %	0.5 %
0.3A	<ul style="list-style-type: none"> - Asphalt at temperatures greater than 50 °C (122 °F) 	0.3 %	0.3 %	0.5 %
0.5	<ul style="list-style-type: none"> - Small capacity (retail) motor-fuel dispensers - Agri-chemical liquids - All other liquid applications not shown in the table where the minimum delivery is less than 700 kg or 1 500 lb 	0.3 %	0.5 %	0.5 %
1.0	<ul style="list-style-type: none"> - Anhydrous ammonia - LP Gas (including vehicle-tank meters) 	0.6 %	1.0 %	1.0 %
2.0	<ul style="list-style-type: none"> - Compressed natural gas as a motor-fuel - All other hydrocarbon gases and any other hydrocarbon gas/air mix applications not shown in the table 	1.5 %	2.0 %	2.0 %
2.5	<ul style="list-style-type: none"> - Cryogenic liquid meters - Liquefied compressed gases other than LP Gas 	1.5 %	2.5 %	2.5 %

(Added 1994) (Amended 1999, 2001, 2013, and 2022)

T.3. Repeatability. – When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 % of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. Also see N.6.3 Repeatability Tests.

(Amended 1992, 1994, 2001, and 2019)

T.4. Type Evaluation Examinations for Liquid-Measuring Devices. – For type evaluation examinations, the tolerance values shall apply under the following conditions:

- (a) with any one liquid within the range of liquids;
- (b) at any one liquid temperature and pressure within the operating range of the meter; and
- (c) at all flow rates within the range of flow rates.

(Added 1993) (Amended 1994)

UR. User Requirements

UR.1. Selection Requirements.

UR.1.1. Discharge Hose-Length. – *The length of the discharge hose on a retail motor-fuel device shall not exceed 4.6 m (15 ft) unless it can be demonstrated that a longer hose is essential to permit deliveries to be made to receiving vehicles or vessels.*

[Nonretroactive as of January 1, 1998]

(Added 1997)

UR.1.2. Minimum Measured Quantity.

- (a) The minimum measured quantity shall be specified by the manufacturer.
- (b) The minimum measured quantity appropriate for a transaction may be specified by the weights and measures authority. A device may have a minimum measured quantity smaller than that specified by the weights and measures authority; however, the device must perform within the performance requirements for the declared minimum measured quantity.

UR.2. Installation Requirements.

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

(Added 1997)

UR.2.2. Discharge Rate. – A device shall be installed so that the actual maximum discharge rate will not exceed the rated maximum discharge rate. Automatic means of flow regulation shall be incorporated in the installation if necessary.

(Added 1997)

UR.2.3. Low-Flow Cut-Off Valve. – If a metering system is equipped with a programmable or adjustable “low-flow cut-off” feature:

- (a) the low-flow cut-off value shall not be set at flow rates lower than the minimum operating flow rate specified by the manufacturer on the meter; and
- (b) the system shall be equipped with flow control valves which prevent the flow of product and stop the indicator from registering product flow whenever the product flow rate is less than the low-flow cut-off value.

(Added 1992)

UR.3. Use of Device.

UR.3.1. Unit Price and Product Identity for Retail Dispensers. – The following information shall be conspicuously displayed or posted on the face of a retail dispenser used in direct sale:

- (a) except for dispensers used exclusively for fleet sales, other price contract sales, and truck refueling (e.g., truck stop dispensers used only to refuel trucks), all of the unit prices at which the product is offered for sale; and
- (b) in the case of a computing type or money-operated type, the unit price at which the dispenser is set to compute.

(Added 1993)

UR.3.1.1. Marking of Equivalent Conversion Factors for Compressed Natural Gas. – A device dispensing compressed natural gas shall have either the statement “1 Gasoline Gallon Equivalent (GGE) means 5.660 lb of Compressed Natural Gas” or “1 Diesel Gallon Equivalent (DGE) means 6.384 lb of Compressed Natural Gas” permanently and conspicuously marked on the face of the dispenser according to the method of sale used.

(Added 2016)

UR.3.1.2. Marking of Equivalent Conversion Factor for Liquefied Natural Gas. – A device dispensing liquefied natural gas shall have the statement “1 Diesel Gallon Equivalent (DGE) means 6.059 lb of Liquefied Natural Gas” permanently and conspicuously marked on the face of the dispenser according to the method of sale used.

(Added 2016)

UR.3.2. Vapor-Return Line. – During any metered delivery of liquefied petroleum gas and other liquids 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.

(Added 1993)

UR.3.3. Recorded Representations for Vehicle Mounted Metering Systems. – Vehicle-mounted metering systems shall be equipped with a means to record all sales where product is delivered through the meter and shall comply with G-S.5.6. Recorded Representations. A copy of the recorded representation issued by the device shall be provided to the customer at the time of delivery or as otherwise specified by the customer.

(Added 1994) (Amended 2023)

UR.3.4. Recorded Representation. – The total price, the total quantity of the delivery, and the price per unit shall be provided on any recorded representation issued by a device of the computing type and containing any one of these values.

(Added 1993) (Amended 2023)

UR.3.5. Ticket in Printing Device. – A ticket shall not be inserted into a device equipped with a ticket printer until immediately before a delivery is begun, and in no case shall a ticket be in the device when the vehicle is in motion while on a public street, highway, or thoroughfare.

(Added 1993)

UR.3.6. Steps After Dispensing. – After delivery to a customer from a retail motor-fuel device:

(a) the starting lever shall be returned to its shutoff position and the zero-set-back interlock engaged; and

(b) the discharge nozzle shall be returned to its designed hanging position unless the primary indicating elements, and recording elements, if the device is equipped and activated to record, have been returned to a definite zero indication.

(Added 1993)

UR.3.7. Return of Indicating and Recording Elements to Zero. – The primary indicating elements (visual), and the primary recording elements when these are returnable to zero, shall be returned to zero immediately before each delivery. Exceptions to this requirement are totalizers on key-lock-operated or other self-operated dispensers and the primary recording element if the device is equipped to record.

(Added 1995) (Amended 1997)

UR.3.8. Return of Product to Storage, Retail Compressed and Liquefied Natural Gas Dispensers. – Provisions at the site shall be made for returning product to storage or disposing of the product in a safe and timely manner during or following testing operations. Such provisions may include return lines, or cylinders adequate in size and number to permit this procedure.

(Added 1998) (Amended 2016)

Table of Contents

	Page
Section 3.38. Carbon Dioxide Liquid-Measuring Devices.....	3-125
A. Application.....	3-125
A.1. General.....	3-125
A.2. Exceptions.....	3-125
A.3. Additional Code Requirements.	3-125
A.4. Type Evaluation.	3-125
S. Specifications.....	3-125
S.1. Design of Indicating and Recording Elements and of Recorded Representations.	3-125
S.1.1. Primary Elements.	3-125
S.1.2. Graduations.....	3-126
S.1.3. Indicators.	3-126
S.1.4. Computing-Type Devices.	3-127
S.2. Design of Measuring Elements.....	3-127
S.2.1. Air/Vapor Elimination.....	3-127
S.2.2. Reverse Flow Measurement.....	3-127
S.2.3. Maintenance of Liquid State.	3-127
S.2.4. Automatic Temperature or Density Compensation.	3-127
S.2.5. Provision for Sealing.....	3-127
S.3. Design of Discharge Lines and Discharge Line Valves.	3-128
S.3.1. Diversion of Measured Liquid.	3-128
S.3.2. Discharge Hose.	3-128
S.4. Marking Requirements.....	3-129
S.4.1. Limitation of Use.	3-129
S.4.2. Discharge Rates.....	3-129
N. Notes.....	3-129
N.1. Test Liquid.	3-129
N.2. Vaporization and Volume Change.....	3-129
N.3. Test Drafts.....	3-129
N.3.1. Gravimetric Test.	3-129
N.3.2. Transfer Standard Test.....	3-129
N.3.3. Volumetric Prover Test Drafts.	3-129
N.4. Testing Procedures.	3-129
N.4.1. Normal Tests.....	3-129
N.4.2. Special Tests.	3-129
N.4.3. Density.	3-129
N.4.4. Automatic Temperature or Density Compensation.	3-130
N.4.5. Repeatability Tests.	3-135
T. Tolerances	3-136
T.1. Application.....	3-136
T.1.1. To Underregistration and to Overregistration.	3-136
T.2. Tolerance Values.	3-136
T.2.1. Repeatability.....	3-136
T.3. On Tests Using Type 2 Transfer Standards.....	3-136
UR. User Requirements.....	3-136

UR.1. Installation Requirements.....	3-136
UR.1.1. Discharge Rate.	3-136
UR.1.2. Length of Discharge Hose.	3-136
UR.1.3. Maintenance of Liquid State.	3-136
UR.2. Use Requirements.....	3-137
UR.2.1. Return of Indicating and Recording Elements to Zero.	3-137
UR.2.2. Condition of Discharge System.....	3-137
UR.2.3. Vapor Equalization Line.....	3-137
UR.2.4. Temperature or Density Compensation.	3-137
UR.2.5. Ticket in Printing Device.....	3-137
UR.2.6. Sale by Weight.....	3-137

Section 3.38. Carbon Dioxide Liquid-Measuring Devices

A. Application

A.1. General. – This code applies to liquid-measuring devices used for the measurement of liquid carbon dioxide.

A.2. Exceptions. – This code does not apply to devices used solely for dispensing a product in connection with operations in which the amount dispensed does not affect customer charges.

A.3. Additional Code Requirements. – In addition to the requirements of this code, Carbon Dioxide Liquid-Measuring Devices shall meet the requirements of Section 1.10. General Code.

A.4. Type Evaluation. – The National Type Evaluation Program will accept for type evaluation only those devices that comply with all requirements of this code.

(Added 1998)

S. Specifications

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

S.1.1. Primary Elements.

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

S.1.1.2. Units. – A device shall indicate and record, if equipped to record, its deliveries in terms of pounds or kilograms or decimal subdivisions or multiples thereof.

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) for small delivery devices:

(1) 1 kilogram; or

(2) 1 pound

(b) for large delivery devices:

(1) 10 kilograms; or

(2) 10 pounds

S.1.1.4. Advancement of Indicating and Recording Elements. – Primary indicating and recording elements shall be susceptible to advancement only by the normal operation of the device. However, a device may be cleared by advancing its elements to zero, but only if:

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

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

S.1.1.5. Return to Zero. – Primary indicating and recording 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 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. The width of main graduations shall be not more than 50 % greater than the width of subordinate graduations. Graduations shall in no case be less than 0.2 mm (0.008 in) in width.

S.1.2.3. Clear Interval Between Graduations. – The clear interval shall be not less than 1.0 mm (0.04 in). If the graduations are not parallel, the measurement shall be made:

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

(Also see S.1.3.6. Travel of Indicator.)

S.1.3. Indicators.

S.1.3.1. Symmetry. – The index of an indicator shall be of the same shape as the graduations at least throughout that portion of its length associated with the graduations.

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

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

- (a) *the width of the narrowest graduation; and*
[Nonretroactive as of January 1, 2002]
(Amended 2001)
- (b) the width of the minimum clear interval between graduations.

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

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

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

S.1.3.6. Travel of Indicator. – If the most sensitive element of the primary indicating element utilizes an indicator and graduations, the relative movement of these parts corresponding to the smallest indicated value shall be no less than 5 mm (0.20 in).

S.1.4. Computing-Type Devices.

S.1.4.1. Recorded Representations. – Any recorded representation issued by a device of the computing type which includes the total computed price shall also include the total quantity of the delivery, and the price per unit.

(Amended 2023)

S.1.4.2. 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.

The total price shall be computed on the basis of the quantity indicated when the value of the smallest division indicated is equal to or less than the value specified in S.1.1.3. Value of Smallest Unit.

S.1.4.3. Money-Values, Mathematical Agreement. – Any digital money-value indication and any recorded money-value on a computing-type device shall be in mathematical agreement with its associated quantity indication or representation to within 1 cent of money-value.

S.2. Design of Measuring Elements.

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

(Amended 2016 and 2018)

S.2.2. Reverse Flow Measurement. – Effective means, automatic in operation, shall be installed to prevent reverse flow measurement.

S.2.3. Maintenance of Liquid State. – A device shall be so designed that the product being measured will remain in a liquid state during passage through the device.

S.2.4. Automatic Temperature or Density Compensation. – A volumetric device shall be equipped with automatic means for adjusting the indication and recorded representation of the measured quantity of the product to indicate or record the quantity of the product measured in terms of pounds.

S.2.5. Provision for Sealing. – For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices. For parameters adjusted using other means, the following applies.

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

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

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

*Audit trails shall use the format set forth in Table S.2.5. Provision for Sealing.**

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

(Amended 2006 and 2019)

Table S.2.5. Categories of Device and Methods of Sealing	
Categories of Device	Methods of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.	The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.	An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available on demand through the device or through another on-site device. The information may also be available electronically. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1 000 records are required. (Note: Does not require 1 000 changes to be stored for each parameter.)

[Nonretroactive as of January 1, 1995]

(Table Added 2006) (Amended 2016)

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 device or the discharge line therefrom, except that a manually controlled outlet that may be opened for purging or draining the measuring system 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.

S.3.2. Discharge Hose. – The discharge hose of a measuring system shall be of a wet hose type with a shutoff valve at its outlet end.

S.4. Marking Requirements.

S.4.1. Limitation of Use. – If a measuring system 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 marked on the device.

S.4.2. Discharge Rates. – A meter shall be marked to show its designed maximum and minimum discharge rates. The marked minimum discharge rate shall not exceed 20 % of the marked maximum discharge rate.

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

(Note Added 2003)

N. Notes

N.1. Test Liquid. – The test liquid shall be carbon dioxide in a compressed liquid state.

N.2. Vaporization and Volume Change. – Care shall be exercised to reduce vaporization and volume changes to a minimum. When testing by weight, the weigh tank and transfer systems shall be pre-cooled to liquid temperature prior to the start of the test to avoid the venting of vapor from the vessel being weighed.

N.3. Test Drafts.

N.3.1. Gravimetric Test. – Weight test drafts shall be equal to at least the amount delivered by the device in 2 minutes at its maximum discharge rate.

N.3.2. Transfer Standard Test. – When comparing a meter with a calibrated transfer standard, the test draft shall be equal to at least the amount delivered by the device in two minutes at its maximum discharge rate.

N.3.3. Volumetric Prover Test Drafts. – Test drafts shall be equal to at least the amount delivered in one minute at its normal discharge rate.

N.4. Testing Procedures.

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

N.4.2. Special Tests. – Any test except as set forth in N.4.1. Normal Tests shall be considered a special test. Tests shall be conducted, if possible, to evaluate any special elements or accessories attached to or associated with the device. A device shall be tested at a minimum discharge rate of:

- (a) not less than the marked minimum discharge rate or 20 % of the maximum rated discharge rate of the device, whichever is less; or
- (b) the lowest discharge rate practicable under the conditions of installation.

“Special” tests may be conducted to develop any characteristics of the device anticipated under the conditions of installation.

N.4.3. Density. – Temperature and pressure of the metered test liquid shall be measured during the test for the determination of density or volume correction when applicable. The appropriate correction values shall apply as specified in Table N.4.4. Automatic Temperature or Density Compensation.

N.4.4. Automatic Temperature or Density Compensation. – If a device is equipped with an automatic temperature or density compensator, the compensator shall be tested by comparing the quantity indicated or recorded by the device (with the compensator connected and operating) with the actual delivered quantity. The appropriate correction values shall apply as specified in Table N.4.4. Automatic Temperature or Density Compensation.

Table N.4.4. Automatic Temperature or Density Compensation							
Temp °F	Pressure		Liquid Density		Vapor Density		Vapor Displacement %
	PSIA	PSIG	lb/gal	(lb-oz)/gal	lb/cu ft	lb/gal	
– 30.00	177.89	163.19	9.127	9 - 2.0	1.989	0.266	2.9
– 29.75	178.75	164.05	9.122	9 - 2.0	1.999	0.267	2.9
– 29.50	179.62	164.92	9.117	9 - 1.9	2.008	0.268	2.9
– 29.25	180.49	165.79	9.113	9 - 1.8	2.018	0.270	3.0
– 29.00	181.36	166.67	9.108	9 - 1.7	2.028	0.271	3.0
– 28.75	182.24	167.54	9.103	9 - 1.7	2.038	0.272	3.0
– 28.50	183.12	168.42	9.098	9 - 1.6	2.048	0.274	3.0
– 28.25	184.00	169.31	9.094	9 - 1.5	2.058	0.275	3.0
– 28.00	184.89	170.19	9.089	9 - 1.4	2.067	0.276	3.0
– 27.75	185.78	171.08	9.084	9 - 1.3	2.077	0.278	3.1
– 27.50	186.67	171.98	9.080	9 - 1.3	2.087	0.279	3.1
– 27.25	187.57	172.87	9.075	9 - 1.2	2.098	0.280	3.1
– 27.00	188.47	173.77	9.070	9 - 1.1	2.108	0.282	3.1
– 26.75	189.37	174.67	9.065	9 - 1.0	2.118	0.283	3.1
– 26.50	190.28	175.58	9.061	9 - 1.0	2.128	0.284	3.1
– 26.25	191.18	176.49	9.056	9 - 0.9	2.138	0.286	3.2
– 26.00	192.10	177.40	9.051	9 - 0.8	2.148	0.287	3.2
– 25.75	193.01	178.32	9.046	9 - 0.7	2.159	0.289	3.2
– 25.50	193.93	179.23	9.041	9 - 0.7	2.169	0.290	3.2
– 25.25	194.85	180.16	9.037	9 - 0.6	2.179	0.291	3.2
– 25.00	195.78	181.08	9.032	9 - 0.5	2.190	0.293	3.2
– 24.75	196.70	182.01	9.027	9 - 0.4	2.200	0.294	3.3
– 24.50	197.64	182.94	9.022	9 - 0.4	2.211	0.296	3.3
– 24.25	198.57	183.87	9.017	9 - 0.3	2.221	0.297	3.3
– 24.00	199.51	184.81	9.013	9 - 0.2	2.232	0.298	3.3
– 23.75	200.45	185.75	9.008	9 - 0.1	2.243	0.300	3.3
– 23.50	201.39	186.70	9.003	9 - 0.0	2.253	0.301	3.3
– 23.25	202.34	187.64	8.998	9 - 0.0	2.264	0.303	3.4
– 23.00	203.29	188.60	8.993	8 - 15.9	2.275	0.304	3.4
– 22.75	204.25	189.55	8.989	8 - 15.8	2.286	0.306	3.4
– 22.50	205.20	190.51	8.984	8 - 15.7	2.296	0.307	3.4

Table N.4.4. Automatic Temperature or Density Compensation							
Temp °F	Pressure		Liquid Density		Vapor Density		Vapor Displacement %
	PSIA	PSIG	lb/gal	(lb-oz)/gal	lb/cu ft	lb/gal	
– 22.25	206.16	191.47	8.979	8 - 15.7	2.307	0.308	3.4
– 22.00	207.13	192.43	8.974	8 - 15.6	2.318	0.310	3.5
– 21.75	208.09	193.40	8.969	8 - 15.5	2.329	0.311	3.5
– 21.50	209.06	194.37	8.964	8 - 15.4	2.340	0.313	3.5
– 21.25	210.04	195.34	8.959	8 - 15.4	2.351	0.314	3.5
– 21.00	211.02	196.32	8.955	8 - 15.3	2.362	0.316	3.5
– 20.75	212.00	197.30	8.950	8 - 15.2	2.374	0.317	3.5
– 20.50	212.98	198.28	8.945	8 - 15.1	2.385	0.319	3.6
– 20.25	213.97	199.27	8.940	8 - 15.0	2.396	0.320	3.6
– 20.00	214.96	200.26	8.935	8 - 15.0	2.407	0.322	3.6
– 19.75	215.95	201.26	8.930	8 - 14.9	2.419	0.323	3.6
– 19.50	216.95	202.25	8.925	8 - 14.8	2.430	0.325	3.6
– 19.25	217.95	203.25	8.920	8 - 14.7	2.441	0.326	3.7
– 19.00	218.95	204.26	8.915	8 - 14.6	2.453	0.328	3.7
– 18.75	219.96	205.27	8.911	8 - 14.6	2.464	0.329	3.7
– 18.50	220.97	206.28	8.906	8 - 14.5	2.476	0.331	3.7
– 18.25	221.99	207.29	8.901	8 - 14.4	2.488	0.333	3.7
– 18.00	223.01	208.31	8.896	8 - 14.3	2.499	0.334	3.8
– 17.75	224.03	209.33	8.891	8 - 14.3	2.511	0.336	3.8
– 17.50	225.05	210.36	8.886	8 - 14.2	2.523	0.337	3.8
– 17.25	226.08	211.38	8.881	8 - 14.1	2.534	0.339	3.8
– 17.00	227.11	212.42	8.876	8 - 14.0	2.546	0.340	3.8
– 16.75	228.15	213.45	8.871	8 - 13.9	2.558	0.342	3.9
– 16.50	229.18	214.49	8.866	8 - 13.9	2.570	0.344	3.9
– 16.25	230.23	215.53	8.861	8 - 13.8	2.582	0.345	3.9
– 16.00	231.27	216.58	8.856	8 - 13.7	2.594	0.347	3.9
– 15.75	232.32	217.62	8.851	8 - 13.6	2.606	0.348	3.9
– 15.50	233.37	218.68	8.846	8 - 13.5	2.618	0.350	4.0
– 15.25	234.43	219.73	8.841	8 - 13.5	2.630	0.352	4.0
– 15.00	235.49	220.79	8.836	8 - 13.4	2.643	0.353	4.0
– 14.75	236.55	221.86	8.831	8 - 13.3	2.655	0.355	4.0
– 14.50	237.62	222.92	8.826	8 - 13.2	2.667	0.357	4.0
– 14.25	238.69	223.99	8.821	8 - 13.1	2.680	0.358	4.1
– 14.00	239.76	225.07	8.816	8 - 13.1	2.692	0.360	4.1
– 13.75	240.84	226.14	8.811	8 - 13.0	2.704	0.362	4.1

Table N.4.4. Automatic Temperature or Density Compensation							
Temp °F	Pressure		Liquid Density		Vapor Density		Vapor Displacement %
	PSIA	PSIG	lb/gal	(lb-oz)/gal	lb/cu ft	lb/gal	
– 13.50	241.92	227.22	8.806	8 - 12.9	2.717	0.363	4.1
– 13.25	243.00	228.31	8.801	8 - 12.8	2.729	0.365	4.1
– 13.00	244.09	229.39	8.796	8 - 12.7	2.742	0.367	4.2
– 12.75	245.18	230.49	8.791	8 - 12.7	2.755	0.368	4.2
– 12.50	246.28	231.58	8.786	8 - 12.6	2.767	0.370	4.2
– 12.25	247.37	232.68	8.781	8 - 12.5	2.780	0.372	4.2
– 12.00	248.48	233.78	8.776	8 - 12.4	2.793	0.373	4.3
– 11.75	249.58	234.89	8.771	8 - 12.3	2.806	0.375	4.3
– 11.50	250.69	236.00	8.765	8 - 12.2	2.819	0.377	4.3
– 11.25	251.80	237.11	8.760	8 - 12.2	2.832	0.379	4.3
– 11.00	252.92	238.22	8.755	8 - 12.1	2.845	0.380	4.3
– 10.75	254.04	239.34	8.750	8 - 12.0	2.858	0.382	4.4
– 10.50	255.16	240.47	8.745	8 - 11.9	2.871	0.384	4.4
– 10.25	256.29	241.60	8.740	8 - 11.8	2.884	0.386	4.4
– 10.00	257.42	242.73	8.735	8 - 11.8	2.897	0.387	4.4
– 9.75	258.56	243.86	8.730	8 - 11.7	2.911	0.389	4.5
– 9.50	259.70	245.00	8.725	8 - 11.6	2.924	0.391	4.5
– 9.25	260.84	246.14	8.719	8 - 11.5	2.937	0.393	4.5
– 9.00	261.98	247.29	8.714	8 - 11.4	2.951	0.394	4.5
– 8.75	263.13	248.44	8.709	8 - 11.3	2.964	0.396	4.5
– 8.50	264.29	249.59	8.704	8 - 11.3	2.978	0.398	4.6
– 8.25	265.44	250.75	8.699	8 - 11.2	2.991	0.400	4.6
– 8.00	266.60	251.91	8.694	8 - 11.1	3.005	0.402	4.6
– 7.75	267.77	253.07	8.688	8 - 11.0	3.019	0.404	4.6
– 7.50	268.93	254.24	8.683	8 - 10.9	3.032	0.405	4.7
– 7.25	270.11	255.41	8.678	8 - 10.8	3.046	0.407	4.7
– 7.00	271.28	256.59	8.673	8 - 10.8	3.060	0.409	4.7
– 6.75	272.46	257.76	8.668	8 - 10.7	3.074	0.411	4.7
– 6.50	273.64	258.95	8.662	8 - 10.6	3.088	0.413	4.8
– 6.25	274.83	260.13	8.657	8 - 10.5	3.102	0.415	4.8
– 6.00	276.02	261.32	8.652	8 - 10.4	3.116	0.417	4.8
– 5.75	277.21	262.52	8.647	8 - 10.3	3.130	0.418	4.8
– 5.50	278.41	263.72	8.641	8 - 10.3	3.144	0.420	4.9
– 5.25	279.61	264.92	8.636	8 - 10.2	3.159	0.422	4.9
– 5.00	280.82	266.12	8.631	8 - 10.1	3.173	0.424	4.9

Table N.4.4. Automatic Temperature or Density Compensation							
Temp °F	Pressure		Liquid Density		Vapor Density		Vapor Displacement %
	PSIA	PSIG	lb/gal	(lb-oz)/gal	lb/cu ft	lb/gal	
– 4.75	282.03	267.33	8.626	8 - 10.0	3.187	0.426	4.9
– 4.50	283.24	268.55	8.620	8 - 9.9	3.202	0.428	5.0
– 4.25	284.46	269.76	8.615	8 - 9.8	3.216	0.430	5.0
– 4.00	285.68	270.98	8.610	8 - 9.8	3.231	0.432	5.0
– 3.75	286.90	272.21	8.604	8 - 9.7	3.245	0.434	5.0
– 3.50	288.13	273.44	8.599	8 - 9.6	3.260	0.436	5.1
– 3.25	289.37	274.67	8.594	8 - 9.5	3.275	0.438	5.1
– 3.00	290.60	275.91	8.589	8 - 9.4	3.289	0.440	5.1
– 2.75	291.84	277.15	8.583	8 - 9.3	3.304	0.442	5.1
– 2.50	293.09	278.39	8.578	8 - 9.2	3.319	0.444	5.2
– 2.25	294.33	279.64	8.573	8 - 9.2	3.334	0.446	5.2
– 2.00	295.58	280.89	8.567	8 - 9.1	3.349	0.448	5.2
– 1.75	296.84	282.14	8.562	8 - 9.0	3.364	0.450	5.3
– 1.50	298.10	283.40	8.556	8 - 8.9	3.379	0.452	5.3
– 1.25	299.36	284.67	8.551	8 - 8.8	3.395	0.454	5.3
– 1.00	300.63	285.93	8.546	8 - 8.7	3.410	0.456	5.3
– 0.75	301.90	287.21	8.540	8 - 8.6	3.425	0.458	5.4
– 0.50	303.18	288.48	8.535	8 - 8.6	3.440	0.460	5.4
– 0.25	304.46	289.76	8.530	8 - 8.5	3.456	0.462	5.4
0.00	305.74	291.74	8.524	8 - 8.4	3.471	0.464	5.4
0.25	307.03	292.33	8.519	8 - 8.3	3.487	0.466	5.5
0.50	308.32	293.62	8.513	8 - 8.2	3.503	0.468	5.5
0.75	309.61	294.92	8.508	8 - 8.1	3.518	0.470	5.5
1.00	310.91	296.21	8.502	8 - 8.0	3.534	0.472	5.6
1.25	312.21	297.52	8.497	8 - 8.0	3.550	0.475	5.6
1.50	313.52	298.82	8.491	8 - 7.9	3.566	0.477	5.6
1.75	314.83	300.13	8.486	8 - 7.8	3.582	0.479	5.6
2.00	316.15	301.45	8.480	8 - 7.7	3.598	0.481	5.7
2.25	317.46	302.77	8.475	8 - 7.6	3.614	0.483	5.7
2.50	318.79	304.09	8.469	8 - 7.5	3.630	0.485	5.7
2.75	320.11	305.42	8.464	8 - 7.4	3.646	0.487	5.8
3.00	321.45	306.75	8.458	8 - 7.3	3.662	0.490	5.8
3.25	322.78	308.08	8.453	8 - 7.2	3.679	0.492	5.8
3.50	324.12	309.42	8.447	8 - 7.2	3.695	0.494	5.8
3.75	325.46	310.77	8.442	8 - 7.1	3.712	0.496	5.9

Table N.4.4. Automatic Temperature or Density Compensation							
Temp °F	Pressure		Liquid Density		Vapor Density		Vapor Displacement %
	PSIA	PSIG	lb/gal	(lb-oz)/gal	lb/cu ft	lb/gal	
4.00	326.81	312.11	8.436	8 - 7.0	3.728	0.498	5.9
4.25	328.16	313.46	8.431	8 - 6.9	3.745	0.501	5.9
4.50	329.52	314.82	8.425	8 - 6.8	3.761	0.503	6.0
4.75	330.88	316.18	8.420	8 - 6.7	3.778	0.505	6.0
5.00	332.24	317.54	8.414	8 - 6.6	3.795	0.507	6.0
5.25	333.61	318.91	8.408	8 - 6.5	3.812	0.510	6.1
5.50	334.98	320.28	8.403	8 - 6.4	3.829	0.512	6.1
5.75	336.35	321.66	8.397	8 - 6.4	3.846	0.514	6.1
6.00	337.73	323.04	8.392	8 - 6.3	3.863	0.516	6.2
6.25	339.12	324.42	8.386	8 - 6.2	3.880	0.519	6.2
6.50	340.51	325.81	8.380	8 - 6.1	3.897	0.521	6.2
6.75	341.90	327.20	8.375	8 - 6.0	3.915	0.523	6.3
7.00	343.30	328.60	8.369	8 - 5.9	3.932	0.526	6.3
7.25	344.70	330.00	8.363	8 - 5.8	3.949	0.528	6.3
7.50	346.10	331.41	8.358	8 - 5.7	3.967	0.530	6.3
7.75	347.51	332.82	8.352	8 - 5.6	3.984	0.533	6.4
8.00	348.92	334.23	8.346	8 - 5.5	4.002	0.535	6.4
8.25	350.34	335.65	8.341	8 - 5.4	4.020	0.537	6.4
8.50	351.76	337.07	8.335	8 - 5.4	4.038	0.540	6.5
8.75	353.19	338.49	8.335	8 - 5.4	4.038	0.540	6.5
9.00	354.62	339.92	8.323	8 - 5.2	4.073	0.545	6.5
9.25	356.06	341.36	8.318	8 - 5.1	4.091	0.547	6.6
9.50	357.49	342.80	8.312	8 - 5.0	4.110	0.549	6.6
9.75	358.94	344.24	8.306	8 - 4.9	4.128	0.552	6.6
10.00	360.38	345.69	8.300	8 - 4.8	4.146	0.554	6.7
10.25	361.84	347.14	8.295	8 - 4.7	4.164	0.557	6.7
10.50	363.29	348.60	8.289	8 - 4.6	4.183	0.559	6.7
10.75	364.75	350.06	8.283	8 - 4.5	4.201	0.562	6.8
11.00	366.22	351.52	8.277	8 - 4.4	4.220	0.564	6.8
11.25	367.68	352.99	8.271	8 - 4.3	4.238	0.567	6.8
11.50	369.16	354.46	8.266	8 - 4.2	4.257	0.569	6.9
11.75	370.64	355.94	8.260	8 - 4.2	4.276	0.572	6.9
12.00	372.12	357.42	8.254	8 - 4.1	4.295	0.574	7.0
12.25	373.60	358.91	8.248	8 - 4.0	4.314	0.577	7.0
12.50	375.09	360.40	8.242	8 - 3.9	4.333	0.579	7.0

Table N.4.4. Automatic Temperature or Density Compensation							
Temp °F	Pressure		Liquid Density		Vapor Density		Vapor Displacement %
	PSIA	PSIG	lb/gal	(lb-oz)/gal	lb/cu ft	lb/gal	
12.75	376.59	361.89	8.236	8 - 3.8	4.352	0.582	7.1
13.00	378.09	363.39	8.230	8 - 3.7	4.371	0.584	7.1
13.25	379.59	364.89	8.224	8 - 3.6	4.390	0.587	7.1
13.50	381.10	366.40	8.219	8 - 3.5	4.410	0.589	7.2
13.75	382.61	367.91	8.213	8 - 3.4	4.429	0.592	7.2
14.00	384.13	369.43	8.207	8 - 3.3	4.449	0.595	7.2
14.25	385.65	370.95	8.201	8 - 3.2	4.468	0.597	7.3
14.50	387.17	372.48	8.195	8 - 3.1	4.488	0.600	7.3
14.75	388.70	374.01	8.189	8 - 3.0	4.508	0.603	7.4
15.00	390.24	375.54	8.183	8 - 2.9	4.527	0.605	7.4
15.25	391.78	377.08	8.177	8 - 2.8	4.547	0.608	7.4
15.50	393.32	378.62	8.171	8 - 2.7	4.567	0.611	7.5
15.75	394.87	380.17	8.165	8 - 2.6	4.587	0.613	7.5
16.00	396.42	381.72	8.159	8 - 2.5	4.608	0.616	7.5
16.25	397.98	383.28	8.153	8 - 2.4	4.628	0.619	7.6
16.50	399.54	384.84	8.147	8 - 2.3	4.648	0.621	7.6
16.75	401.10	386.41	8.141	8 - 2.2	4.669	0.624	7.7
17.00	402.67	387.98	8.134	8 - 2.2	4.689	0.627	7.7
17.25	404.25	389.55	8.128	8 - 2.1	4.710	0.630	7.7
17.50	405.82	391.13	8.122	8 - 2.0	4.731	0.632	7.8
17.75	407.41	392.71	8.116	8 - 1.9	4.751	0.635	7.8
18.00	409.00	394.30	8.110	8 - 1.8	4.772	0.638	7.9
18.25	410.59	395.89	8.104	8 - 1.7	4.793	0.641	7.9
18.50	412.19	397.49	8.098	8 - 1.6	4.814	0.644	7.9
18.75	413.79	399.09	8.092	8 - 1.5	4.835	0.646	8.0
19.00	415.39	400.70	8.085	8 - 1.4	4.857	0.649	8.0
19.25	417.00	402.31	8.079	8 - 1.3	4.878	0.652	8.1
19.50	418.62	403.92	8.073	8 - 1.2	4.900	0.655	8.1
19.75	420.24	405.54	8.067	8 - 1.1	4.921	0.658	8.2
20.00	421.86	407.17	8.061	8 - 1.0	4.943	0.661	8.2

N.4.5. Repeatability Tests. – Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors such as temperature, pressure, and flow rate are reduced to the extent that they will not affect the results obtained. When conducting the tests, the discharge rates shall be within the minimum and maximum discharge rates as marked by

the manufacturer. For devices equipped with an automatic temperature or density compensator, results shall be based on tests with either:

- (1) all runs conducted with the compensated (net) volume (e.g., with the temperature or density compensator activated); or
- (2) all runs conducted with the uncompensated (gross) volume (e.g., with the temperature or density compensator deactivated).

(Amended 2019)

T. Tolerances

T.1. Application.

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

T.2. Tolerance Values. – The maintenance and acceptance tolerances for normal and special tests shall be as shown in Table T.2. Accuracy Classes and Tolerances for Carbon Dioxide Liquid-Measuring Devices.

Table T.2. Accuracy Classes and Tolerances for Carbon Dioxide Liquid-Measuring Devices				
Accuracy Class	Application	Acceptance Tolerance	Maintenance Tolerance	Special Test Tolerance
2.5	Liquid carbon dioxide	1.5 %	2.5 %	2.5 %

(Table Added 2003) (Amended 2003)

T.2.1. Repeatability. – When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 % of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. Also see N.4.5. Repeatability Tests.
(Added 2002) (Amended 2019)

T.3. On Tests Using Type 2 Transfer Standards. – When commercial meters are tested using a Type 2 transfer standard, the tolerance applied to the meter under test shall be calculated using the formula specified in Section 1.10. General Code, paragraph G-T.5. Tolerances on Tests When Type 2 Transfer Standards Are Used.
(Amended 2023)

UR. User Requirements

UR.1. Installation Requirements.

UR.1.1. Discharge Rate. – A device shall be so installed that the actual maximum discharge rate will not exceed the rated maximum discharge rate. If necessary, means for flow regulation shall be incorporated in the installation.

UR.1.2. Length of Discharge Hose. – The discharge hose shall be of such a length and design as to keep vaporization of the liquid to a minimum.

UR.1.3. Maintenance of Liquid State. – A device shall be so installed and operated that the product being measured shall remain in the liquid state during passage through the meter.

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 shall be returned to zero immediately before each delivery.

UR.2.2. Condition of Discharge System. – The discharge hose, up to the valve at the end of the discharge hose, shall be completely filled and pre-cooled to liquid temperatures before a “zero” condition is established and prior to the start of a commercial delivery. Means shall be provided to fill the discharge hose with liquid prior to the start of a delivery.

UR.2.3. Vapor Equalization Line. – A vapor equalization line shall not be used during a metered delivery unless the quantity of vapor displaced from the buyer’s tank to the seller’s tank is deducted from the metered quantity. The appropriate correction values shall apply as specified in Table N.4.4. Automatic Temperature or Density Compensation.

UR.2.4. Temperature or Density Compensation.

UR.2.4.1. Use of Automatic Temperature or Density Compensators. – Devices equipped with an automatic temperature or density compensator shall have the compensator connected, operable, and in use at all times. Such automatic temperature or density compensator may not be removed.

UR.2.4.2. Recorded Representations. – Any recorded representation based on a reading of a device that is equipped with an automatic temperature or density compensator shall include that the quantity delivered has been temperature or density compensated.

(Amended 2023)

UR.2.5. Ticket in Printing Device. – A ticket shall not be inserted into a device equipped with a ticket printer until immediately before a delivery is begun, and in no case shall a ticket be in the device when the vehicle is in motion while on a public street, highway, or thoroughfare.

UR.2.6. Sale by Weight. – All quantity determinations shall be made by means of an approved and sealed weighing or measuring device. All sales shall be stated in kilograms or pounds.

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Table of Contents

	Page
Section 3.39. Hydrogen Gas-Measuring Devices	3-141
A. Application.....	3-141
A.1. General.....	3-141
A.2. Exceptions.....	3-141
A.3. Additional Code Requirements.	3-141
A.4. Type Evaluation.	3-141
S. Specifications.....	3-141
S.1. Indicating and Recording Elements.	3-141
S.1.1. Indicating Elements.....	3-141
S.1.2. Vehicle Fuel Dispensers.	3-141
S.1.3. Units.....	3-141
S.1.4. Value of Smallest Unit.	3-142
S.2. Operating Requirements.	3-142
S.2.1. Return to Zero.....	3-142
S.2.2. Indicator Reset Mechanism.....	3-142
S.2.3. Provision for Power Loss.....	3-142
S.2.4. Display of Unit Price and Product Identity.	3-142
S.2.5. Money-Value Computations.	3-143
S.2.6. Recorded Representations, Point of Sale Systems.....	3-143
S.2.7. Indication of Delivery.....	3-143
S.2.8. <i>Automatic Timeout – Pay-At-Vehicle Fuel Dispensers</i>	3-143
S.3. Design of Measuring Elements and Measuring Systems.	3-143
S.3.1. Maximum and Minimum Flow-Rates.....	3-143
S.3.2. Adjustment Means.....	3-143
S.3.3. Provision for Sealing.	3-143
S.3.4. Automatic Density Correction.	3-145
S.3.5. Pressurizing the Discharge Hose.....	3-145
S.3.6. Zero-Set-Back Interlock, Retail Vehicle Fuel Devices.....	3-145
S.4. Discharge Lines and Valves.	3-145
S.4.1. Diversion of Measured Product.....	3-145
S.4.2. Directional Flow Valves.....	3-145
S.4.3. Other Valves.	3-145
S.5. Markings.....	3-145
S.5.1. Location of Marking Information; Hydrogen-Fuel Dispensers.	3-146
S.6. Recording Element.	3-146
S.6.1. Recorded Representations.....	3-146
S.7. Totalizers for Vehicle Fuel Dispensers.	3-146
S.8. Minimum Measured Quantity.	3-146
N. Notes.....	3-147
N.1. Minimum Measured Quantity.	3-147
N.2. Test Medium.	3-147
N.3. Test Drafts.....	3-147
N.4. Tests.....	3-147
N.4.1. Master Meter (Transfer) Standard Test.....	3-147
N.4.2. Gravimetric Tests.....	3-147

N.4.3.	PVT Pressure Volume Temperature Test.	3-147
N.5.	Minimum Measured Quantity.	3-147
N.6.	Testing Procedures.	3-147
N.6.1.	General.	3-147
N.6.2.	Repeatability Tests.	3-148
N.7.	Density.	3-148
T.	Tolerances	3-148
T.1.	Tolerances, General.	3-148
T.2.	Tolerances.	3-148
T.3.	Repeatability.	3-148
T.4.	Tolerance Application on Test Using Type 2 Transfer Standard Test Method.	3-148
T.5.	Tolerance Application in Type Evaluation Examinations for Devices.	3-149
UR.	User Requirements	3-149
UR.1.	Selection Requirements.	3-149
UR.1.1.	Computing-Type Device; Retail Dispenser.	3-149
UR.1.2.	Discharge Hose-Length.	3-149
UR.1.3.	Minimum Measured Quantity.	3-149
UR.2.	Installation Requirements.	3-149
UR.2.1.	Manufacturer's Instructions.	3-149
UR.2.2.	Discharge Rate.	3-149
UR.2.3.	Low-Flow Cut-Off Valve.	3-150
UR.3.	Use of Device.	3-150
UR.3.1.	Unit Price and Product Identity for Retail Dispensers.	3-150
UR.3.2.	Vehicle-Mounted Measuring Systems Recording Element.	3-150
UR.3.3.	Recorded Representations.	3-150
UR.3.4.	Steps After Dispensing.	3-150
UR.3.5.	Return of Indicating and Recording Elements to Zero.	3-150
UR.3.6.	Return of Product to Storage, Retail Hydrogen Gas Dispensers.	3-150
UR.3.7.	Conversion Factors.	3-150

Section 3.39. Hydrogen Gas-Measuring Devices

The status of Section 3.39. Hydrogen Gas-Measuring Devices was changed from “tentative” to “permanent” effective January 1, 2020.

(Added 2010) (Amended 2019)

A. Application

A.1. General. – This code applies to devices that are used for the measurement of hydrogen gas in the vapor state used as a vehicle fuel.

A.2. Exceptions. – This code does not apply to:

- (a) Devices used solely for dispensing a product in connection with operations in which the amount dispensed does not affect customer charges.
- (b) The wholesale delivery of hydrogen gas.
- (c) Devices used for dispensing a hydrogen gas with a hydrogen fuel index lower than 99.97 % and concentrations of specified impurities that exceed level limits in the latest version of SAE International J2719 “Hydrogen Fuel Quality for Fuel Cell Vehicles.”
- (d) Systems that measure pressure, volume, and temperature with a calculating device to determine the mass of gas accumulated in or discharged from a tank of known volume.

A.3. Additional Code Requirements. – In addition to the requirements of this code, Hydrogen Gas-Measuring Devices shall meet the requirements of Section 1.10. General Code.

A.4. Type Evaluation. – The National Type Evaluation Program (NTEP) will accept for type evaluation only those devices that comply with all requirements of this code.

S. Specifications

S.1. Indicating and Recording Elements.

S.1.1. Indicating Elements. – A measuring assembly shall include an indicating element that continuously displays measurement results relative to quantity and total price. Indications shall be clear, definite, accurate, and easily read under normal conditions of operation of the device.

S.1.2. Vehicle Fuel Dispensers. – A hydrogen gas dispenser used to fuel vehicles shall be of the computing type and shall indicate the mass, the unit price, and the total price of each delivery.

S.1.3. Units.

S.1.3.1. Units of Measurement. – Deliveries shall be indicated and recorded in kilograms and decimal subdivisions thereof.

S.1.3.2. Numerical Value of Quantity-Value Divisions. – The value of an interval (i.e., increment or scale division) shall be equal to:

- (a) 1, 2, or 5; or

- (b) a decimal multiple or submultiple of 1, 2, or 5.

Examples: quantity-value divisions may be 10, 20, 50, 100; or 0.01, 0.02, 0.05; or 0.1, 0.2, or 0.5; etc.

S.1.3.3. Maximum Value of Quantity-Value Divisions. – The maximum value of the quantity-value division shall not be greater than 0.5% of the minimum measured quantity.

S.1.3.4. Values Defined. – Indicated values shall be adequately defined by a sufficient number of figures, words, symbols, or combinations thereof. A display of “zero” shall be a zero digit for all displayed digits to the right of the decimal mark and at least one to the left.

S.1.4. Value of Smallest Unit. – The value of the smallest unit of indicated delivery, and recorded delivery if the device is equipped to record, shall not exceed the equivalent of:

- (a) 0.001 kg on devices with a marked maximum flow rate of 30 kg/min or less; or
- (b) 0.01 kg on devices with a marked maximum flow rate of more than 30 kg/min.

S.2. Operating Requirements.

S.2.1. Return to Zero.

- (a) The primary indicating and the primary recording elements, if the device is equipped to record, shall be provided with a means for readily returning the indication to zero either automatically or manually.
- (b) It shall not be possible to return primary indicating elements, or primary recording elements, beyond the correct zero position.

S.2.2. Indicator Reset Mechanism. – The reset mechanism for the indicating element shall not be operable during a delivery. Once the zeroing operation has begun, it shall not be possible to indicate a value other than the latest measurement, or “zeros” when the zeroing operation has been completed.

S.2.3. Provision for Power Loss.

S.2.3.1. Transaction Information. – In the event of a power loss, the information needed to complete any transaction in progress at the time of the power loss (such as the quantity and unit price, or sales price) shall be determinable for at least 15 minutes at the dispenser or at the console if the console is accessible to the customer.

S.2.3.2. User Information. – The device memory shall retain information on the quantity of fuel dispensed and the sales price totals during power loss.

S.2.4. Display of Unit Price and Product Identity.

S.2.4.1. Unit Price. – A computing or money-operated device shall be able to display on each face the unit price at which the device is set to compute or to dispense.

S.2.4.2. Product Identity. – A device shall be able to conspicuously display on each side the identity of the product being dispensed.

S.2.4.3. Selection of Unit Price. – When a product is offered for sale at more than one unit price through a computing device, the selection of the unit price shall be made prior to delivery using controls on the device or other customer-activated controls. A system shall not permit a change to the unit price during delivery of a product.

S.2.4.4. Agreement Between Indications. – All quantity, unit price, and total price indications within a measuring system shall agree for each transaction.

S.2.5. Money-Value Computations. – A computing device shall compute the total sales price at any single-purchase unit price for which the product being measured is offered for sale at any delivery possible within either the measurement range of the device or the range of the computing elements, whichever is less.

S.2.5.1. Auxiliary Elements. – If a system is equipped with auxiliary indications, all indicated money value and quantity divisions of the auxiliary element shall be identical with those of the primary element.

S.2.5.2. Display of Quantity and Total Price. – When a delivery is completed, the total price and quantity for that transaction shall be displayed on the face of the dispenser for at least 5 minutes or until the next transaction is initiated by using controls on the device or other user-activated controls.

S.2.6. Recorded Representations, Point of Sale Systems. – A receipt shall be available through a built-in or separate recording element for transactions conducted with point-of-sale systems or devices activated by debit cards, credit cards, and/or cash. The receipt shall contain the following information for products delivered by the dispenser:

- (a) the total mass of the delivery;
- (b) the unit price;
- (c) the total computed price; and
- (d) the product identity by name, symbol, abbreviation, or code number.

(Amended 2023)

S.2.7. Indication of Delivery. – The device shall automatically show on its face the initial zero condition and the quantity delivered (up to the nominal capacity).

S.2.8. Automatic Timeout – Pay-At-Vehicle Fuel Dispensers. – *Once a vehicle fuel dispenser has been authorized, it must deauthorize within two minutes if not activated. Reauthorization of the vehicle fuel dispenser must be performed before any product is delivered. If the time limit to deauthorize the vehicle fuel dispenser is programmable, it shall not accept an entry greater than two minutes.*

[Nonretroactive as of January 1, 2020]

(Added 2019)

S.3. Design of Measuring Elements and Measuring Systems.

S.3.1. Maximum and Minimum Flow-Rates. – The ratio of the maximum to minimum flow-rates specified by the manufacturer for devices measuring gases shall be 10:1 or greater.

S.3.2. Adjustment Means. – An assembly shall be provided with means to change the ratio between the indicated quantity and the quantity of gas measured by the assembly. A bypass on the measuring assembly shall not be used for these means.

S.3.2.1. Discontinuous Adjusting Means. – When the adjusting means changes ratio between the indicated quantity and the quantity of measured gas in a discontinuous manner, the consecutive values of the ratio shall not differ by more than 0.1 %.

S.3.3. Provision for Sealing. – For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as

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

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

- (a) each individual measurement element;
- (b) any adjustable element for controlling delivery rate when such rate tends to affect the accuracy of deliveries;
- (c) the zero-adjustment mechanism; and
- (d) any metrological parameter that detrimentally affects the metrological integrity of the device or system.

When applicable, the adjusting mechanism shall be readily accessible for purposes of affixing a security seal. Audit trails shall use the format set forth in Table S.3.3. Categories of Device and Methods of Sealing.

(Amended 2019)

Table S.3.3. Categories of Device and Methods of Sealing	
Categories of Device	Method of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.	The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.	An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available on demand through the device or through another on-site device. The information may also be available electronically. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1 000 records are required. (Note: Does not require 1 000 changes to be stored for each parameter.)

(Amended 2016)

S.3.4. Automatic Density Correction.

- (a) An automatic means to determine and correct for changes in product density shall be incorporated in any hydrogen gas-measuring system where measurements are affected by changes in the density of the product being measured.
- (b) Volume-measuring devices with automatic temperature compensation used to measure hydrogen gas as a vehicle fuel shall be equipped with an automatic means to determine and correct for changes in product density due to changes in the temperature, pressure, and composition of the product.

S.3.5. Pressurizing the Discharge Hose. – The discharge hose for hydrogen gas shall automatically pressurize to a pressure equal to or greater than the receiving vessel prior to the device beginning to register the delivery. The indications shall not advance as a result of the initial pressurization or the purging/bleeding of the discharge hose.

S.3.6. Zero-Set-Back Interlock, Retail Vehicle Fuel Devices.

- (a) A device shall be constructed so that:
 - (1) when the device is shut-off at the end of a delivery an automatic interlock prevents a subsequent delivery until the indicating element and recording elements, if the device is equipped and activated to record, have been returned to their zero positions; and
 - (2) it shall not be possible to return the discharge nozzle to its start position unless the zero set back interlock is engaged or becomes engaged.
- (b) For systems with more than one:
 - (1) dispenser supplied by a single measuring element, an effective automatic control valve in each dispenser prevents product from being delivered until the indicating elements on that dispenser are in a correct zero position; or
 - (2) hose supplied by a single measuring element, effective automatic means must be provided to prevent product from being delivered until the indicating element(s) corresponding to each hose are in a correct zero position.

S.4. Discharge Lines and Valves.

S.4.1. Diversion of Measured Product. – No means shall be provided by which any measured product can be diverted from the measuring device.

S.4.2. Directional Flow Valves. – If a reversal of flow could result in errors that exceed the tolerance for the minimum measured quantity, a valve or valves or other effective means, automatic in operation (and equipped with a pressure limiting device, if necessary) to prevent the reversal of flow shall be properly installed in the system. (Also see N.1. Minimum Measured Quantity.)

S.4.3. Other Valves. – Check valves and closing mechanisms that are not used to define the measured quantity shall have relief valves (if necessary) to dissipate any abnormally high pressure that may arise in the measuring assembly.

S.5. Markings. – A measuring system shall be conspicuously, legibly, and indelibly marked with the following information:

- (a) pattern approval mark (i.e., type approval number);

- (b) name and address of the manufacturer or his trademark and, if required by the weights and measures authority, the manufacturer's identification mark in addition to the trademark;
- (c) model designation or product name selected by the manufacturer;
- (d) nonrepetitive serial number;
- (e) the accuracy class of the device as specified by the manufacturer consistent with Table T.2. Accuracy Classes and Tolerances for Hydrogen-Gas Measuring Devices;
- (f) maximum and minimum flow rates in kilograms per unit of time;
- (g) maximum working pressure;
- (h) applicable range of ambient temperature if other than -10°C to $+50^{\circ}\text{C}$;
- (i) minimum measured quantity; and
- (j) product limitations (such as fuel quality), if applicable.

S.5.1. Location of Marking Information; Hydrogen-Fuel Dispensers. – The marking information required in General Code, paragraph G S.1. Identification shall appear as follows:

- (a) within 60 cm (24 in) to 150 cm (60 in) from the base of the dispenser;
- (b) either internally and/or externally provided the information is permanent and easily read; and accessible for inspection; and
- (c) on a portion of the device that cannot be readily removed or interchanged (i.e., not on a service access panel).

The use of a dispenser key or tool to access internal marking information is permitted for retail hydrogen-measuring devices.

S.6. Recording Element. – When an assembly is equipped with means for recording the measured quantity, the recorded information must agree with the indications on the dispenser for the transaction and the recorded values shall be clearly defined.

S.6.1. Recorded Representations. – When a quantity is delivered the recorded representation quantity shall include an identification number, the time and date, and the name of the seller.

(Amended 2023)

S.7. Totalizers for Vehicle Fuel Dispensers. – Vehicle fuel dispensers shall be equipped with a nonresettable totalizer for the quantity delivered through each separate measuring device.

S.8. Minimum Measured Quantity. – The minimum measured quantity shall satisfy the conditions of use of the measuring system as follows:

- (a) Measuring systems having a maximum flow rate less than or equal to 4 kg/min shall have a minimum measured quantity not exceeding 0.5 kg.
- (b) Measuring systems having a maximum flow rate greater than 4 kg/min but not greater than 12 kg/min shall have a minimum measured quantity not exceeding 1.0 kg.

N. Notes

N.1. Minimum Measured Quantity. – The minimum measured quantity shall be specified by the manufacturer.

N.2. Test Medium. – The device shall be tested with the product commercially measured except that, in a type evaluation examination, hydrogen gas as specified in NIST Handbook 130 shall be used.

N.3. Test Drafts. – The minimum test shall be one test draft at twice the declared minimum measured quantity and one test draft at approximately five times the minimum measured quantity or 4 kg, whichever is greater. More tests may be performed over the range of normal quantities dispensed. (Also see T.3. Repeatability.)

The test draft shall be made at flows representative of that during normal delivery. The pressure drop between the dispenser and the proving system shall not be greater than that for normal deliveries. The control of the flow (e.g., pipework or valve(s) size, etc.) shall be such that the flow of the measuring system is maintained within the range specified by the manufacturer.

N.4. Tests.

N.4.1. Master Meter (Transfer) Standard Test. – When comparing a measuring system with a calibrated transfer standard, the minimum test shall be one test draft at the declared minimum measured quantity and one test draft at approximately ten times the minimum measured quantity or 1 kg, whichever is greater. More tests may be performed over the range of normal quantities dispensed.

N.4.1.1. Verification of Master Metering Systems. – A master metering system used to verify a hydrogen gas-measuring device shall be verified before and after the verification process. A master metering system used to calibrate a hydrogen gas-measuring device shall be verified before starting the calibration and after the calibration process.

N.4.2. Gravimetric Tests. – The weight of the test drafts shall be equal to at least twice the amount delivered by the device at the declared minimum measured quantity and one test draft at approximately five times the minimum measured quantity or 4 kg, whichever is greater. More tests may be performed over the range of normal quantities dispensed.

N.4.3. PVT Pressure Volume Temperature Test. – The minimum test with a calibrated volumetric standard shall be one test draft at twice the declared minimum measured quantity and one test draft at approximately five times the minimum measured quantity or 4 kg, whichever is greater. More tests may be performed over the range of normal quantities dispensed.

N.5. Minimum Measured Quantity. – The device shall be tested for a delivery equal to the declared minimum measured quantity when the device is likely to be used to make deliveries on the order of the declared minimum measured quantity.

N.6. Testing Procedures.

N.6.1. General. – The device or system shall be tested under normal operating conditions of the dispenser.

The test draft shall be made at flows representative of that during normal delivery. The pressure drop between the dispenser and the proving system shall not be greater than that for normal deliveries. The control of the flow (e.g., pipework or valve(s) size, etc.) shall be such that the flow of the measuring system is maintained within the range specified by the manufacturer.

N.6.2. Repeatability Tests. – Tests for repeatability should include a minimum of three consecutive test drafts of approximately the same size and be conducted under controlled conditions where variations in factors are reduced to minimize the effect on the results obtained. When conducting the tests, the discharge rates shall be within the minimum and maximum discharge rates as marked by the manufacturer.

(Amended 2019)

N.7. Density. – Temperature and pressure of hydrogen gas shall be measured during the test for the determination of density or volume correction factors when applicable. For the thermophysical properties of hydrogen the following publications shall apply: for density calculations at temperatures above 255 K and pressures up to 120 MPa, a simple relationship may be used that is given in the publication of Lemmon et al., J. Res. NIST, 2008. Calculations for a wider range of conditions and additional thermophysical properties of hydrogen are available free of charge online at the “NIST Chemistry WebBook, NIST Standard Reference Database Number 69” (www.webbook.nist.gov/chemistry), or available for purchase from NIST as the computer program NIST Standard Reference Database 23 “NIST Reference Fluid Thermodynamic and Transport Properties Database (REFPROP): Version 10.0” (www.nist.gov/srd/refprop). These calculations are based on the reference Leachman, J.W., Jacobsen, R.T, Lemmon, E.W., and Penoncello, S.G. “Fundamental Equations of State for Parahydrogen, Normal Hydrogen, and Orthohydrogen” published in the Journal of Physical and Chemical Reference Data (www.nist.gov/publications/fundamental-equations-state-parahydrogen-normal-hydrogen-and-orthohydrogen?pub_id=832374).

T. Tolerances

T.1. Tolerances, General.

- (a) The tolerances apply equally to errors of underregistration and errors of overregistration.
- (b) The tolerances apply to all products at all temperatures measured at any flow rate within the rated measuring range of the device.

T.2. Tolerances. – The tolerances for hydrogen gas measuring devices are listed in Table T.2. Accuracy Classes and Tolerances for Hydrogen Gas-Measuring Devices. (Proposed tolerance values are based on previous work with compressed gas products and will be confirmed based on performance data evaluated by the U.S. National Work Group.)

Table T.2. Accuracy Classes and Tolerances for Hydrogen Gas-Measuring Devices			
Accuracy Class	Application or Commodity Being Measured	Acceptance Tolerance	Maintenance Tolerance
7.0	Hydrogen gas as a vehicle fuel	5.0 %	7.0 %

(Amended 2016)

T.3. Repeatability. – When multiple tests are conducted at approximately the same flow rate and draft size, the range of the test results for the flow rate shall not exceed 40 % of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. Also see N.6.2. Repeatability Tests.

(Amended 2019)

T.4. Tolerance Application on Test Using Type 2 Transfer Standard Test Method. – When commercial meters are tested using a Type 2 transfer standard, the tolerance applied to the meter under test shall be calculated using the formula specified in Section 1.10. General Code, G-T.5. Tolerances on Tests When Type 2 Transfer Standards Are Used.

(Amended 2023)

T.5. Tolerance Application in Type Evaluation Examinations for Devices. – For type evaluation examinations, the tolerance values shall apply under the following conditions:

- (a) at any temperature and pressure within the operating range of the device, and
- (b) for all quantities greater than the minimum measured quantity.

UR. User Requirements

UR.1. Selection Requirements.

UR.1.1. Computing-Type Device; Retail Dispenser. – A hydrogen gas dispenser used to refuel vehicles shall be of the computing type and shall indicate the mass, the unit price, and the total price of each delivery.

UR.1.2. Discharge Hose-Length. – The length of the discharge hose on a retail fuel dispenser:

- (a) shall not exceed 4.6 m (15 ft) unless it can be demonstrated that a longer hose is essential to permit deliveries to be made to receiving vehicles or vessels;
- (b) shall be measured from its housing or outlet of the discharge line to the inlet of the discharge nozzle; and
- (c) shall be measured with the hose fully extended if it is coiled or otherwise retained or connected inside a housing.

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

UR.1.3. Minimum Measured Quantity.

- (a) The minimum measured quantity shall be specified by the manufacturer.
- (b) The minimum measured quantity appropriate for a transaction may be specified by the weights and measures authority. A device may have a declared minimum measured quantity smaller than that specified by the weights and measures authority; however, the device must perform within the performance requirements for the declared or specified minimum measured quantity up to deliveries at the maximum measurement range.
- (c) The minimum measured quantity shall satisfy the conditions of use of the measuring system as follows:
 - (1) measuring systems having a maximum flow rate less than or equal to 4 kg/min shall have a minimum measured quantity not exceeding 0.5 kg; and
 - (2) measuring systems having a maximum flow rate greater than 4 kg/min but not greater than 12 kg/min shall have a minimum measured quantity not exceeding 1.0 kg.

UR.2. Installation Requirements.

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

UR.2.2. Discharge Rate. – A device shall be installed so that after initial equalization the actual maximum discharge rate will not exceed the rated maximum discharge rate. Automatic means of flow regulation shall be incorporated in the installation if necessary.

UR.2.3. Low-Flow Cut-Off Valve. – If a measuring system is equipped with a programmable or adjustable "low-flow cut-off" feature:

- (a) the low-flow cut-off value shall not be set at flow rates lower than the minimum operating flow rate specified by the manufacturer on the measuring device; and
- (b) the system shall be equipped with flow control valves which prevent the flow of product and stop the indicator from registering product flow whenever the product flow rate is less than the low-flow cut-off value.

UR.3. Use of Device.

UR.3.1. Unit Price and Product Identity for Retail Dispensers. – The unit price at which the dispenser is set to compute shall be conspicuously displayed or posted on the face of a retail dispenser used in direct sale.

UR.3.2. Vehicle-Mounted Measuring Systems Recording Element.

(Amended 2023)

UR.3.2.1. Recording Element. – Vehicle-mounted measuring systems shall be equipped with a means to record all sales where product is delivered through the device and shall comply with G-S.5.6. Recorded Representations. A copy of the recorded representation issued by the device shall be provided to the customer at the time of delivery or as otherwise specified by the customer.

(Amended 2023)

UR.3.2.2. Ticket in Printing Device. – A ticket shall not be inserted into a device equipped with a ticket printer until immediately before a delivery is begun, and in no case shall a ticket be in the device when the vehicle is in motion while on a public street, highway, or thoroughfare.

UR.3.3. Recorded Representations. – The total price, the total quantity of the delivery, and the price per unit shall be provided on any recorded representation issued by a device of the computing type and containing any one of these values.

(Amended 2023)

UR.3.4. Steps After Dispensing. – After delivery to a customer from a retail dispenser:

- (a) the device shall be shut-off at the end of a delivery, through an automatic interlock that prevents a subsequent delivery until the indicating elements and recording elements, if the device is equipped and activated to record, have been returned to their zero positions; and
- (b) the discharge nozzle shall not be returned to its start position unless the zero set-back interlock is engaged or becomes engaged by the act of disconnecting the nozzle or the act of returning the discharge nozzle.

UR.3.5. Return of Indicating and Recording Elements to Zero. – The primary indicating elements (visual), and the primary recording elements shall be returned to zero immediately before each delivery.

UR.3.6. Return of Product to Storage, Retail Hydrogen Gas Dispensers. – Provisions at the site shall be made for returning product to storage or disposing of the product in a safe and timely manner during or following testing operations. Such provisions may include return lines, or cylinders adequate in size and number to permit this procedure.

UR.3.7. Conversion Factors. – Established correction values. (Also see references in N.7. Density.) shall be used whenever measured hydrogen gas is billed. All sales shall be based on kilograms.

Table of Contents

	Page
Section 3.40. Electric Vehicle Fueling Systems.....	3-153
A. Application	3-153
A.1. General.....	3-153
A.2. Exceptions.....	3-153
A.3. Additional Code Requirements.	3-153
A.3.1. Electric Vehicle Supply Equipment (EVSE) with Integral Time-Measuring Devices.....	3-153
A.4. Type Evaluation.....	3-153
S. Specifications.....	3-153
S.1. Primary Indicating and Recording Elements.	3-153
S.1.1. Electric Vehicle Supply Equipment (EVSE).	3-153
S.1.2. EVSE Indicating Elements.	3-153
S.1.3. EVSE Units.....	3-154
S.2. EVSE Operating Requirements.	3-154
S.2.1. EVSE Return to Zero.....	3-154
S.2.2. EVSE Indicator Zero Reset Mechanism.	3-154
S.2.3. EVSE Provision for Power Loss.....	3-154
S.2.4. EVSE Indication of Unit Price and Equipment Capacity and Type of Voltage.....	3-155
S.2.5. EVSE Money-Value Computations.	3-155
S.2.6. EVSE Recorded Representations.....	3-156
S.2.7. <i>Indication of Delivery</i>	3-156
S.2.8. <i>Automatic Timeout – Pay-At-EVSE</i>	3-156
S.3. Design of Measuring Elements and Measuring Systems.	3-157
S.3.1. Metrological Components.....	3-157
S.3.2. Terminals.	3-157
S.3.3. Provision for Sealing.....	3-157
S.3.4. Data Storage and Retrieval.	3-158
S.3.5. Temperature Range for System Components.	3-158
S.4. Connections.	3-159
S.4.1. Diversion of Measured Electricity.	3-159
S.4.2. Directional Control.	3-159
S.5. Markings.....	3-159
S.5.1. Location of Marking Information; EVSE.	3-159
S.5.2. EVSE Identification and Marking Requirements.....	3-159
S.5.3. Abbreviations and Symbols.	3-159
S.6. Printer.	3-160
S.6.1. Printed Receipt.....	3-160
S.7. Totalizers for EVSE Systems.....	3-160
S.8. Minimum Measured Quantity (MMQ).	3-160
N. Notes.....	3-160
N.1. Minimum Test Draft (Size).....	3-160
N.2. EVSE System Test Loads.	3-160
N.3. Test of an EVSE System.....	3-160
N.3.1. Testing of an AC EVSE.....	3-160
N.3.2. Type Evaluation Testing of a DC EVSE.....	3-161
N.3.3. <i>Performance Verification in the Field of a DC EVSE</i>	3-161

N.4.	Repeatability Tests	3-161
T.	Tolerances.....	3-161
T.1.	Tolerances, General.	3-161
T.2.	Accuracy Test Tolerances.....	3-162
T.2.1.	EVSE Accuracy Test Tolerances AC Systems.	3-162
T.2.2.	<i>EVSE Accuracy Test Tolerances for DC Systems.</i>	3-162
T.3.	Repeatability.	3-162
T.4.	Tolerance Application in Type Evaluation Examinations for EVSEs.	3-162
UR.	User Requirements.....	3-162
UR.1.	Selection Requirements.	3-162
UR.1.1.	Computing-Type Device; Retail EVSE.	3-162
UR.1.2.	Connection Cord-Length.	3-162
UR.2.	Installation Requirements.	3-163
UR.2.1.	Maximum Deliverable Current.	3-163
UR.2.2.	Manufacturer's Instructions.	3-163
UR.2.3.	Load Range.	3-163
UR.2.4.	Regulation Conflicts and Permit Compliance.	3-163
UR.2.5.	Responsibility, Unattended EVSE.	3-163
UR.3.	Use of EVSE.....	3-163
UR.3.1.	Unit Price for Retail EVSE Devices.	3-163
UR.3.2.	Return of Indicating and Recording Elements to Zero.	3-163
UR.3.3.	EVSE Recorded Representations.....	3-163
UR.3.4.	EVSE in Operation.	3-164
UR.3.5.	Steps After Charging.....	3-164

Section 3.40. Electric Vehicle Fueling Systems

Section 3.40. Electric Vehicle-Fueling Systems was added as a “tentative code” in 2015. In July 2022, the status of the code was changed from “tentative” to “permanent” effective January 1, 2023.

(Amended 2022)

A. Application

A.1. General. – This code applies to devices, accessories, and systems used for the measurement of electricity dispensed in vehicle fuel applications wherein a quantity determination or statement of measure is used wholly or partially as a basis for sale or upon which a charge for service is based.

A.2. Exceptions. – This code does not apply to:

- (a) The use of any measure or measuring device owned, maintained, and used by a public utility or municipality only in connection with measuring electricity subject to the authority having jurisdiction such as the Public Utilities Commission.
- (b) Electric Vehicle Supply Equipment (EVSEs) used solely for dispensing electrical energy in connection with operations in which the amount dispensed does not affect customer charges or compensation.
- (c) The wholesale delivery of electricity.

A.3. Additional Code Requirements. – In addition to the requirements of this code, Electric Fueling Systems shall meet the requirements of Section 1.10. General Code.

A.3.1. Electric Vehicle Supply Equipment (EVSE) with Integral Time-Measuring Devices. – An EVSE that is used for both the sale of electricity as vehicle fuel and used to measure time during which services (e.g., vehicle parking) are received. These devices shall also meet the requirements of Section 5.55. Timing Devices.

A.4. Type Evaluation. – The National Type Evaluation Program (NTEP) will accept for type evaluation only those EVSEs that comply with all requirements of this code and have received safety certification by a nationally recognized testing laboratory (NRTL).

S. Specifications

S.1. Primary Indicating and Recording Elements.

S.1.1. Electric Vehicle Supply Equipment (EVSE). – An EVSE used to charge electric vehicles shall be of the computing type and shall indicate the electrical energy, the unit price, and the total price of each transaction.

- (a) EVSEs capable of applying multiple unit prices over the course of a single transaction shall also be capable of indicating the start and stop time, the total quantity of energy delivered, the unit price, and the total price for the quantity of energy delivered during each discrete phase corresponding to one of the multiple unit prices.
- (b) EVSEs capable of applying additional fees for time-based and other services shall also be capable of indicating the total time measured; the unit price(s) for the additional time-based service(s); the total computed price(s) for the time measured; and the total transaction price, including the total price for the energy and all additional fees.

S.1.2. EVSE Indicating Elements. – An EVSE used to charge electric vehicles shall include an indicating element that accumulates continuously and displays, for a minimum of 15 seconds at the activation by the user

and at the start and end of the transaction, the correct measurement results relative to quantity and total price. Indications shall be clear, definite, accurate, and easily read under normal conditions of operation of the device. All indications and representations of electricity sold shall be clearly identified and separate from other time-based fees indicated by an EVSE that is used for both the sale of electricity as vehicle fuel and the sale of other separate time-based services (e.g., vehicle parking).

S.1.2.1. Multiple EVSEs Associated with a Single Indicating Element. – A system with a single indicating element for two or more EVSEs shall be provided with means to display information from the individual EVSE(s) selected or displayed, and shall be provided with an automatic means to indicate clearly and definitely which EVSE is associated with the displayed information.

S.1.3. EVSE Units.

S.1.3.1. EVSE Units of Measurement. – EVSE units used to charge electric vehicles shall be indicated and recorded in kilowatt-hours (kWh) and decimal subdivisions thereof.

(Amended 2022)

S.1.3.2. EVSE Value of Smallest Unit. – The value of the smallest unit of indicated delivery by an EVSE, and recorded delivery if the EVSE is equipped to record:

- (a) for AC systems shall not exceed 0.000 1 kWh;
- (b) for DC systems shall not exceed 0.001 kWh; and
- (c) the value of the kWh shall be expressed only as a decimal submultiple of 1 that satisfy (a) and (b).

(Amended 2022)

S.1.3.3. Values Defined. – Indicated values shall be adequately defined by a sufficient number of figures, words, symbols, or combinations thereof. An indication of “zero” shall be a zero digit for all displayed digits to the right of the decimal mark and at least one to the left.

S.2. EVSE Operating Requirements.

S.2.1. EVSE Return to Zero.

- (a) The primary indicating and the primary recording elements of an EVSE used to charge electric vehicles, if the EVSE is equipped to record, shall be provided with a means for readily returning the indication to zero either automatically or manually.
- (b) It shall not be possible to return primary indicating elements, or primary recording elements, beyond the correct zero position.

S.2.2. EVSE Indicator Zero Reset Mechanism. – The reset mechanism for the indicating element of an EVSE used to charge electric vehicles shall not be operable during a transaction. Once the zeroing operation has begun, it shall not be possible to indicate a value other than: the latest measurement; “all zeros;” blank the indication; or provide other indications that cannot be interpreted as a measurement during the zeroing operation.

S.2.3. EVSE Provision for Power Loss.

S.2.3.1. Transaction Information. – In the event of a power loss, the information needed to complete any transaction (i.e., delivery is complete and payment is settled) in progress at the time of the power loss (such as the quantity and unit price, or sales price) shall be determinable through one of the means listed below or the transaction shall be terminated without any charge for the electrical energy transfer to the vehicle:

- (a) at the EVSE;

- (b) at the console, if the console is accessible to the customer;
- (c) via on site internet access; or
- (d) through toll-free phone access.

For EVSEs in parking areas where vehicles are commonly left for extended periods, the information needed to complete any transaction in progress at the time of the power loss shall be determinable through one of the above means for at least eight hours.

S.2.3.2. Transaction Termination. – In the event of a power loss, either:

- (a) the transaction shall terminate at the time of the power loss; or
- (b) the EVSE may continue charging without additional authorization if the EVSE is able to determine it is connected to the same vehicle before and after the supply power outage.

In either case, there must be a clear indication on the receipt provided to the customer of the interruption, including the date and time of the interruption along with other information required under S.2.6. EVSE Recorded Representations.

S.2.3.3. User Information. – The EVSE memory, or equipment on the network supporting the EVSE, shall retain information on the quantity of fuel dispensed and the sales price totals during power loss.

S.2.4. EVSE Indication of Unit Price and Equipment Capacity and Type of Voltage.

S.2.4.1. Unit Price. – An EVSE shall be able to indicate on each face the unit price at which the EVSE is set to compute or to dispense at any point in time during a transaction.

S.2.4.2. Equipment Capacity and Type of Voltage. – An EVSE shall be able to conspicuously indicate on each face the maximum rate of energy transfer (i.e., maximum power) and the type of current associated with each unit price offered (e.g., 7 kW AC, 25 kW DC, etc.).

S.2.4.3. Selection of Unit Price. – When electrical energy is offered for sale at more than one unit price through an EVSE, the selection of the unit price shall be made prior to delivery through a deliberate action of the purchaser to select the unit price for the fuel delivery. Except when the conditions for variable price structure have been approved by the customer prior to the sale, a system shall not permit a change to the unit price during delivery of electrical energy.

Note: When electrical energy is offered at more than one unit price, selection of the unit price may be through the deliberate action of the purchaser: 1) using controls on the EVSE; 2) through the purchaser's use of personal or vehicle-mounted electronic equipment communicating with the system; or 3) verbal instructions by the customer.

S.2.4.4. Agreement Between Indications. – All quantity, unit price, and total price indications within a measuring system shall agree for each transaction.

S.2.5. EVSE Money-Value Computations. – An EVSE shall compute the total sales price at any single-purchase unit price for which the electrical energy being measured is offered for sale at any delivery possible within either the measurement range of the EVSE or the range of the computing elements, whichever is less.

S.2.5.1. Money-Value Divisions Digital. – An EVSE with digital indications shall comply with the requirements of paragraph G-S.5.5. Money-Values, Mathematical Agreement, and the total price computation at the end of the transaction shall be based on quantities not exceeding 0.01 kWh.

(Amended 2023)

S.2.5.2. Auxiliary Elements. – If a system is equipped with auxiliary indications, all indicated money value and quantity divisions of the auxiliary element shall be identical to those of the primary element.

S.2.6. EVSE Recorded Representations. – A receipt, either printed or electronic, providing the following information shall be available at the completion of all transactions:

- (a) the total quantity of the energy delivered with unit of measure;
- (b) the total computed price of the energy sale;
- (c) the unit price of the energy, and for systems capable of applying multiple unit prices for energy during a single transaction, the following additional information is required:
 - (1) the start and stop time of each phase during which one of the multiple unit prices was applied;
 - (2) the unit price applied during each phase;
 - (3) the total quantity of energy delivered during each phase;
 - (4) the total purchase price for the quantity of energy delivered during each phase;
- (d) the maximum rate of energy transfer (i.e., maximum power) and type of current (e.g., 7 kW AC, 25 kW DC, etc.);
- (e) any additional separate charges included in the transaction (e.g., charges for parking time) including:
 - (1) the time and date when the service begins and the time and date when the service ends; or the total time interval purchased, and the time and date that the service either begins or ends;
 - (2) the unit price applied for the time-based service;
 - (3) the total purchase price for the quantity of time measured during the complete transaction;
- (f) the final total price of the complete transaction including all items;
- (g) the unique EVSE identification number;
- (h) the business name; and
- (i) the business location.

S.2.7. Indication of Delivery. – The EVSE shall automatically show on its face the initial zero condition and the quantity delivered (up to the capacity of the indicating elements).

All DC EVSE placed into service prior to January 1, 2025 are exempt from this requirement until January 1, 2028.

(Amended 2022 and 2024)

S.2.8. Automatic Timeout – Pay-At-EVSE. – *Once an EVSE has been authorized, it must deauthorize within two minutes if not activated. Reauthorization of the EVSE must be performed before any electrical energy is delivered and/or timing charges assessed. If the time limit to deauthorize the EVSE is programmable, it shall not accept an entry greater than two minutes.*

[Nonretroactive as of January 1, 2020]

(Added 2019)

S.3. Design of Measuring Elements and Measuring Systems.

S.3.1. Metrological Components. – An EVSE measuring system shall be designed and constructed so that metrological components are adequately protected from environmental conditions likely to be detrimental to accuracy. The system shall be designed to prevent undetected access to adjustment mechanisms and terminal blocks by providing for application of a physical security seal or an audit trail.

S.3.2. Terminals. – The terminals of the EVSE system shall be arranged so that the possibility of short circuits while removing or replacing the cover, making connections, or adjusting the system, is minimized.

S.3.3. Provision for Sealing. – For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices. For parameters adjusted using other means, the following applies.

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

- (a) each individual measurement element;
- (b) any adjustable element for controlling voltage or current when such control tends to affect the accuracy of deliveries;
- (c) any adjustment mechanism that corrects or compensates for energy loss between the system and vehicle connection; and
- (d) any metrological parameter that detrimentally affects the metrological integrity of the EVSE or system.

When applicable, the adjusting mechanism shall be readily accessible for purposes of affixing a security seal. Audit trails shall use the format set forth in Table S.3.3. Categories of Device and Methods of Sealing.

(Amended 2019)

Table S.3.3. Categories of Device and Methods of Sealing	
Categories of Device	Method of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.	The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring EVSE or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual EVSEs at a location. If the counters are located in the system controller rather than at the individual EVSE, means must be provided to generate a copy of the information through an on-site device; this information may be provided electronically in lieu of or in addition to a hard copy at the time of inspection.
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.	An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. The event logger information may be provided electronically in lieu of or in addition to a hard copy at the time of inspection, provided the event logger information is retained in the system for future reference. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the EVSE, but not more than 1 000 records are required. (Note: Does not require 1 000 changes to be stored for each parameter.)

(Amended 2021)

S.3.4. Data Storage and Retrieval.

- (a) EVSE data accumulated and indicated shall be unalterable and accessible.
- (b) Values indicated or stored in memory shall not be affected by electrical, mechanical, or temperature variations, radio-frequency interference, power failure, or any other environmental influences to the extent that accuracy is impaired.
- (c) Memory and/or display shall be recallable for a minimum of three years. A replaceable battery shall not be used for this purpose.

S.3.5. Temperature Range for System Components. – EVSEs shall be accurate and correct over the temperature range of – 40 °C to + 85 °C (– 40 °F to + 185 °F). If the system or any measuring system components are not capable of meeting these requirements, the temperature range over which the system is capable shall be stated on the NTEP CC, marked on the EVSE, and installations shall be limited to the narrower temperature limits.

S.4. Connections.

S.4.1. Diversion of Measured Electricity. – No means shall be provided by which any measured electricity can be diverted from the measuring device.

S.4.1.1. Unauthorized Disconnection. – Means shall be provided to automatically terminate the transaction in the event that there is an unauthorized break in the connection with the vehicle.

S.4.2. Directional Control. – If a reversal of energy flow could result in errors that exceed the tolerance for the minimum measured quantity, effective means, automatic in operation to prevent or account for the reversal of flow shall be properly installed in the system. (See N.1. Minimum Test Draft [Size])

S.5. Markings. – The following identification and marking requirements are in addition to the requirements of Section 1.10. General Code, paragraph G-S.1. Identification.

S.5.1. Location of Marking Information; EVSE. – The marking information required in General Code, paragraph G-S.1. Identification shall appear as follows:

- (a) within 60 cm (24 in) to 150 cm (60 in) from ground level; and
- (b) on a portion of the EVSE that cannot be readily removed or interchanged (e.g., not on a service access panel).

S.5.2. EVSE Identification and Marking Requirements. – In addition to all the marking requirements of Section 1.10. General Code, paragraph G-S.1. Identification, each EVSE shall have the following information conspicuously, legibly, and permanently marked:

- (a) voltage rating;
- (b) maximum current deliverable;
(Amended 2023 and 2024)
- (c) type of current (AC or DC or, if capable of both, both shall be listed);
- (d) minimum measured quantity (MMQ); and
- (e) temperature limits, if narrower than and within – 40 °C to + 85 °C (– 40 °F to + 185 °F).
(Amended 2021)

S.5.2.1. Marking of Accuracy Class, DC EVSEs Placed in Service Prior to 2025. – A DC EVSE that was placed into service prior to 2025 and is subject to the tolerances of T.2.2.(a) is a Class 5 EVSE, and shall be marked with Class 5. The marking shall be conspicuously and legibly displayed in a position plainly visible to a person accessing a charging port of the EVSE. The indicating element may be used for the marking, provided the marking is visible to the customer prior to the beginning of the transaction.

(Added 2024)

(Amended 2024)

S.5.3. Abbreviations and Symbols. – The following abbreviations or symbols may appear on an EVSE system.

- (a) VAC = volts alternating current;
- (b) VDC = volts direct current;
- (c) MDA = maximum deliverable amperes;

(d) kWh = kilowatt hour; and
(Amended 2023)

(e) MCD = maximum current deliverable.
(Added 2024)

S.6. Printer. – When a system is equipped with means for printing the measured quantity, the printed information must agree with the indications on the EVSE for the transaction and the printed values shall be clearly defined.

S.6.1. Printed Receipt. – Any delivered, printed quantity shall include an EVSE identification number that uniquely identifies the EVSE from all other EVSEs within the seller’s facility, the time and date, and the name of the seller. This information may be printed by the EVSE system or pre-printed on the ticket.

S.7. Totalizers for EVSE Systems. – EVSE systems shall be designed with a nonresettable totalizer for the quantity delivered through each separate measuring device. Totalizer information shall be adequately protected and unalterable. Totalizer information shall be provided by the system and readily available on site or via on site internet access.

S.8. Minimum Measured Quantity (MMQ). – The minimum measured quantity shall satisfy the conditions of use of the measuring system as follows:

(a) Measuring systems shall have a minimum measured quantity not exceeding:

(1) 0.5 kWh for AC EVSE; and

(2) 1.0 kWh for DC EVSE.

Note: To minimize the duration of required testing, manufacturers may want to consider limiting the declared MMQ to the level of 0.1 kWh for AC EVSE.

(Note Added 2023)

(Amended 2023)

N. Notes

N.1. Minimum Test Draft (Size). – Full and light load tests shall require test of the EVSE System for a delivery of the minimum measured quantity as declared by the manufacturer.

N.2. EVSE System Test Loads. – EVSE measuring system testing shall be accomplished by connecting the test load and test standard at the point where the fixed cord is connected to the vehicle. Losses in the cord between the EVSE under test and the test standard should be automatically corrected for in the EVSE quantity indication for direct comparison to the test standard and also while the EVSE is in normal operation. For EVSEs that require a customer-supplied cord, system testing shall be accomplished by connecting the test load and test standard at the point where the customer’s cord is connected to the EVSE.

N.3. Test of an EVSE System. – The testing methodology compares the total energy delivered in a transaction and the total cost charged as displayed/reported by the EVSE with that measured by the measurement standard. Each test shall be performed for at least the minimum measured quantity (MMQ).

N.3.1. Testing of an AC EVSE. – Accuracy tests shall be performed at the following current levels:

(a) A point between 4 A and 10 A;

(b) A point between 40 % and 60 % of the MDA; and

- (c) A point between 70 % and 100 % of the MDA.

(Amended 2024)

N.3.2. Type Evaluation Testing of a DC EVSE. – Tests shall be performed at the following voltage points one between 350 VDC and 450 VDC and if supported by the EVSE a second at between 700 VDC and 900 VDC:

Accuracy tests shall be performed at the following current levels:

- (a) A point between 10 % and 20 % of the MDA, but not less than 30 A;
- (b) A point between 40 % and 60 % of the MDA; and
- (c) A point between 70 % and 100 % of the MDA.

(Amended 2024)

N.3.3. Performance Verification in the Field of a DC EVSE. – Accuracy tests shall be performed at any voltage and the following current levels:

- (a) A point between 10 % and 20 % of the MDA, but not less than 30 A; and
- (b) A point between 25 % and 100 % of the MDA, with the recommendation to test at the maximum power level within that range that is possible using the test load and test standard available.

Note: The test points (a) and (b) above must not be at the same current level. It is recommended that the current levels should be separated to the extent that the test load and test standard will allow.

For DC systems it is anticipated that an electric vehicle may be used as the test load. Under that circumstance, testing at the load presented by the vehicle shall be sufficient for field verification provided that it is greater than 40 % of the MDA and no less than 30 A.

All DC EVSE placed into service prior to January 1, 2025 are exempt from this requirement until January 1, 2028.

(Amended 2022 and 2024)

N.4. Repeatability Tests. – Tests for repeatability shall include a minimum of three consecutive tests at the same load, similar time period, etc., and be conducted under conditions where variations in factors are reduced to minimize the effect on the results obtained.

T. Tolerances

T.1. Tolerances, General.

- (a) The tolerances apply equally to errors of underregistration and errors of overregistration.
- (b) The tolerances apply to all deliveries measured at any load within the rated measuring range of the EVSE.
- (c) Where instrument transformers or other components are used, the provisions of this section shall apply to all system components.

T.2. Accuracy Test Tolerances.

T.2.1. EVSE Accuracy Test Tolerances for AC Systems. – The tolerances for EVSE load tests for AC Systems are:

(a) Acceptance Tolerance: 1.0 %; and

(b) Maintenance Tolerance: 2.0 %.

(Amended 2022 and 2024)

T.2.2. EVSE Accuracy Test Tolerances for DC Systems. – The tolerances for EVSE load tests for DC systems shall be as follows:

(a) For a DC system that was placed in service prior to January 1, 2025, and that is marked Class 5, acceptance and maintenance tolerances are: 5.0 %. This paragraph T.2.2.(a) shall expire on January 1, 2034; after that date, all DC EVSEs shall be subject to the tolerances of paragraph T.2.2.(b).

(b) For any DC system not subject to paragraph T.2.2.(a), tolerances are:

(1) Acceptance Tolerance: 1.0 %; and

(2) Maintenance Tolerance: 2.0 %.

(Added 2024)

All DC EVSE placed into service prior to January 1, 2025 are exempt from this requirement until January 1, 2028.

T.3. Repeatability. – When multiple load tests are conducted at the same load condition, the range of the load test results shall not exceed 25 % of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance.

T.4. Tolerance Application in Type Evaluation Examinations for EVSEs. – For type evaluation examinations, the acceptance tolerance values shall apply under the following conditions:

(a) at any temperature, voltage, load, and power factor within the operating range of the EVSE;

(b) regardless of the influence factors in effect at the time of the conduct of the examination; and

(c) for all quantities greater than the minimum measured quantity.

UR. User Requirements**UR.1. Selection Requirements.**

UR.1.1. Computing-Type Device, Retail EVSE. – An EVSE used to charge electric vehicles shall be of the computing type and shall indicate the electrical energy, the unit price, and the total price of each delivery.

UR.1.2. Connection Cord-Length. – An adequate means for cord management shall be in use when the cord exceeds 25 ft in length.

UR.2. Installation Requirements.

UR.2.1. Maximum Deliverable Current. – The marked maximum deliverable current shall not exceed the total capacity in amperes of the EVSE or the thermal overload protectors of the installation site.

UR.2.2. Manufacturer's Instructions. – An EVSE shall be installed in accordance with the manufacturer's instructions, and the installation shall be sufficiently secure and rigid to maintain this condition.

UR.2.3. Load Range. – An EVSE shall be installed so that the current and voltage will not exceed the rated maximum values over which the EVSE is designed to operate continuously within the specified accuracy. Means to limit current and/or voltage shall be incorporated in the installation if necessary.

UR.2.4. Regulation Conflicts and Permit Compliance. – If any provision of Section UR.2. Installation Requirements is less stringent than that required of a similar installation by the serving utility, the installation shall be in accordance with those requirements of the serving utility.

The installer of any EVSE shall obtain all necessary permits.

UR.2.5. Responsibility, Unattended EVSE. – An unattended EVSE shall have clearly and conspicuously displayed thereon, or immediately adjacent thereto, adequate information detailing the name, address, and phone number of the local responsible party for the device.

UR.3. Use of EVSE.

UR.3.1. Unit Price for Retail EVSE Devices. – The unit price at which the EVSE is set to compute shall be conspicuously displayed or posted on the face of the retail EVSE used in direct sale.

UR.3.2. Return of Indicating and Recording Elements to Zero. – The primary indicating elements (visual) and the primary recording elements shall be returned to zero immediately before each transaction.

UR.3.3. EVSE Recorded Representations. – A receipt, either printed or electronic, providing the following information shall be available at the completion of all transactions:

- (a) the total quantity of the energy delivered with unit of measure;
- (b) the total computed price of the energy sale;
- (c) the unit price of the energy; and for systems capable of applying multiple unit prices for energy during a single transaction, the following additional information is required:
 - (1) the start and stop time of each phase during which one of the multiple unit prices was applied;
 - (2) the unit price applied during each phase;
 - (3) the total quantity of energy delivered during each phase;
 - (4) the total purchase price for the quantity of energy delivered during each phase;
- (d) the maximum rate of energy transfer (i.e., maximum power) and type of current (e.g., 7 kW AC, 25 kW DC, etc.);
- (e) any additional separate charges included in the transaction (e.g., charges for parking time) including:
 - (1) the time and date when the service begins and the time and date when the service ends; or the total time interval purchased, and the time and date that the service either begins or ends;

- (2) the unit price applied for the time-based service;
- (3) the total purchase price for the quantity of time measured during the complete transaction;
- (f) the final total price of the complete transaction including all items;
- (g) the unique EVSE identification number;
- (h) the business name; and
- (i) the business location.

UR.3.4. EVSE in Operation. – The EVSE shall be permanently, plainly, and visibly identified so that it is clear which EVSE and connector is in operation.

UR.3.5. Steps After Charging. – After delivery to a customer from a retail EVSE:

- (a) the EVSE shall be shut-off at the end of a charge, through an automatic interlock that prevents subsequent charging until the indicating elements and recording elements, if the EVSE is equipped and activated to record, have been returned to their zero positions; and
- (b) the vehicle connector shall not be returned to its starting position unless the zero set-back interlock is engaged or becomes engaged by the act of disconnecting from the vehicle or the act of returning the connector to the starting position.

Table of Contents

	Page
Section 3.41. Non-Utility Electricity-Measuring Systems – Tentative Code.....	169
A. Application.....	169
A.1. General.....	169
A.2. Exceptions.....	169
A.3. Additional Code Requirements.....	169
A.4. Type Evaluation.....	169
A.5. NUEMS Type Notation.	169
S. Specifications.....	170
S.1. Indicating and Recording Elements.....	170
S.1.1. Units.	170
S.1.2. Nominal Capacity.....	170
S.1.3. NUEMS Indications.	170
S.2. Design of Measuring Elements and Measuring Systems.	170
S.2.1. Metrological Components.....	170
S.2.2. Provision for Sealing.	170
S.2.3. NUEMS Watthour Registration Retention.....	171
S.3. Markings.....	171
S.3.1. Location of Marking Information.....	172
S.3.2. Device Identification and Marking Requirements.....	172
S.3.3. Device Identification and Marking Requirements – External Sensors.....	175
S.3.4. Electronic Marking Display Security Protocol.....	178
S.3.5. Abbreviations and Symbols.	178
S.3.6. Abbreviations and Symbols.	178
N. Notes.....	179
N.1. NUEMS No-Load Test.	179
N.2. NUEMS Starting Load Test.	179
N.3. NUEMS Minimum Test Duration.	179
N.4. NUEMS Test Loads.....	179
N.5. Test of a NUEMS.	179
N.6. Repeatability Tests.....	179
T. Tolerances.....	179
T.1. Tolerances, General.....	179
T.2. No-Load Test.....	180
T.3. NUEMS Starting Load Test.....	180
T.4. Load Test Tolerances.	180
T.5. Repeatability.....	180
UR. User Requirements.....	180
UR.1. Selection Requirements.	180
UR.1.1. Customer Indicating Element, Accessibility.....	180
UR.1.2. NUEMS Required.	180
UR.1.3. Suitability of Equipment.....	180
UR.1.4. Sensors.	181
UR.2. Installation Requirements.	181
UR.2.1. Manufacturer’s Instructions.	181

UR.2.2. Load Range.....	181
UR.2.3. Regulation Conflicts and Permit Compliance.....	181
UR.2.4. NUEMS Installation Requirements.....	181
UR.3. Use of Device.....	182
UR.3.1. Recorded Representations.....	182
UR.4. Submitting a NUEMS for Testing.....	182
Appendix D. Definitions	183
active energy.....	183
alternating current (AC).	183
ampere.....	183
audit trail.	183
balanced load.....	183
basic lightning impulse insulation level (BIL).....	183
bidirectional.....	183
burden (B).	183
calibration parameter.....	184
configuration parameter.	184
current.	184
current class (CL).....	184
current sensor.....	184
electronic marking display.....	184
element.....	184
energy flow.....	184
equipment, commercial.	184
ES NUEMS body.....	184
external sensor.	184
event counter.	185
event logger.	185
form designation (FM).	185
hertz (Hz).....	185
internal sensor.....	185
kilowatt (kW).....	185
kilowatt-hour (kWh).....	185
line service.....	185
load service.....	185
load, full.	185
load, light.....	186
master meter, electric.	186
meter, self-contained.	186
metrological components.....	186
nominal current.....	186
nominal voltage.	186
non-integral.	186
non-utility electricity measuring system (NUEMS).	186

ohm.	186
percent error.....	186
power factor (PF).	186
primary indicating or recording elements.	187
reactive power.....	187
register ratio (R_r).	187
remote configuration capability.	187
retail device.	187
sensor ratio.	187
serving utility.....	187
starting load.	187
submeter.	187
tenant.....	187
test amperes (TA).....	187
thermal overload protector.....	188
unit price.....	188
utility.	188
volt.	188
watt.	188
watthour (Wh).....	188
watthour constant (K_h).	188
watthour test constant (K_t).	188

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Section 3.41. Non-Utility Electricity-Measuring Systems – Tentative Code

This tentative code has only a trial or experimental status and is not intended to be enforced. The requirements are designed for study prior to the development and adoption of a final code. Officials wanting to conduct an official examination of a Non-Utility Electricity-Measuring System (NUEMS) are advised to see paragraph G A.3. Special and Unclassified Equipment.

(Tentative Code Added 2024)

NUEMS Acronym and Definition: As used throughout this code, a Non-Utility Electricity-Measuring System or “NUEMS” is defined as an electricity measuring system comprised of all the metrologically relevant components required to measure electrical energy, store the result, and report the result used in non-utility sales of electricity wherein the sale is based in whole or in part on one or more measured quantities.

Safety Note: This code does not specifically discuss Safety. It is essential that all personnel working with the devices covered by this code and associated electrical equipment be properly trained and adhere to all applicable safety standards, regulations, and codes. See also General Code Paragraph G-N.1. Conflict of Laws and Regulations.

A. Application

A.1. General. – This code applies to measuring systems used in non-utility sales of electric energy wherein the sale is based in whole or in part on one or more measured quantities.

A.2. Exceptions. – This code does not apply to:

- (a) The use of any measuring system owned, maintained, and/or used by a utility.
- (b) Measuring systems used solely for delivering electric energy in connection with operations in which the amount delivered does not affect customer charges or compensation.
- (c) Electric vehicle fueling systems. (See 3.40. Electric Vehicle Fueling Systems Code).
- (d) Transactions not subject to weights and measures authority.

A.3. Additional Code Requirements. – In addition to the requirements of this code, Non-Utility Electricity-Measuring Systems shall meet the requirements of Section 1.10. General Code.

A.4. Type Evaluation. – The National Type Evaluation Program (NTEP) will accept for type evaluation only those measuring systems that have received safety certification by a nationally recognized testing laboratory (also referred to as “NRTL”) and shall issue an NTEP Certificate of Conformance only to those measuring systems that comply with all requirements of this code.

A.5. NUEMS Type Notation. – Code sections and subsections with an [ES] notation apply to External Sensor NUEMS only. Code sections and subsections with a [IS] notation apply to Internal Sensor NUEMS only. Code sections and subsections without [ES] or [IS] notation apply to both NUEMS types.

S. Specifications

S.1. Indicating and Recording Elements.

S.1.1. Units. – Units for any indicated or recorded measurements of active energy shall be in terms of the kilowatt-hours (kWh).

S.1.1.1. Numerical Value of Quantity-Value Divisions. – The value of an increment shall be equal to a decimal multiple or submultiple of 1.

Examples: quantity-value divisions may be 10; or 0.01; or 0.1; etc.

S.1.1.2. Digital Indications. – An indication shall include the display of a number for all places that are displayed to the right of the decimal point and at least one place to the left. Otherwise, leading zeros are not required.

S.1.2. Nominal Capacity. – *A device shall have a minimum capacity indication of five digits of resolution.*
[Nonretroactive as of January 1, 2025]

S.1.3. NUEMS Indications.

S.1.3.1. Primary Indicating Element. – Each NUEMS shall be equipped with a primary indicating element that includes a display visible and accessible after installation which at a minimum clearly indicates the number of kilowatt-hours measured by the NUEMS.

S.1.3.2. Test Output. – A NUEMS shall have either: (1) a rotating disk indicator; (2) a pulse output (visible or infrared), or (3) an electrical pulse (in the form of a closure relay or an electronic means), which provides a pulse with Kt or Kh Watt-Hours per pulse. The value of Kt or Kh shall be such that the NUEMS's accuracy can be tested in 5 minutes or less for any specific test.

S.1.3.3. Segments. – A segmented digital indicating element shall have an easily accessible provision for checking that all segments are operational.

S.1.3.4. Real-time Indicating Element. – If the indicating element is not on continuously, it shall be accumulated continuously so that real-time measurement is indicated during activation.

S.1.3.5. Multiple Loads, Single Indicating Element. – A primary indicating, or combination indicating-recording element coupled to two or more loads shall be provided with a means to easily, clearly, and definitely display information from a selected load and shall automatically indicate which load is associated with the currently displayed information.

S.1.3.6. NUEMS With a Register Ratio. – For NUEMS with a register ratio, the register ratio shall be indicated on the front of the registers that are not an integral part of the NUEMS nameplate. Means shall be provided for the tenant to read the register.

S.2. Design of Measuring Elements and Measuring Systems.

S.2.1. Metrological Components. – A NUEMS shall be designed and constructed so that metrological components are adequately protected from environmental conditions likely to be detrimental to accuracy based on the specified installation locations for the NUEMS:

S.2.2. Provision for Sealing. – Adequate provision shall be made for an approved means of security (e.g., data change audit trail) or physically applying security seals in such a manner that undetected access to metrologically

significant mechanisms and parameters is prevented. Specifically, after sealing no adjustment or change may be made to:

- (a) any measuring element;
- (b) any metrological parameter that affects the metrological integrity of the device or system; and
- (c) any wiring connection which affects the measurement.

When applicable, any adjusting mechanism shall be readily accessible for purposes of affixing a security seal. Audit trails shall use the format set forth in Table S.2.2. Categories of Device and Methods of Sealing.

Table S.2.2. Categories of Device and Methods of Sealing	
Categories of Device	Method of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware.	The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode. The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information.
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). The device shall clearly indicate that it is in the remote configuration mode and record such message or shall not accumulate kWh while in this mode.	An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1 000 records are required. (Note: Does not require 1 000 changes to be stored for each parameter.)

S.2.3. NUEMS Watthour Registration Retention. – The NUEMS shall retain the total accumulated watthour registration and shall not be affected by electrical, mechanical or temperature variations, radio-frequency interference, power failure, or any other environmental influences to the extent that accuracy is impaired. This also applies to other billable quantities.

S.3. Markings. – The following identification and marking requirements are in addition to the requirements of Section 1.10 General Code, paragraph G-S.1. Identification.

S.3.1. Location of Marking Information. – The marking information may be placed either internally or externally (as specified in paragraphs S.3.2. Device Identification and Marking Requirements and S.3.3. Device Identification and Marking Requirements – External Sensors and in the associated tables) provided.

- (a) the information is permanent and easily read; and accessible for inspection;
- (b) the information is on a portion of the device that cannot be readily removed or interchanged (e.g., not on a service access panel). A readily removable cover is an acceptable location for the required information provided: (1) the information is permanently marked elsewhere on the device or is readily accessible through other means such as through an electronic marking display; or (2) a unique marking on the removable cover can be matched with what is programmed into or permanently marked on the ES NUEMS body, thus linking that marking (and any other markings) included on the cover with that specific device; and
- (c) accessing the information does not require accessing an area with live exposed voltages greater than 40 V.

The use of a key or tool to access internal marking information is permitted for retail electricity-measuring devices. Where possible, clear covers should be used to enable viewing of internally marked information.

S.3.2. Device Identification and Marking Requirements. – In addition to all the marking requirements of Section 1.10 General Code, paragraph G-S.1. Identification, each device shall have the following information conspicuously, legibly, and indelibly marked on the nameplate or register.

S.3.2.1. Device Identification and Marking Requirements, Internal Sensor (IS) NUEMS. – Device Identification and Marking Requirements, Internal Sensor (IS) NUEMS. – The following markings shall be physically marked on an Internal Sensor (IS) NUEMS.

- (a) AC voltage range or rating in VAC;
- (b) Watthour constant (K_h) or Watthour test constant (K_t);
- (c) Register ratio (R_r) for NUEMS with a rotating disc and multiplier (if greater than one) preceded by “multiply by” or “mult by”;
- (d) Number of wires (W);
- (e) Form designation (FM) (for A-base and socket NUEMS only); and
- (f) Current Class (CL).

S.3.2.2. Device Identification and Marking Requirements of External Sensor (ES) NUEMS. – In addition to the identification requirements specified in Section 1.10 General Code, paragraph G-S.1. Identification, External Sensor (ES) NUEMS shall have the following legibly, and indelibly marked on the ES NUEMS body as shown in:

- Tables S.3.2.2.a. Device Identification and Marking Requirements for External Sensor (ES) NUEMS; and
- Table S.3.2.2.b. Descriptors for Table S.3.2.2.a. Device Identification and Marking Requirements - External Sensor (ES) NUEMS.

Table S.3.2.2.a. Device Identification and Marking Requirements for External Sensor (ES) NUEMS		
	Physical Marking	Electronic Marking Display*, **
Manufacturer or Distributor name, initials, or trademark (1)	R	D
Model Prefix (2)	O	D
Model (3)	R	D
Serial Number Prefix (4)	O	D
Serial Number (5)	R	D
NTEP CC Number with Prefix (6)	R	D
<i>NUEMS Voltage Input Rating (7)</i> <i>[Nonretroactive as of January 1, 2024]</i>	O	D
<i>Voltage Sensor Rating (8)</i> <i>[Nonretroactive as of January 1, 2024]</i>	O	D
<i>Voltage Sensor Ratio (9)</i> <i>[Nonretroactive as of January 1, 2024]</i>	O	D
<i>NUEMS Current Input Rating (10)</i> <i>[Nonretroactive as of January 1, 2024]</i>	O	D
<i>Sensor Primary Current Rating (11)</i> <i>[Nonretroactive as of January 1, 2024]</i>	O	D
<i>Sensor True Ratio (12)</i> <i>[Nonretroactive as of January 1, 2024]</i>	O	D
K _h or K _t (13)	O	D
Sensor Input Polarity (14)	R	--
Bi-directional (15)	O	D
Temperature Range if narrower than –20 °C to + 50 °C (– 4 °F to + 122 °F) (16)	O	D
<p>R Required to be marked on the NUEMS</p> <p>O Required to be marked on the NUEMS only if information is not available on a display</p> <p>D Alternate when information is not marked physically on the NUEMS. If device identification and markings are provided on an electronic marking display, then all fields must be provided.</p> <p>*“Electronic Marking Display” includes, but is not limited to, displays of the required marking information through a NUEMS display or other secondary display connected to the NUEMS. If the information is provided via a secondary display then the display shall be provided by the device owner/operator as specified in UR.2.4.7. Devices for Viewing Marking Information Provided Via an Electronic Marking Display, External Sensor (ES) NUEMS. Also see S.3.4. Electronic Marking Display Security Protocol.</p> <p>**Instructions on how to view required markings shall be marked on the device or provided in the NTEP CC.</p> <p>General:</p> <ul style="list-style-type: none"> Numbers appearing in parentheses (e.g., (1)) following each marking requirement above correspond to numbered descriptors in Table S.3.2.2.b. Descriptors for Table S.3.2.2.a. Device Identification and Marking Requirements - External Sensor (ES) NUEMS. For requirements and details on application, see Table S.3.2.2.b. Descriptors for Table S.3.2.2.a Device Identification and Marking Requirements - External Sensor (ES) NUEMS. 		

Table S.3.2.2.b. Descriptors for Table S.3.2.2.a Device Identification and Marking Requirements - External Sensor (ES) NUEMS
1. Manufacturer's Identification. Marked per General Code paragraph G-S.1. Identification.
2. Manufacturer's Model Prefix. For an External Sensor (ES) NUEMS having its NTEP number clearly identified, conspicuously and indelibly marked on the ES NUEMS body, where the NTEP certificate contains the complete marking details (including a description of the location and purpose of specific markings), the associated NUEMS is not required to be physically marked per General Code paragraph G-S.1. Identification (b)(1).
3. Manufacturer's Model Identifier. Also see General Code paragraph G-S.1. Identification.
4. Serial Number Prefix. For an External Sensor (ES) NUEMS having its NTEP number clearly identified, conspicuously and indelibly marked on the ES NUEMS body, where the NTEP certificate contains the complete marking details (including a description of the location and purpose of specific markings), the associated NUEMS is not required to be physically marked per General Code paragraph G-S.1. Identification (c)(1).
5. Serial Number. Also see General Code paragraph G-S.1. Identification.
6. NTEP Certificate of Conformance Number and Prefix. Marked per General Code paragraph G-S.1. Identification.
<p>7. <i>NUEMS Voltage Input Rating (V).</i> The nominal voltage input(s) for the voltage channel of the ES NUEMS body (e.g., 120VAC, 600VAC, 120-480VAC, etc.). Multiple forms of the term such as "Rated Voltage," "Max Voltage," and "Reference Voltage" are permitted.</p> <p>[Nonretroactive as of January 1, 2024]</p>
<p>8. <i>Voltage Sensor Rating (V_{nom}).</i> The nominal input at the voltage sensor. If a voltage sensor is not used this marking is not required. If a voltage sensor is used, a multiplier can be used in place of V_{nom} and voltage sensor ratio. The Voltage Sensor Rating shall be prefaced with the abbreviation "V_{nom}".</p> <p>[Nonretroactive as of January 1, 2024]</p>
<p>9. <i>Voltage Sensor Ratio (V_{rat}).</i> Ratio of sensor primary voltage to sensor output voltage. If a voltage sensor is not used this marking is not required. If a voltage sensor is used, a multiplier can be used in place of V_{nom} and voltage sensor ratio. The Voltage Sensor Ratio shall be prefaced with the abbreviation "V_{rat}".</p> <p>[Nonretroactive as of January 1, 2024]</p> <p>Example of Voltage Sensor Ratio Marking: 480V:120V</p>
<p>10. <i>NUEMS Current Input Rating (I_{nom}).</i> The nominal current or voltage input for the current channel of the ES NUEMS body. The NUEMS Current Input Rating shall be prefaced with the abbreviation "I_{nom}".</p> <p>The output of the current sensor must match the input configuration of the ES NUEMS body. This is determined by dividing Sensor Primary Current Rating (11) by the True Ratio (12). The computed quotient must match the NUEMS Current Input Rating (10).</p> <p>[Nonretroactive as of January 1, 2024]</p> <p>Example 1: Sensor Primary Current Rating = 200A True Ratio = 100A:5A Calculation: $(200A) \div (100A/5A) = (200A) \div (20) = 10A$</p>

<p>Example 2:</p> <p>Sensor Primary Current Rating = 200A</p> <p>True Ratio = 400A:0.3V</p> <p>Calculation: $(200A) \div (400A/0.3V) = (200A) * (0.3V/400A) = 60W/400A = 0.15V$</p> <p>NOTE: W=Watts=Amperes*Volts</p>
<p>11. <i>Sensor Primary Current Rating (SI_{nom}). The nominal current input through the sensor. The Sensor Primary Current Rating shall be prefaced with the abbreviation “SI_{nom}”.</i></p> <p><i>[Nonretroactive as of January 1, 2024]</i></p>
<p>12. <i>Current Sensor Ratio. The ratio of sensor primary amperes to sensor output amperes or volts shall be physically marked on a NUEMS unless it is displayed electronically. This is to be expressed as xxxA:yyyA or xxxA:yyyV. The number of digits is the number needed to express the values. The Current Sensor Ratio must match the marked ratio of the sensor as required in Table S.3.3.a.</i></p> <p><i>[Nonretroactive as of January 1, 2024]</i></p> <p>Examples of current sensor ratio markings include:</p> <p>200A:5A</p> <p>400A:0.3V</p>
<p>13. Kh or Kt. Watthour constant or watthour test constant.</p>
<p>14. Sensor Input Polarity. Sensor input connection with intended polarity shall be physically marked on the NUEMS when direction-sensitive.</p>
<p>15. Bi-Directional. A NUEMS equipped to register the accumulation of energy in both directions (i.e., for delivered and received energy).</p>
<p>16. Temperature Range if Narrower Than $-20\text{ }^{\circ}\text{C}$ to $+50\text{ }^{\circ}\text{C}$ ($-4\text{ }^{\circ}\text{F}$ to $+122\text{ }^{\circ}\text{F}$): If the device is rated for use over a range that is narrower than and within $-20\text{ }^{\circ}\text{C}$ to $+50\text{ }^{\circ}\text{C}$ ($-4\text{ }^{\circ}\text{F}$ to $+122\text{ }^{\circ}\text{F}$), this must be physically and/or electronically marked.</p>

S.3.3. Device Identification and Marking Requirements – External Sensors. – In addition to all the marking requirements of Section 1.10 General Code, paragraph G-S.1. Identification, each external sensor that is non-integral with the ES NUEMS body shall have the following conspicuously, legibly, and indelibly marked as shown in Table S.3.3.a. Device Identification and Marking Requirements – External Sensors and in Table S.3.3.b. Descriptors for Table S.3.3.a. Device Identification and Marking Requirements – External Sensors.

Table S.3.3.a. Device Identification and Marking Requirements – External Sensors		
	Physical Marking on Sensor	Electronic Marking Display*
Manufacturer name, initials, trademark (1)	R	D
Model Prefix (2)	O	D
Model (3)	R	D
Serial Number Prefix “S/N” (4)	O	D
Serial Number (5)	R	D
True Ratio (6) [Nonretroactive as of January 1, 2024]	R	D
Maximum Primary Current (7)	O	D
Rated Frequency (Hz) (8)	O	D
Maximum Safety Voltage Rating (9)	O	D
Polarity (10)	O	D
<p>R Required to be marked on the device O Required to be marked on the device if information is not available on an electronic marking display D Required when data is displayed on an electronic marking display.</p> <p>*“Electronic Marking Display” includes, but is not limited to, displays of the required marking information through a NUEMS display or other secondary display connected to the NUEMS. If the information is provided via a secondary display then the display shall be provided by the device owner/operator as specified in UR.2.4.7. Devices for Viewing Marking Information Provided Via an Electronic Marking Display, External Sensor (ES) NUEMS. Also see S.3.4. Electronic Marking Display Security Protocol.</p> <p>Notes:</p> <ul style="list-style-type: none"> Numbers appearing in parentheses (e.g., (1)) following each marking requirement above correspond to numbered descriptors in Table S.3.3.b. Descriptors for Table S.3.3.a. Device Identification and Marking Requirements - External Sensors. For requirements and details on application, see Table S.3.3.b. Descriptors for Table S.3.3.a. Device Identification and Marking Requirements - External Sensors. 		

Table S.3.3.b. Descriptors for Table S.3.3.a. Device Identification and Marking Requirements - External Sensors	
1.	Manufacturer's Identification. Marked per General Code paragraph G-S.1. Identification.
2.	Manufacturer's Model Prefix. The General Code paragraph G-S.1. Identification (b)(1) model prefix marking requirement for the sensor(s) may be met with a physical marking. Alternatively, the marking requirement may be satisfied through an electronic display provided that the NUEMS has its NTEP number clearly identified, conspicuously and indelibly marked on the ES NUEMS body, where the NTEP certificate contains the complete marking details (including a description of the location and purpose of specific markings).
3.	Manufacturer's Model. Also see General Code paragraph G-S.1. Identification.
4.	Serial Number Prefix. For a NUEMS having its NTEP number clearly identified, conspicuously and indelibly marked on the sensor(s), where the NTEP certificate contains the complete marking details (including a description of the location and purpose of specific markings), the associated sensor is not required to meet General Code paragraph G-S.1. Identification (c)(1).
5.	Serial Number. Also see General Code paragraph G-S.1. Identification.
6.	<p><i>Voltage Sensor Ratio or Current Sensor Ratio. The ratio, in primary amperes or volts to secondary amperes or volts shall be physically marked on each sensor. This is to be expressed as xxxA:yyyA; or xxxA:yyyV; or xxxV:yyyV. The number of digits is the number needed to express the values.</i></p> <p><i>[Nonretroactive as of January 1, 2024]</i></p> <p>Examples of current sensor ratio markings include:</p> <p style="padding-left: 40px;">200A:5A 400A:0.3V</p> <p>Examples of voltage sensor ratio markings include:</p> <p style="padding-left: 40px;">480V:120V</p>
7.	Maximum Primary Current. The maximum primary current at which the sensor can be safely and accurately operated.
8.	Rated Frequency. A sensor shall be marked with its rated frequency if other than 40Hz to 400Hz.
9.	<p>Maximum Safe Operating Voltage. A sensor shall be marked with a Maximum Safe Operating Voltage if it is less than 600VAC.</p> <p>Example of sensor maximum safe operating voltage ratings:</p> <ul style="list-style-type: none"> • 250 Vac • 250 VAC • 50 V <p>Note: The maximum safe operating voltage rating marking may not be higher than the voltage to which the device was verified during type evaluation.</p>
10.	Polarity Marking. The sensor shall be marked to indicate proper orientation when the accuracy of the NUEMS is affected by orientation.

S.3.4. Electronic Marking Display Security Protocol. – If an Electronic Marking Display is used as described in Table S.3.2.2.a. and Table S.3.3.a. protocols shall be in place to prevent tampering with the displayed markings and/or data.

S.3.5. Abbreviations and Symbols. – When using abbreviations or symbols on an ES NUEMS body, sensor, or indicator, the following shall be used.

Symbol	Description
AC	Alternating Current (i.e., VAC)
Cl	Class
FM	Form
Hz	Hertz, Frequency or Cycles Per Second
I _{nom}	NUEMS Current Input Rating
K _h	Watthour Constant; Revolution or Pulse
K _t	Watthour Test Constant
kWh	Kilowatt-hour
R _r	Register Ratio
SI _{nom}	Sensor Primary Current Rating
TA	Test Amperes
V	Volts
V _{nom}	Voltage Sensor Rating
V _{rat}	Voltage Sensor Ratio
W	Wire (example 240V 3W)
Wh	Watthour

S.3.6. Abbreviations and Symbols. – These are abbreviations that may occur but are not required to be used or limited to the listed abbreviations.

Symbol	Description
Δ	Delta Power Supply
B	Burden
BIL	Basic Lightning Impulse Insulation Factor
IEEE	Institute of Electrical and Electronics Engineers
Mult By	Multiply By
PD	Printable Data
PTR	Potential Transformer Ratio (Same as VTR)
SD	Soft Data
VTR	Voltage Transformer Ratio
Y	WYE Power Supply

N. Notes

N.1. NUEMS No-Load Test. – A NUEMS no-load test shall be conducted by applying rated voltage to the NUEMS under test and no current load applied. This test shall be conducted during type evaluation and may be conducted during field testing as deemed necessary. The test duration shall be ten minutes.

N.2. NUEMS Starting Load Test. – A NUEMS starting load test shall be conducted by applying rated voltage at a load of 0.25% of the Current Class (CL) or the Sensor Primary Current Rating at unity power factor. The test shall be conducted during type evaluation and may be conducted during field testing as deemed necessary.

N.3. NUEMS Minimum Test Duration. – A NUEMS full load test shall consist of a minimum of 10 Kt or Kh output indications and a light load test shall consist of a minimum of one Kh or Kt output indication.

N.4. NUEMS Test Loads.

- (a) Internal Sensor (IS) NUEMS shall be balanced-load tested, and may be single-element tested, for NUEMS accuracy at full and light loads.
- (b) External Sensor (ES) NUEMS shall be single-element tested for system accuracy at full and light loads. NUEMS testing shall be accomplished by applying the test load to the sensor(s) with the voltage circuits energized. When it is not feasible to test the system by injecting a primary current, testing using customer load shall be sufficient for field verification.
- (c) The reference voltage phases (A, B, or C) at the NUEMS shall be the same phase as the load.

N.5. Test of a NUEMS.

- (a) The test load applied for a full load test shall be 15 % of either the Current Class (CL) or the Sensor Primary Current Rating.
- (b) The test load applied for a light load test shall be conducted at 1.5 % to 3 % of either the Current Class (CL) or the Sensor Primary Current Rating.
- (c) The test load applied for a full load test of a NUEMS for a 0.5 power factor lagging setting shall be 15 % of either the Current Class (CL) or the Sensor Primary Current Rating. This test shall be conducted during type evaluation and may be conducted during in-service (field) or laboratory testing as deemed necessary.
- (d) The test load applied for a light load test for a 0.5 power factor lagging setting shall be conducted at 3 % to 6 % of either the Class (CL) or the Sensor Primary Current Rating. This test shall be conducted during type evaluation and may be conducted during in-service (field) or laboratory testing as deemed necessary.
- (e) All tests shall be made at the rated voltage ± 10 %.

N.6. Repeatability Tests. – When conducted, tests for repeatability shall include a minimum of three consecutive tests at the same load, similar time period, etc. and be conducted under conditions where variations in factors are reduced to minimize the effect on the results obtained.

T. Tolerances

T.1. Tolerances, General.

- (a) The tolerances apply equally to errors of underregistration and errors of overregistration.

- (b) The tolerances apply to all electric energy measured at any load within the rated measuring range of the device.
- (c) Where sensors or other components are used, the provisions of this section shall apply to the entire NUEMS.

T.2. No-Load Test. – A NUEMS shall not indicate more than one K_t or K_h .

T.3. NUEMS Starting Load Test. – The K_t or K_h output indications shall continue to advance. The purpose of this section is to verify that the NUEMS accumulates energy at the starting load.

T.4. Load Test Tolerances. – Tolerances for NUEMS shall be as shown in Table T.4. Tolerances for NUEMS. When it is not feasible to test the system by injecting a primary current, tolerances specified under “Tests Conducted at 0.5 Lagging Power Factor” shall apply.

Table T.4. Tolerances for NUEMS		
	Tests Conducted at Unity Power Factor	Tests Conducted at 0.5 Lagging Power Factor
Acceptance Tolerances	1.0 %	2.0 %
Maintenance Tolerance	2.0 %	3.0 %

T.5. Repeatability . – When multiple load tests are conducted at the same load condition, the range of the load test results shall not exceed 25 % of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance.

UR. User Requirements

UR.1. Selection Requirements.

UR.1.1. Customer Indicating Element, Accessibility. – For systems in which the primary indicating element is not reasonably accessible to the customer, one of the following shall be provided.

- (a) Console display which is accessible to the customer on which the customer can unambiguously select the NUEMS output associated with this load.
- (b) Remote display which is provided to customer as a part of the system.
- (c) At the option of the customer, an application that provides readings in real time.

UR.1.2. NUEMS Required. – When a tenant is not directly served by the serving utility, and charges for electric energy are not included in the fixed periodic rent charges, a dedicated NUEMS that measures only the energy used at the discretion of the tenant shall be used.

UR.1.3. Suitability of Equipment. – A NUEMS shall be suitable for use on its electrical system.

UR.1.3.1. Service Applications. – A NUEMS shall accurately measure all loads 5 percent or greater of the electric service capacity of the tenant. Service capacity shall be determined by the master thermal overload protectors to the tenants’ service or by the rated capacity of the wiring and its circuits used to provide power from the service panel to the tenant.

$$Annual\ Max = \sum_{phases} \left[\frac{Phase\ Voltage * Current\ Class}{1\ 000} \right] * Hours\ per\ Year$$

NOTE: Current Class is equivalent to Sensor Primary Current Rating.

UR.1.3.2. Quantity-Value Division. – The configured quantity-value division shall not exceed the minimum increment to be used in billing.

UR.1.4. Sensors. – Each sensor output shall be correctly matched to the corresponding ES NUEMS body input.

UR.2. Installation Requirements.

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

UR.2.2. Load Range. – A device shall be installed so that the current and voltage will not exceed the maximum continuous ratings of the NUEMS. If necessary, means to limit current and/or voltage shall be incorporated in the installation.

UR.2.3. Regulation Conflicts and Permit Compliance. – If any provision of this section (UR.2. Installation Requirements) is less stringent than that required of a similar installation by the National Electrical Code®, as amended and adopted by the Local Authority having Jurisdiction, the installation shall be in accordance with the National Electric Code.

The installer of any new NUEMS service shall obtain all necessary permits and shall conform to all applicable regulations.

UR.2.4. NUEMS Installation Requirements.

UR.2.4.1. Certification. – It is the responsibility of the owner of a NUEMS to obtain written approval for each metered load service from the serving utility, public utility commission, or other entity with jurisdiction over electric utilities in the location the NUEMS is to be installed.

The required approval shall meet the requirements of that entity and shall identify the address, space, or number, of the premise served by the NUEMS connection; be signed by an agency representative; and shall clearly state the:

- the installation meets all installation and accessibility requirements for similar installation governed by the presiding entity.
- installation is on a tariff schedule that qualifies for electric meter use,
- billing format, rates, and charges conform to all applicable tariff rules,
- date of such determination, and
- designee's name and title if performed by a designee, and the name and title of the presiding entity authorizing the designee to make the determination.

The approval shall be provided to the local Weights & Measures authority prior to a NUEMS being used for commercial purposes.

UR.2.4.2. NUEMS Test Features. – All NUEMS shall be provided with test features to facilitate common tests methods used in the electrical submetering industry.

UR.2.4.3. Safety Mechanism. – NUEMS installations that are equipped with current sensors with a current output that is not self-limiting shall have a mechanism installed to allow the NUEMS, or its components, to be connected to or removed for safe testing without the risk of dangerous voltages that can result from secondary open circuit current sensors.

UR.2.4.4. Metered Circuits (Submeter Load Service). – For NUEMS with separate line and load service connections, all electricity used by a tenant shall be taken exclusively from the load service of the tenant's NUEMS. This service and its associated NUEMS shall accurately measure the tenant's load and be capable of being used only at the discretion of the tenant.

UR.2.4.5. Dedicated Tenant NUEMS Service. – A NUEMS shall serve only the space, lot, building, room, suite, stall, slip, or any other termed premise occupied and/or used by the tenant.

UR.2.4.6. NUEMS Tenant Premise Identification. – Tenant premise identification shall be clearly and permanently shown on or at the NUEMS, and on all separate components of a NUEMS, including, but not limited to, current sensor(s), modem(s), and transmitter(s) if equipped. Remote indications and all printed indications shall be readily identifiable and readily associated with the tenant's premise. Printed indications shall also include time and date information. For field configured systems the information shall be after actual configuration is established.

UR.2.4.7. Devices for Viewing Marking Information Provided Via an Electronic Marking Display, External Sensor (ES) NUEMS. – When required markings are provided via an electronic display the owner/operator of the NUEMS is responsible for providing means for viewing this information on the site at the time of inspection or on request. See also Table S.3.2.2.a. Device Identification and Marking Requirements for External Sensor (ES) NUEMS.

UR.2.4.8. External Sensors and Test Output. – The NUEMS shall be installed in such a way that the test output and external sensors are both located within proximity of each other which will allow for testing by a single inspector from a reasonable test position.

UR.3. Use of Device.

UR.3.1. Recorded Representations. – A record, either printed or electronic, providing the following information on electrical energy usage shall be available at the end of the billable interval:

- (a) the total quantity of the energy delivered with unit of measure;
- (b) the total computed price of the energy sale;
- (c) the unit price of the energy.

For systems capable of applying multiple unit prices for energy during the billable interval, the following additional information is required:

- (1) A schedule of the rate time periods and the unit price applied for each;
- (2) the total quantity of energy delivered during each;
- (3) the total purchase price for the quantity of energy delivered during each rate time period.

UR.4. Submitting a NUEMS for Testing. – Each NUEMS Submitted for inspection shall have all necessary components assembled, connected, and configured as intended for use. Components may include, but are not limited to, the ES NUEMS body, sensor(s), indicator(s), etc.”.

Appendix D. Definitions

The following definitions are proposed for addition to NIST Handbook 44 Appendix D, Definitions at the time when the status of this Tentative Code is changed from “tentative” to “permanent.” Until such time that the status of the code is designated as “permanent,” these proposed definitions will remain in this section of the Tentative Code.

The specific code to which the definition applies is shown in [brackets] at the end of the definition. Definitions for the General Code [1.10] apply to all codes in Handbook 44.

A

active energy. – The integral of active power with respect to time. Typically measured in units of kilowatt-hours (kWh), or watt-hours.

$$E(T) = \int_0^T v(t) \cdot i(t) \cdot dt$$

Where T is much greater than the period of the AC line frequency. [3.41]

alternating current (AC). – An electric current that reverses direction in a circuit at regular intervals. [3.40, 3.41]

ampere. – The practical unit of electric current. It is the quantity of current caused to flow by a potential difference of one volt through a resistance of one ohm. One ampere is equal to the flow of one coulomb of charge per second. One coulomb is the unit of electric charge equal in magnitude to the charge of 6.24×10^{18} electrons. [3.40, 3.41]

audit trail. – An electronic count and/or information record of the changes to the values of the calibration or configuration parameters of a device. [1.10, 2.20, 2.21, 2.24, 3.30, 3.31, 3.32, 3.34, 3.35, 3.36, 3.37, 3.38, 3.39, 3.40, 3.41, 5.54, 5.56(a), 5.58]

(Added 1993)

B

balanced load. – Balanced load is used to indicate equal currents in all phases and relatively equal voltages between phases and between each phase and neutral (if one exists); with approximately equal watts in each phase of the load. [3.41]

basic lightning impulse insulation level (BIL). – A specific insulation level expressed in kilovolts of the crest value of a standard lightning impulse. (Example: BIL = 10 Kv) [3.41]

bidirectional. – A NUEMS equipped to register the accumulation of energy in both directions (i.e., for delivered and received energy. A bidirectional NUEMS shall fall into at least one of the following categories:

- (a) Single register or net meter that displays the difference between the delivered and received energy; or
- (b) Separate register(s) for delivered or received. [3.41]

burden (B). – The impedance of the circuit connected to the instrument transformer's secondary winding. (Example: B = 21 Ohms Max) [3.41]

C

calibration parameter. – Any adjustable parameter that can affect measurement or performance accuracy and, due to its nature, needs to be updated on an ongoing basis to maintain device accuracy, e.g., span adjustments, linearization factors, and coarse zero adjustments. [2.20, 2.21, 2.24, 3.30, 3.31, 3.32, 3.34, 3.35, 3.36, 3.37, 3.38, 3.39, 3.40, 3.41, 5.54, 5.56(a), 5.58]

(Added 1993)

configuration parameter. – Any adjustable or selectable parameter for a device feature that can affect the accuracy of a transaction or can significantly increase the potential for fraudulent use of the device and, due to its nature, needs to be updated only during device installation or upon replacement of a component, e.g., division value (increment), sensor range, and units of measurement. [2.20, 2.21, 2.24, 3.30, 3.31, 3.32, 3.34, 3.35, 3.36, 3.37, 3.38, 3.39, 3.40, 3.41, 5.54, 5.56(a), 5.58]

(Added 1993)

current. – The rate of the flow of electrical charge past any one point in a circuit. The unit of measurement is amperes or coulombs per second. [3.40, 3.41]

current class (CL). – For self-contained meters, the manufacturer's designated maximum rated current a NUEMS can measure continuously without damage and without exceeding limits of accuracy. (Example: CL 200) [3.41]

current sensor. – A device able to measure and output analog or digital representations of one or more currents. Examples of current sensors are current transformers, low-voltage current transducers, and Rogowski coils. [3.41]

E

electronic marking display. – A device used for the electronic visual presentation of marking requirements. [3.41]

element. – A combination of a voltage-sensing unit and a current-sensing unit, which provides an output proportional to the quantities measured. Meters can include multiple elements based on service type. For mechanical meters, this is also referred to as a “stator.” (*OWM is seeking written permission from National Electrical Manufacturers Association (NEMA) to reprint . Oral permission was received.*) [3.41]

energy flow. – The flow of energy between line and load terminals (conductors) of a NUEMS. Flow from the line to the load terminals is considered energy delivered. Energy flowing in the opposite direction (i.e., from the load to line terminals) is considered as energy received. [3.41]

equipment, commercial. – Weights, measures, and weighing and measuring devices, instruments, elements, and systems or portion thereof, used or employed in establishing the measurement or in computing any basic charge or payment for services rendered on the basis of weight or measure. As used in this definition, measurement includes the determination of size, quantity, value, extent, area, composition (limited to meat and poultry), constituent value (for grain), or measurement of quantities, things, produce, or articles for distribution or consumption, purchased, offered, or submitted for sale, hire, or award. [1.10, 2.20, 2.21, 2.22, 2.24, 3.30, 3.31, 3.32, 3.33, 3.34, 3.35, 3.36, 3.37, 3.38, 3.39, 3.40, 3.41, 4.40, 5.51, 5.56(a), 5.56(b), 5.57, 5.58, 5.59]

(Added 2008)

ES NUEMS body. – The element of the NUEMS that calculates the electricity usage using the signals from the external sensor. [3.41]

external sensor. – Any voltage sensor or current sensor not located inside of the meter body NUEMS itself and not inside the sealed enclosure containing the NUEMS. [3.41]

event counter. – A nonresettable counter that increments once each time the mode that permits changes to sealable parameters is entered and one or more changes are made to sealable calibration or configuration parameters of a device. [2.20, 2.21, 2.24, 3.30, 3.31, 3.32, 3.34, 3.35, 3.36, 3.37, 3.38, 3.39, 3.40, 3.41, 5.54, 5.56(a), 5.56(b), 5.57, 5.58]

(Added 1993)

event logger. – A form of audit trail containing a series of records where each record contains the number from the event counter corresponding to the change to a sealable parameter, the identification of the parameter that was changed, the time and date when the parameter was changed, and the new value of the parameter. [2.20, 2.21, 2.24, 3.30, 3.31, 3.32, 3.34, 3.35, 3.36, 3.37, 3.38, 3.39, 3.40, 3.41, 5.54, 5.56(a), 5.56(b), 5.57, 5.58]

(Added 1993)

F

form designation (FM). – An alphanumeric designation denoting the circuit arrangement for which the NUEMS is applicable and its specific terminal arrangement. The same designation is applicable to equivalent NUEMS for all manufacturers. (Example: FM 2S) [3.41]

H

hertz (Hz). – Frequency or cycles per second. One cycle of an alternating current or voltage is one complete set of positive and negative values of the current or voltage. [3.40, 3.41]

(Added 2022)

I

internal sensor. – Any voltage sensor or current sensor located inside of the meter body NUEMS itself or inside the sealed enclosure containing the NUEMS. [3.41]

K

kilowatt (kW). – A unit of power equal to 1 000 watts. [3.40, 3.41]

(Added 2022)

kilowatt-hour (kWh). – A unit of energy equal to 1 000 watthours. [3.40, 3.41]

(Added 2022)

L

line service. – The service terminals or conductors connecting the (NUEMS) to the power source. [3.41]

load service. – The service terminals or conductors connecting the (NUEMS) to the electrical load (e.g., vehicle, tenant, etc.). [3.41]

load, full. – A test condition with rated voltage, current at 100 % of test amps level, and power factor of 1.0. [3.40, 3.41]

(Added 2022)

load, light. – A test condition with rated voltage, current at 10% of test amps level, and power factor of 1.0. [3.40, 3.41]

(Added 2022)

M

master meter, electric. – A (NUEMS) owned, maintained, and used for commercial billing purposes by the serving utility. All the electric energy served to a submetered service system is recorded by the master meter. [3.41]

meter, self-contained. – A meter in which the terminals are arranged for connection to the circuit being measured without using external instrument transformers. [3.41]

metrological components. – Elements or features of a measurement device or system that perform the measurement process or that may affect the final quantity determination or resulting price determinations. This includes accessories that can affect the validity of transactions based upon the measurement process. The measurement process includes determination of quantities; the transmission, processing, storage, or other corrections or adjustments of measurement data or values; and the indication or recording of measurement values or other derived values such as price or worth or charges. [3.40, 3.41]

(Added 2022)

N

nominal current. – The manufacturer’s designated maximum rated current a NUEMS can measure continuously without damage and without exceeding limits of accuracy. [3.41]

nominal voltage. – The manufacturer’s designated maximum rated voltage a NUEMS can measure continuously without damage and without exceeding limits of accuracy. [3.41]

non-integral. – Used to describe external sensors that can be disconnected from the meter body. [3.41]

non-utility electricity measuring system (NUEMS). – An electricity measuring system comprised of all the metrologically relevant components required to measure electrical energy, store the result, and report the result used in non-utility sales of electricity wherein the sale is based in whole or in part on one or more measured. [3.41]

O

ohm. – The practical unit of electric resistance that allows one ampere of current to flow when the impressed potential is one volt. [3.40, 3.41]

(Added 2022)

P

percent error. – Percent error is calculated as follows:

percent error = (NUEMS reading – standard reading)/standard reading x 100
[3.41]

power factor (PF). – The ratio of “active power” to “apparent power” in an AC circuit. It describes the efficient use of available power. [3.40, 3.41]

(Added 2022)

primary indicating or recording elements. – The term “primary” is applied to those principal indicating (visual) elements 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. (Also see “indicating element” and “recording element.”) [1.10, 3.40, 3.41]

R

reactive power. – For sinusoidal quantities in a two-wire circuit, reactive power is the product of the voltage, the current, and the sine of the phase angle between them, using the current as the reference. [3.41]

register ratio (R_r). – The number of revolutions of the gear meshing with the worm or pinion on the rotor shaft per complete rotation of the fastest (most sensitive) wheel or dial pointer. [3.41]

remote configuration capability. – The ability to adjust a weighing or measuring device or change its sealable parameters from or through some other device that is not itself necessary to the operation of the weighing or measuring device or is not a permanent part of that device. [2.20, 2.21, 2.24, 3.30, 3.31, 3.32, 3.34, 3.35, 3.36, 3.37, 3.38, 3.39, 3.40, 3.41, 5.54, 5.56(a), 5.58]

(Added 1993)

retail device. – A measuring device primarily used to measure product for the purpose of sale to the end user. [3.30, 3.32, 3.37, 3.39, 3.40, 3.41]

(Amended 1987, 2004, 2019, and 2022)

S

sensor ratio. – The stated ratio of the primary circuit current or voltage compared to the secondary circuit current or voltage. (Example: CSR = 200 : 0.1) [3.41]

serving utility. – The utility distribution company that owns the master meter and sells electric energy to the owner of a submeter system. [3.40, 3.41]

(Added 2022)

starting load. – The minimum load above which the device will indicate energy flow continuously. [3.40, 3.41]

(Added 2022)

submeter. – A meter or meter system downstream of the electric master meter. [3.40, 3.41]

(Added 2022)

T

tenant. – The person or persons served electric energy from a non-utility electricity-measuring system (NUEMS). [3.41]

test amperes (TA). – The full load current (amperage) specified by the device manufacturer for testing and calibration adjustment. (Example: TA 30). [3.40, 3.41]

(Added 2022)

thermal overload protector. – A circuit breaker or fuse that automatically limits the maximum current in a circuit. [3.40, 3.41]

(Added 2022)

U

unit price. – The price at which the product is being sold and expressed in whole units of measurement. [1.10, 2.20, 3.30, 3.31, 3.32, 3.37, 3.39, 3.40, 3.41]

(Added 1992)

utility. – A corporation, person, agency, authority, or other legal entity or instrumentality aligned with distribution facilities for delivery of electric energy for use primarily by the public. Included are investor-owned electric utilities, municipal and State utilities, Federal electric utilities, and rural electric cooperatives. A few entities that are tariff based and corporately aligned with companies that own distribution facilities are also included.

A list of recognized utilities in the U.S. can be found at the U.S. Energy Information Administration (EIA) at: <https://www.eia.gov/electricity/data/eia861> [3.41]

V

volt. – The practical unit of electromotive force. One volt will cause one ampere to flow when impressed across a resistance of one ohm. [3.40, 3.41]

(Added 2022)

W

watt. – The practical unit of electric power. In an alternating-current circuit (AC), the power in watts is volts times amperes multiplied by the circuit power factor. [3.40, 3.41]

(Added 2022)

watthour (Wh). – The practical unit of electric energy, which is expended in one hour when the average power consumed during the hour is one watt. [3.40, 3.41]

(Added 2022)

watthour constant (K_h). – The expression of the relationship between the energy applied to the meter and the output indication, expressed as “watthours per revolution” or “watthours per output indication.” [3.41]

watthour test constant (K_t). – The expression of the relationship between the energy applied to the meter and the output indication, expressed as “watthours per output indication,” when the meter is in test mode [3.41]

Section 4

Table of Contents

	Page
4.40. Vehicle Tanks Used as Measures	4-3
4.41. Liquid Measures	4-9
4.42. Farm Milk Tanks.....	4-13
4.43. Measure-Containers	4-21
4.44. Graduates.....	4-27
4.45. Dry Measures	4-33
4.46. Berry Baskets and Boxes.....	4-37

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Table of Contents

	Page
Section 4.40. Vehicle Tanks Used as Measures.....	4-5
A. Application	4-5
A.1. General.....	4-5
A.2. Exceptions.....	4-5
A.3. Additional Code Requirements.....	4-5
S. Specifications.....	4-5
S.1. Design of Compartments.....	4-5
S.1.1. Compartment Distortion.....	4-5
S.1.2. Venting.....	4-5
S.1.3. Completeness of Delivery.....	4-5
S.1.4. Fill or Inspection Opening.....	4-5
S.1.5. Dome Flange and Baffle Plates.....	4-5
S.1.6. Compartment and Piping Capacities and Emergency Valve.....	4-5
S.1.7. Expansion Space.....	4-6
S.2. Design of Compartment Indicators.....	4-6
S.2.1. General.....	4-6
S.2.2. Number of Indicators.....	4-6
S.2.3. Identification of Multiple Indicators.....	4-6
S.2.4. Location.....	4-6
S.2.5. Permanence.....	4-6
S.2.6. Adjustable Indicators.....	4-6
S.2.7. Sensitiveness.....	4-7
S.3. Design of Compartment Discharge Manifold.....	4-7
S.4. Marking of Compartments.....	4-7
S.4.1. Compartment Identification.....	4-7
S.4.2. Compartment Capacity, Single Indicator.....	4-7
S.4.3. Compartment Capacity, Multiple Indicators.....	4-7
N. Notes.....	4-7
N.1. Test Liquid.....	4-7
N.2. Evaporation and Volume Change.....	4-7
N.3. To Deliver.....	4-7
N.4. Gauging of Compartments.....	4-7
N.5. Adjustment and Remarking.....	4-7
T. Tolerances.....	4-8
T.1. Application.....	4-8
T.1.1. To Excess and to Deficiency.....	4-8
T.2. Tolerance Values.....	4-8
UR. User Requirements	4-8
UR.1. Conditions of Use.....	4-8
UR.1.1. Filling.....	4-8
UR.1.2. Delivering.....	4-8

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Section 4.40. Vehicle Tanks Used as Measures

A. Application

A.1. General. – This code applies to vehicle tanks when these are used as commercial measures.

A.2. Exceptions. – This 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 Section 3.31. Code for Vehicle-Tank Meters).

A.3. Additional Code Requirements. – In addition to the requirements of this code, Vehicle Tanks Used as Measures shall meet the requirements of Section 1.10. General Code.

S. Specifications

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 0.25 L per 750 L (0.5 pt per 200 gal), or fraction thereof, of the nominal compartment capacity, or to more than 0.5 L (1 pt), whichever is greater. (This specification prescribes a limit on permissible distortion only, and is not to be construed as setting up a secondary tolerance on compartment capacities to be added to the values given in tolerance paragraph T.2. Tolerance Values.)

S.1.2. Venting. – During filling operations, effective venting of a compartment shall be provided to permit air to escape from all spaces 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 20 cm ($7\frac{5}{8}$ in), or, if other than circular, have an effective area of less than 290 cm² (45 in²).

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. Marking of Compartments.

S.1.6.1. On Vehicle Tanks Equipped for Bottom Loading. – On equipment designed for bottom loading, the compartment capacity shall include the piping of a compartment to the valve located on the upstream side of the manifold and immediately adjacent thereto or, if not manifolded, to the outlet valve, provided that on or immediately adjacent to the marking as specified in S.4. Marking of Compartments the following words or a statement of similar meaning shall be affixed: “Warning: Emergency valves must be opened before checking measurement.”

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 % 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 five indicators.
(Amended 1972)

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. Location. – An indicator shall be located:

- (a) midway between the sides of its compartment;
- (b) as nearly as practicable midway between the ends of its compartment, and in no case offset by more than 10 % of the compartment space or 15 cm (6 in), whichever is less;
(Amended 1972)
- (c) so that it does not extend into, nor more than 15 cm (6 in) from that section of the compartment defined by a vertical projection of the fill opening;
(Amended 1974)
- (d) at a depth, measuring from the top of the dome opening, not lower than 46 cm (18 in) for fill openings of less than 38 cm (15 in) in diameter, or, if other than circular, an effective area of less than 1130 cm² (175 in²), and not lower than 61 cm (24 in) for larger fill openings; and
- (e) to provide a clearance of not less than 5 cm (2 in) between indicators.

S.2.5. Permanence. – Any indicator that is not intended to remain adjustable and all brackets or supports 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 1.0 mm (0.04 in) 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 ensure that:

- (a) liquid can flow through the delivery line leading from only one compartment at one time and that flow of liquid from one compartment to any other is automatically prevented; or
- (b) all compartments will discharge simultaneously.

If the discharge valves from two or more compartments are automatically controlled so that they can only be operated together, thus effectively connecting these compartments to one another, such compartments shall, for purposes of this paragraph, be construed to be one compartment.

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 more indicators shall be clearly, permanently, and conspicuously marked with a statement identifying:

- (a) each indicator by a letter or number; and
- (b) immediately adjacent to each letter or number, the capacity of the compartment as defined by the particular indicator.

N. Notes

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 gauged “to deliver.” If the compartment is gauged by measuring the test liquid into the tank, the inside tank walls shall first be thoroughly wetted.

N.4. Gauging of Compartments. – When a compartment is gauged 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 Remark. – 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

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. Maintenance and Acceptance Tolerances on Vehicle-Tank Compartments.

Table 1. Maintenance and Acceptance Tolerances on Vehicle-Tank Compartments		
Nominal Capacity of Compartment	Maintenance and Acceptance Tolerances	
Gallons	Expressed in Quarts	Expressed in Gallons
200 or less	2	0.5
201 to 400, inclusive	3	0.75
401 to 600, inclusive	4	1.0
601 to 800, inclusive	5	1.25
801 to 1000, inclusive	6	1.50
over 1000	Add 1 quart per 200 gallons or fraction thereof	Add 0.25 gallon per 200 gallons or fraction thereof

UR. User Requirements

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. Each compartment shall be used for an individual delivery only; that is, an individual delivery shall consist of the entire contents of a compartment or compartments.

(Amended 1976)

Table of Contents

	Page
Section 4.41. Liquid Measures	4-11
A. Application	4-11
A.1. General.....	4-11
A.2. Exceptions.....	4-11
A.3. Additional Code Requirements	4-11
S. Specifications.....	4-11
S.1. Units.....	4-11
S.2. Material.....	4-11
S.3. Capacity Point.....	4-11
S.4. Reinforcing Rings.....	4-11
S.5. Discharge.....	4-11
S.6. Marking Requirements.....	4-11
T. Tolerances.....	4-12
T.1. Tolerance Values.....	4-12

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Section 4.41. Liquid Measures

A. Application

A.1. General. – This code applies to liquid measures; that is, to rigid measures of capacity designed for general and repeated use in the measurement of liquids.

A.2. Exceptions. – The code does not apply to test measures or other volumetric standards.

A.3. Additional Code Requirements. – In addition to the requirements of this code, Liquid Measures shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1. Units.

- (a) The capacity of a liquid measure marked in SI units shall be 0.1 L, 0.2 L, 0.5 L, 1 L, 2 L, 5 L, or a multiple of 5 L, and the measure shall not be subdivided.
- (b) The capacity of a liquid measure marked in U.S. customary units shall be 1 gill, ½ liq pt, 1 liq pt, 1 liq qt, ½ gal, 1¼ gal, 1½ gal, or a multiple of 1 gal, and the measure shall not be subdivided. However, 3 pt and 5 pt brick molds and 2½ gal (10 qt) 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 not be less than the appropriate value given in Table 1. Minimum Thickness of Metal for Liquid Measures.

Table 1. Minimum Thickness of Metal for Liquid Measures		
Nominal Capacity	Minimum Thickness	
	For Iron or Steel, Plated, or Unplated (inch)	For Copper or Aluminum (inch)
1 pint or less	0.010	0.020
1 quart, ½ gallon, 1 gallon	0.014	0.028
Over 1 gallon	0.016	0.032

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 of 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 to 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

T.1. Tolerance Values. – Maintenance tolerances in excess and in deficiency shall be as shown in Table 2. Maintenance Tolerances, in Excess and in Deficiency, for Liquid Measures. 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 pt or less	2.0	0.4	1.0	0.2
1 pt	3.0	0.7	1.5	0.3
1 qt	4.0	0.9	2.0	0.5
½ gal	6.0	1.4	3.0	0.7
	fluid ounces	cubic inches	fluid drams	cubic inches
1 and ¼ gal	1.0	1.8	4.0	0.9
1½ gal	1.5	2.7	6.0	1.4
	fluid ounces	cubic inches	fluid ounces	cubic inches
2 gal	2.0	3.5	1.0	1.8
3 and 4 gal	4.0	7.0	2.0	3.6
5 gal	6.0	11.0	3.0	5.4
10 gal	10.0	18.0	5.0	9.0

Table of Contents

	Page
Section 4.42. Farm Milk Tanks.....	4-15
A. Application	4-15
A.1.General.....	4-15
A.2. Exceptions.....	4-15
A.3. Additional Code Requirements.	4-15
S. Specifications	4-15
S.1. Components.....	4-15
S.2. Design of Tank.	4-15
S.2.1. Level.	4-15
S.2.2. Level-Indicating Means.	4-15
S.2.3. Portable Tank.	4-15
S.2.4. Capacity.....	4-16
S.3. Design of Indicating Means.....	4-16
S.3.1. General.	4-16
S.3.2. Gauge-Rod Bracket or Supports.	4-16
S.3.3. Gauge Rod.	4-16
S.3.4. Surface-Gauge Bracket or Supports.....	4-16
S.3.5. Surface Gauge.....	4-16
S.3.6. External Gauge Assemblies.	4-16
S.3.7. Graduations.	4-17
S.3.8. <i>Design of Indicating Means on Tanks with a Capacity Greater than 8 000 Liters or 2 000 Gallons.</i>	4-17
S.4. Design of Volume Chart.....	4-17
S.4.1. General.....	4-17
S.4.2. For a Tank of 1 000 Liters, or 250 Gallons, or Less.	4-18
S.4.3. For a Tank of 1 001 Liters to 2 000 Liters, or 251 Gallons to 500 Gallons.	4-18
S.4.4. For a Tank of Greater than 2 000 Liters, or 500 Gallons.	4-18
S.5. Gauging.	4-18
S.5.1. Level.	4-18
S.5.2. To Deliver.	4-18
S.5.3. Preparation of Volume Chart.	4-18
S.6. Identification.....	4-18
N. Notes.....	4-18
N.1. Test Liquid.....	4-18
N.2. Evaporation and Volume Change.	4-18
N.3. To Deliver.....	4-18
N.4. Level.	4-18
N.5. Test Methods.....	4-18
N.5.1. Verification of Master Metering Systems.	4-18
N.5.2. Temperature Changes in Water Supply.....	4-19
N.6. Reading the Meniscus.	4-19
T. Tolerances.....	4-19
T.1. Application.....	4-19
T.2. Minimum Tolerance Values.	4-19
T.3. Basic Tolerance Values.	4-19

T.4. Basic Tolerance Values, Master Meter Method.	4-19
UR. User Requirements.....	4-19
UR.1. Installation.....	4-19
UR.2. Level Condition.....	4-19
UR.2.1. Stationary Tank.....	4-19
UR.2.2. Portable Tank.....	4-19
UR.3. Weight Chart.	4-19
UR.4. Use.	4-19

Section 4.42. Farm Milk Tanks

A. Application

A.1. General. – 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.

A.2. Exceptions. – This code does not apply to tanks mounted on highway vehicles.

A.3. Additional Code Requirements. – In addition to the requirements of this code, Farm Milk Tanks shall meet the requirements of Section 1.10. General Code.

S. Specifications

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) a means for reading the level of liquid in the tank, such as a removable gauge rod or surface gauge; and
- (c) a chart for converting level-of-liquid readings to volume.

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. Level-Indicating Means. – A tank shall be permanently equipped with sensitive means by which the level of the tank can be determined.

S.2.2.1. On a Stationary Tank. – A stationary tank shall be provided with such level-indicating means as 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; provided, that when leveling lugs or the top edge or edges of the tank are used as the reference for level determinations, there shall be supplied with the tank a sensitive spirit level of appropriate dimensions, and the positions where such level is intended to be used shall be permanently marked on the reference surface of the tank; and provided further, that when leveling lugs are used they shall be so designed, constructed, and installed at the factory that any alteration of the original position or condition, such as by hammering or filing, would be difficult and would become obvious. A stationary tank with a nominal capacity of 2 000 L or 500 gal, or greater shall be provided with at least two similar level-indicating means, and these shall be located in opposite and distant positions from each other to facilitate an accurate level determination in both directions of the tank's horizontal plane.

(Amended 1980)

S.2.2.2. On a Portable Tank. – A portable tank shall be provided with either a two-way or a circular level.

S.2.3. Portable Tank. – A portable tank shall be of the center-reading type; that is, it shall be so designed that the gauge rod or surface gauge, when properly positioned for use, will be approximately in the vertical axis of the tank, centrally positioned with respect to the tank walls.

S.2.4. Capacity. – *A farm milk tank shall be clearly and permanently marked on a surface visible after installation with its capacity as determined by the manufacturer. The capacity shall not exceed an amount that can be agitated without overflowing and that can be measured accurately with the liquid at rest.*

[Nonretroactive as of January 1, 1979]

S.3. Design of Indicating Means.

S.3.1. General. – *A tank shall include indicating means and shall be calibrated over the entire range of the volume of the tank from 5 % of capacity or 2 m³ (500 gal) whichever is less, to its maximum capacity.*

[Nonretroactive as of January 1, 1986]

(Added 1985)

S.3.2. Gauge-Rod Bracket or Supports. – If a tank is designed for use with a gauge rod, a substantial and rigid gauge-rod bracket or other suitable supporting elements for positioning the gauge rod shall be provided. A gauge rod and its brackets 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 gauge rod is properly seated on its brackets or supports, there shall be a clearance of at least 7.5 cm (3 in) between the graduated face of the rod and any tank wall or other surface that it faces.

S.3.3. Gauge 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 volume range within which readings of liquid level are to be made.

S.3.4. Surface-Gauge Bracket or Supports. – If a tank is designed for use with a surface gauge, a substantial and rigid surface-gauge bracket or other suitable supporting elements for positioning the surface gauge shall be provided. A surface gauge and its brackets or other supporting elements shall be so constructed that, whenever the gauge 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.3.5. Surface Gauge. – When properly engaged with its bracket and set to its lowest position, a surface gauge shall not touch the bottom of the tank. The gauge shall be graduated throughout an interval corresponding to the volume range within which readings of liquid level are to be made.

S.3.6. External Gauge Assemblies.

S.3.6.1. Design and Installation. – The gauge assembly shall be designed to meet sanitary requirements and shall be readily accessible for cleaning purposes. The gauge assembly shall be mounted in a vertical position and equipped with a sliding mechanism to assist in determining the liquid level.

S.3.6.2. Gauge Tube. – The gauge tube shall be borosilicate glass or approved rigid plastic or rigidly supported flexible tubing with a uniform internal diameter not less than 2 cm (¾ in). It shall be designed and constructed so that all product in the gauge can be discarded in such a manner that no product in the gauge tube will enter the discharge line or tank.

(Amended 1983)

S.3.6.3. Scale Plate. – The scale plate shall be mounted adjacent to and parallel with the gauge tube and be no more than 7 mm (¼ in) from the tube.

S.3.6.4. Scale Graduations. – The graduation lines shall be clear and easily readable and shall comply with the requirements of paragraphs included under S.3.7. Graduations.

S.3.6.5. Venting. – An external gauge tube shall be adequately vented at the top, open to the atmosphere. Any attachment to the gauge tube shall not adversely affect the operation of this vent.

(Added 1984)

(Added 1977)

S.3.7. Graduations.

S.3.7.1. Spacing and Width of Graduations. – On a gauge rod or surface gauge, the spacing of the graduations, center to center, shall be not more than 1.6 mm (0.062 5 in or $\frac{1}{16}$ in) and shall not be less than 0.8 mm (0.031 25 in or $\frac{1}{32}$ in). The graduations shall not be less than 0.12 mm (0.005 in) in width, and the clear interval between adjacent edges of successive graduations shall be not less than 0.4 mm (0.015 625 in or $\frac{1}{64}$ in).

S.3.7.2. Values of Graduations. – On a gauge rod or surface gauge, the graduations may be designated in inches or in centimeters and fractions thereof, or may be identified in a numerical series without reference to inches or centimeters or fractions thereof. In either case, a volume chart shall be provided for each such rod or gauge and each tank with which it is associated, showing values in terms of the graduation on the rod or gauge. If a rod or gauge is associated with but one tank, in lieu of linear or numerical series graduations and volume chart, values in terms of volume of liquid in the tank may be shown directly on the rod or gauge.

S.3.7.3. Value of Graduated Interval. – The value of a graduated interval on a gauge rod or surface gauge (exclusive on the interval from the bottom of the tank to the lowest graduation) shall not exceed:

- (a) 2 L for a tank of a nominal capacity of 1 000 L or less; $\frac{1}{2}$ gal for a tank of a nominal capacity of 250 gal or less;
- (b) 4 L for a tank of a nominal capacity of 1 001 L to 2 000 L, inclusive; 1 gal for a tank of a nominal capacity of 251 gal to 500 gal, inclusive;
- (c) 6 L for a tank of a nominal capacity of 2 001 L to 6 000 L, inclusive; $1\frac{1}{2}$ gal for a tank of a nominal capacity of 501 gal to 1 500 gal, inclusive;
- (d) 8 L for a tank of a nominal capacity of 6 001 L to 10 000 L, inclusive; 2 gal for a tank of a nominal capacity of 1 501 gal to 2 500 gal, inclusive; or
- (e) 8 L plus 4 L for each additional 10 000 L or fraction thereof, for tanks of nominal capacity above 10 000 L or 2 gal plus 1 gal for each additional 2 500 gal or fraction thereof, for tanks with nominal capacity above 2 500 gal.

(Amended 1980)

S.3.8. Design of Indicating Means on Tanks with a Capacity Greater than 8 000 Liters or 2 000 Gallons. – Any farm milk tank with a capacity greater than 8 000 L, or 2 000 gal, shall be equipped with an external gauge assembly.

[Nonretroactive and applicable only to tanks manufactured after January 1, 1981]

(Added 1980)

S.4. Design of Volume Chart.

S.4.1. General. – A volume chart shall show volume values only, over the entire range of the volume of the tank from 5 % of capacity or 2 m³ (500 gal) whichever is less, to its maximum capacity.* 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.

*[*Nonretroactive as of January 1, 1986]*

(Amended 1985)

S.4.2. For a Tank of 1 000 Liters, or 250 Gallons, or Less. – The volume chart for a tank of nominal capacity of 1 000 L, or 250 gal, or less shall show values at least to the nearest 1 L, or ¼ gal.

S.4.3. For a Tank of 1 001 Liters to 2 000 Liters, or 251 Gallons to 500 Gallons. – The volume chart for a tank of nominal capacity of 1 001 L to 2 000 L, or 251 gal to 500 gal, inclusive, shall show values at least to the nearest 2 L, or ½ gal.

S.4.4. For a Tank of Greater than 2 000 Liters, or 500 Gallons. – The volume chart for a tank of nominal capacity of greater than 2 000 L, or 500 gal, shall show values at least to the nearest gallon, or 4 L.
(Amended 1980)

S.5. Gauging.

S.5.1. Level. – A farm milk tank shall be level, as shown by the level-indicating means, during the original gauging operation.

S.5.2. To Deliver. – A farm milk tank shall be originally gauged “to deliver.” If the tank is gauged by measuring the test liquid into the tank, the inside tank walls shall first be thoroughly wetted and the tank shall then be drained for 30 seconds after the main drainage flow has ceased.

S.5.3. Preparation of Volume Chart. – When a tank is gauged for the purposes of preparing a volume chart, tolerances are not applicable, and the chart shall be prepared as accurately as practicable.

S.6. Identification. – A tank and any gauge rod, surface gauge, spirit level, and volume chart intended to be used therewith shall be mutually identified, as by a common serial number, in a prominent and permanent manner.

N. Notes

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 gauged by measuring the test liquid delivered 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 level, as shown by the level-indicating means, during gauging and testing.

N.5. Test Methods. – Acceptance tests of milk tanks may be of either the prover method or the master meter method provided that the master metering system is capable of operating within 25 % of the applicable tolerance found in T.3. Basic Tolerance Values. Subsequent tests may be of either the prover method or the master meter method provided that the master metering system is capable of operating within 25 % of the applicable tolerance found in T.4. Basic Tolerance Values, Master Meter Method.

N.5.1. Verification of Master Metering Systems. – A master metering system used to gauge a milk tank shall be verified before and after the gauging process. A master metering system used to calibrate a milk tank shall be verified before starting the calibration and re-verified at least every quarter of the tank capacity, or every 2 000 L (500 gal), whichever is greater. The above process of re-verifying the master metering system may be waived if the system is verified using a NIST traceable prover with a minimum of two tests immediately before and one test immediately after the gauging process and that each test result is within 25 % of T.3. Basic Tolerance Values.
(Added 2001) (Amended 2012)

N.5.2. Temperature Changes in Water Supply. – When using a master metering system to gauge or calibrate a milk tank, the official shall monitor the temperature of the water before and after changing sources of supply. If the water temperature of the new source changes by more than 2.8 °C (5 °F) from the previous supply, the official shall re-verify the accuracy of the master metering system as soon as possible after the system reaches temperature equilibrium with the new supply source.

(Added 2001)

N.6. Reading the Meniscus. – When a reading or setting is to be obtained from a meniscus formed by milk or other opaque liquid, the index or reading line is the position of the highest point of the center of the meniscus. When calibrating a device with water and the device is to be used with an opaque liquid, the reading should be obtained accordingly; that is, the position of the highest point of the center of the meniscus.

(Added 1984)

T. Tolerances

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 tolerance applied shall be not smaller than the volume corresponding to the graduated interval at the point of test draft on the indicating means or 2 L (½ gal), whichever is greater.

(Amended 1980)

T.3. Basic Tolerance Values. – The basic maintenance and acceptance tolerance shall be 0.2 % of the volume of test liquid in the tank at each test draft.

(Amended 1975)

T.4. Basic Tolerance Values, Master Meter Method. – The basic maintenance and acceptance tolerance for tanks tested by the master meter method shall be 0.4 % of the volume of test liquid in the tank at each test draft.

(Added 1975)

UR. User Requirements

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.2.1.1. Leveling Lugs. – If leveling lugs are provided on a stationary tank, such lugs shall not be hammered or filed to establish or change a level condition of the tank.

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 % or approximately three degrees in any direction.

UR.3. Weight Chart. – An auxiliary weight chart may be provided, on which shall be prominently displayed the weight per unit volume value used to derive the weight values from the official volume chart.

UR.4. Use. – A farm milk tank shall not be used to measure quantities greater than an amount that can be agitated without overflowing.

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Table of Contents

	Page
Section 4.43. Measure-Containers	4-23
A. Application	4-23
A.1. General.....	4-23
A.2. Exceptions.....	4-23
A.3. Additional Code Requirements	4-23
S. Specifications.....	4-23
S.1. Units.....	4-23
S.2. Capacity Point.....	4-23
S.3. Shape.....	4-23
S.4. Marking.....	4-23
S.4.1. Capacity Point.....	4-23
S.4.2. Capacity Statement.	4-23
N. Notes.....	4-24
N.1. Test Liquid.....	4-24
N.2. Preparation of Container for Test.....	4-24
N.2.1. General.....	4-24
N.2.2. Restraining Form for Test.....	4-24
T. Tolerances.....	4-24
T.1. Tolerances on an Individual Measure.	4-24
T.2. Tolerance on Average Capacity.....	4-24
UR. User Requirements	4-24
UR.1. Limitation of Use	4-24

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Section 4.43. Measure-Containers

A. Application

A.1. General. – This code applies to measure-containers, including lids or closures if such are necessary to provide total enclosure of the measured commodity, as follows:

- (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, ice milk, or sherbet) 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.

A.2. Exceptions. – This code does not apply to rigid containers used for milk, cream, or other fluid dairy products, which are covered by packaging requirements.

A.3. Additional Code Requirements. – In addition to the requirements of this code, Measure-Containers shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1. Units. – The capacity of a measure-container shall be a multiple of or a binary submultiple of a quart or a liter, and the measure shall not be subdivided. However, for prepackaged measure-containers, any capacity less than $\frac{1}{4}$ L or $\frac{1}{2}$ liq pt shall be permitted.

(Amended 1979)

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 horizontal cross-sectional plane established by the bottom surface of the removable lid or cap when seated in 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 Section S.1. Units.

N. Notes

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 Containers of One Liter, One Quarter Less. – Bulging of the sides of a rectangular measure-container of 1 L (1 qt) 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.

(Amended 1979)

N.2.2.2. For Rectangular Prepackaged Measure-container of Two Quarts or Two Liters or Greater. – A rectangular prepackaged measure-container of 2 L (2 qt) 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 1.6 mm ($\frac{1}{16}$ in) 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 0.4 mm ($\frac{1}{64}$ in).)

(Amended 1979)

T. Tolerances

T.1. Tolerances on an Individual Measure. – The acceptance tolerances in excess and in deficiency on an individual measure shall be as shown in Table 1. Acceptance Tolerances, in Excess and in Deficiency, for Measure-Containers.

T.2. Tolerance on Average Capacity. – The average capacity on a random sample of 10 measures selected from a lot of 25 or more shall be equal to or greater than the nominal capacity.

(Amended 1979)

UR. User Requirements

UR.1. Limitation of Use. – The use of a measure-container with a rectangular cross section of a capacity of 2 L (2 qt) or greater shall be limited to the packaging, in advance of sale, of ice cream, sherbet, or other similar frozen desserts.

(Amended 1979)

Table 1. Acceptance Tolerances, in Excess and in Deficiency, for Measure-Containers				
Nominal Capacity	Tolerance			
	In Excess		In Deficiency	
	milliliters		milliliters	
¼ liter or less	10		5.0	
½ liter	15		7.5	
1 liter	20		10.0	
Over 1 liter	Add per liter 10 milliliters		Add per liter 5.0 milliliters	
	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
2 quarts	9	2.0	4.5	1.0
3 quarts	10	2.4	5.0	1.2
4 quarts	12	2.8	6.0	1.2
Over 4 quarts	Add per quart 3 fluid drams	Add per quart 0.7 cubic inch	Add per quart 1.5 fluid drams	Add per quart 0.35 cubic inch

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Table of Contents

	Page
Section 4.44. Graduates.....	4-29
A. Application	4-29
A.1. General.....	4-29
A.2. Additional Code Requirements.....	4-29
S. Specifications.....	4-29
S.1. Units.....	4-29
S.2. Initial Interval.	4-29
S.3. Shape.....	4-29
S.4. Material.....	4-30
S.5. Dimensional Proportions.	4-30
S.5.1. On a Circular Conical Graduate.....	4-30
S.5.2. On a Cylindrical Graduate.	4-30
S.6. Base.....	4-30
S.7. Design of Graduations.	4-30
S.7.1. General.....	4-30
S.7.2. On a Single-Scale Graduate.	4-30
S.7.3. On a Double-Scale or a Duplex Graduate.....	4-30
S.8. Basis of Graduation.....	4-30
S.9. Marking Requirements.....	4-30
N. Notes.....	4-31
N.1. Test Liquid.....	4-31
N.2. Temperature Control.....	4-31
T. Tolerances.....	4-31
T.1. Tolerance Values.....	4-31

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Section 4.44. Graduates

A. Application

A.1. General. – This code applies to subdivided glass measures of capacity, either cylindrical or conical in shape.

A.2. Additional Code Requirements. – In addition to the requirements of this code, Graduates shall meet the requirements of Section 1.10. General Code.

S. Specifications

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. Design Details for Graduates.

Table 1. Design Details for Graduates				
Nominal Capacity	To be Graduated Between		Value of Graduated Intervals	Number at Each Graduation Divisible by
milliliters	milliliters		milliliters	milliliters
5	1 and	5	$\frac{1}{2}$	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
500	100 and	500	25	50
1 000	200 and	1 000	50	100
minims	minims		minims	minims
60	15 and	60	5	10 ^a
120	30 and	120	10	20 ^b
fluid drams	fluid drams		fluid drams	fluid drams
4	1 and	4	$\frac{1}{2}$	1
8	2 and	8	1	2
fluid ounces	fluid ounces		fluid ounces	fluid ounces
2	$\frac{1}{2}$ and	2	$\frac{1}{4}$	$\frac{1}{2}$
4	1 and	4	$\frac{1}{2}$	1
8	2 and	8	$\frac{1}{2}$	1
16	4 and	16	1	2
32	8 and	32	2	4
^a And, in addition, at the first (15-minim) graduation.				
^b And, in addition, at the first (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.

S.3. Shape. – A graduate of a capacity of more than 15 mL (4 fl dr) may be of either the cylindrical or circular conical type. A graduate of a capacity of 15 mL (4 fl dr) or less shall be of the single-scale cylindrical type.

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 Circular Conical Graduate. – The inside measurement from the bottom of a circular 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 %, or approximately 15 degrees, from the horizontal.

S.7. Design of Graduations.

S.7.1. General. – Graduations shall be perpendicular to the vertical axis of the graduate and parallel to each other. Graduations shall be continuous, of uniform thickness not greater than 0.4 mm (0.015 in), clearly visible, permanent, and indelible under normal conditions of use.

(Amended 1977)

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.

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. Clear Space Between Ends of Main Graduations on Double Scale Graduates.

Table 2. Clear Space Between Ends of Main Graduations on Double Scale Graduates	
Inside Diameter of Graduate at the Graduations (inches)	Clear Space Between Ends of Main Graduations (inch)
Less than 1.5	$\frac{1}{8}$ to $\frac{1}{4}$
1.5 to 3, inclusive	$\frac{1}{4}$ to $\frac{1}{2}$
Over 3	$\frac{3}{8}$ to $\frac{5}{8}$

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.

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

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 any detrimental temperature effects to the practicable minimum.

T. Tolerances

T.1. Tolerance Values. – Maintenance and acceptance tolerances in excess and in deficiency shall be as shown in Table 3. Maintenance and Acceptance Tolerances, in Excess and Deficiency, for Graduates 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
From	To but Not Including		From	To but Not Including	
millimeters		milliliters	inches		minims
0	16	0.1	0	$\frac{9}{16}$	2
16	21	0.2	$\frac{9}{16}$	$\frac{13}{16}$	3
21	26	0.4	$\frac{13}{16}$	$1\frac{1}{16}$	6
26	31	0.6	$1\frac{1}{16}$	$1\frac{5}{16}$	10
31	36	0.8	$1\frac{5}{16}$	$1\frac{9}{16}$	15
36	41	1.1	$1\frac{9}{16}$	$1\frac{13}{16}$	20
41	46	1.4	$1\frac{13}{16}$	$2\frac{1}{16}$	30
46	51	1.8	$2\frac{1}{16}$	$2\frac{5}{16}$	40
51	56	2.2	$2\frac{5}{16}$	$2\frac{9}{16}$	50
56	61	2.8	$2\frac{9}{16}$	$2\frac{13}{16}$	65
61	66	3.4	$2\frac{13}{16}$	$3\frac{1}{16}$	80
66	71	4.1	$3\frac{1}{16}$	$3\frac{5}{16}$	95
71	76	4.8	$3\frac{5}{16}$	$3\frac{9}{16}$	110
76	81	5.6	$3\frac{9}{16}$	$3\frac{13}{16}$	130
81	86	6.4	$3\frac{13}{16}$	$4\frac{1}{16}$	150
86	91	7.2			
91	96	8.1			
96	101	9.0			

(Amended 1974)

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Table of Contents

	Page
Section 4.45. Dry Measures	4-35
A. Application	4-35
A.1. General.....	4-35
A.2. Exceptions.....	4-35
A.3. Additional Code Requirements	4-35
S. Specifications.....	4-35
S.1. Units.....	4-35
S.2. Material.....	4-35
S.3. Shape.....	4-35
S.3.1. Conical Dry Measure.....	4-35
S.4. Capacity Point.....	4-35
S.5. Top Reinforcement.....	4-35
S.6. Marking Requirements.....	4-36
N. Notes.....	4-36
N.1. Testing Medium.....	4-36
N.1.1. Watertight Dry Measures.....	4-36
N.1.2. Non-Watertight Dry Measures.....	4-36
T. Tolerances.....	4-36
T.1. Tolerance Values.....	4-36

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Section 4.45. Dry Measures

A. Application

A.1. General. – This code applies to rigid measures of capacity designed for general and repeated use in the measurement of solids, including the capacities of $\frac{1}{2}$ bu or more.

A.2. Exceptions.

- (a) This code does not apply to “standard containers” used for the measurement of fruits and vegetables and as shipping containers thereof.
- (b) This code does not apply to berry baskets and boxes. (Also see Section 4.46. Code for Berry Baskets and Boxes.)
(Added 1976)

A.3. Additional Code Requirements. – In addition to the requirements of this code, Dry Measures shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1. Units. – The capacity of a measure shall be 1 bu, 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 $\frac{1}{2}$ bu 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. Minimum Top Diameters for Dry Measure other than Baskets. The bottom of a measure, other than a basket, shall be perpendicular to the vertical 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 movable.

Table 1. Minimum Top Diameters for Dry Measures other than Baskets	
Nominal Capacity	Minimum Top Diameter Inches
1 pint	4
1 quart	$5\frac{3}{8}$
2 quarts	$6\frac{5}{8}$
$\frac{1}{2}$ peck	$8\frac{1}{2}$
1 peck	$10\frac{7}{8}$
$\frac{1}{2}$ bushel	$13\frac{3}{4}$

S.3.1. Conical Dry Measure. – If conical, the top diameter shall exceed the bottom diameter by not more than 10 % of the bottom diameter.

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 qt 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 $\frac{1}{2}$ in high and $\frac{1}{4}$ in wide on a measure of any capacity between $\frac{1}{2}$ pt and 1 pk.
- (b) At least 1 in high and $\frac{1}{2}$ in wide on a measure of a capacity of $\frac{1}{2}$ bu or more.
- (c) On a measure of a capacity of $\frac{1}{4}$ pt or less, the statement shall be as prominent as practicable, considering the size and design of such measure.

N. Notes

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. Non-Watertight Dry Measures. – A dry measure shall be tested either volumetrically using rapeseed as a testing medium or geometrically through inside measurement and calculation.

(Amended 1988)

T. Tolerances

T.1. Tolerance Values. – Maintenance tolerances in excess and in deficiency shall be as shown in Table 2. Maintenance Tolerances, in Excess and in Deficiency, for Dry Measure. 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 Cubic Inches	In Deficiency Cubic Inches
$\frac{1}{32}$ pint or less	0.1	0.05
$\frac{1}{16}$ pint	0.15	0.1
$\frac{1}{8}$ pint	0.25	0.15
$\frac{1}{4}$ pint	0.5	0.3
$\frac{1}{2}$ pint	1.0	0.5
1 pint	2.0	1.0
1 quart	3.0	1.5
2 quarts	5.0	2.5
$\frac{1}{2}$ peck	10.0	5.0
1 peck	16.0	8.0
$\frac{1}{2}$ bushel	30.0	15.0
1 bushel	50.0	25.0

Table of Contents

	Page
Section 4.46. Berry Baskets and Boxes.....	4-39
A. Application	4-39
A.1. General.....	4-39
A.2. Additional Code Requirements.....	4-39
S. Specifications.....	4-39
S.1. Units.....	4-39
S.2. Materials.....	4-39
S.3. Capacity Point.....	4-39
N. Notes.....	4-39
N.1. Method of Test.....	4-39
T. Tolerances.....	4-39
T.1. Tolerances on Individual Measures.....	4-39
T.2. Tolerances on Average Capacity.....	4-39

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Section 4.46. Berry Baskets and Boxes

A. Application

A.1. General. – This code applies to baskets and boxes for berries and small fruits in capacities of 1 dry quart and less.

A.2. Additional Code Requirements. – In addition to the requirements of this code, berry baskets and boxes shall meet the requirements of Section 1.10. General Code.

S. Specifications

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. Materials. – A berry basket or box shall be made of any suitable materials 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

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

T.1. Tolerances on Individual Measures. – Maintenance and acceptance tolerances in excess and deficiency on an individual measure shall be as shown in Table 1. Maintenance and Acceptance Tolerances in Excess and in Deficiency.

T.2. Tolerances on Average Capacity. – The average capacity on a random sample of 10 measures selected from a lot of 25 or more shall be equal to or greater than the nominal capacity.

(Amended 1979)

Table 1. Maintenance and Acceptance Tolerances in Excess and in Deficiency		
Nominal Capacity	Tolerance	
	In Excess Cubic Inches	In Deficiency Cubic Inches
½ pint	1	0.5
1 pint	2	1.0
1 quart	3	1.5

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Section 5

Table of Contents

	Page
5.50. Fabric-Measuring Devices.....	5-3
5.51. Wire- and Cordage-Measuring Devices.....	5-9
5.52. Linear Measures.....	5-15
5.53. Odometers.....	5-19
5.54. Taximeters	5-25
5.55. Timing Devices.....	5-39
5.56.(a) Grain Moisture Meters.....	5-47
5.56.(b) Grain Moisture Meters.....	5-59
5.57. Near-Infrared Grain Analyzers	5-69
5.58. Multiple Dimension Measuring Devices	5-79
5.59. Electronic Livestock, Meat, and Poultry Evaluation Systems and/or Devices	5-93
5.60. Transportation Network Measurement Systems – Tentative Code.....	5-97

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Table of Contents

	Page
Section 5.50. Fabric-Measuring Devices	5-5
A. Application	5-5
A.1. General.....	5-5
A.2. Devices Used to Measure Other Similar Material in Sheet, Roll, or Bolt Form.	5-5
A.3. Additional Code Requirements.	5-5
S. Specifications.....	5-5
S.1. Units.....	5-5
S.2. Design of Indicating Elements.....	5-5
S.2.1. Graduations.....	5-5
S.2.2. Indicator.....	5-5
S.2.3. Money-Value Computations.....	5-6
S.2.4. Return to Zero.....	5-6
S.3. Marking Requirements.....	5-6
S.4. Design Accuracy.....	5-6
N. Notes.....	5-7
N.1. Testing Medium.....	5-7
T. Tolerances.....	5-7
T.1. Tolerance Values.	5-7
UR. User Requirements	5-7
UR.1. Installation Requirements.	5-7
UR.1.1. Installation.	5-7
UR.2. Use Requirements.	5-7
UR.2.1. Limitation of Use.....	5-7
UR.2.2. Return of Indicating Elements to Zero.....	5-7

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Section 5.50. Fabric-Measuring Devices

A. Application

A.1. General. – 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.

A.2. Devices Used to Measure Other Similar Material in Sheet, Roll, or Bolt Form. – Insofar as they are clearly appropriate, the requirements and provisions of this code apply also to devices designed for the commercial measurement of other material similar to fabrics, in sheet, roll, or bolt form.

A.3. Additional Code Requirements. – In addition to the requirements of this code, Fabric-Measuring Devices shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1. Units. – A fabric-measuring device shall indicate lengths as follows:

- (a) For devices indicating in metric units, lengths shall be indicated in terms of 5 cm; 10 cm; 25 cm; or 50 cm and meters.

In addition, lengths may be indicated in terms of any or all of the following subdivisions: millimeters and centimeters.

- (b) For devices indicating in U.S. customary units, lengths shall be indicated in terms of $\frac{1}{8}$ yd; $\frac{1}{4}$ yd; or $\frac{1}{2}$ yd; and yards.

In addition, lengths may be indicated in terms of any or all of the following subdivisions: $\frac{1}{8}$ yd; $\frac{1}{16}$ yd; inches and feet.

Digital indicators may indicate values in decimal fractions.

(Amended 1977)

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 % greater than the width of subordinate graduations. Graduations shall in no case be less than 0.2 mm (0.008 in) in width.

S.2.1.3. Clear Interval between Graduations. – The clear interval between graduations shall be at least 6 mm for cm graduations ($\frac{1}{4}$ in for $\frac{1}{8}$ yd graduations), and 3 mm for 20 cm graduations ($\frac{1}{8}$ in for 1 in graduations).

S.2.2. Indicator.

S.2.2.1. Symmetry. – The index of an indicator shall be symmetrical with respect to the graduations, at least throughout that portion of its length associated with the graduations.

S.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 1.0 mm (0.04 in).

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 0.4 mm (0.015 in).

S.2.2.4. Clearance. – The clearance between the index of an indicator and the graduations shall in no case be more than 1.5 mm (0.06 in).

S.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 two-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 $\frac{1}{2}$ cent shall be dropped and the next higher cent shall be shown in the case of a fraction of $\frac{1}{2}$ 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 10 cm ($\frac{1}{8}$ yd) 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 positions.

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

N.1. Testing Medium. – A fabric-measuring device shall be tested with a suitable testing tape approximately 7.62 cm (3 in) wide and with a graduated length of at least 11 m (12 yd), made from such material and having such surface finish as to provide dimensional stability and reduce slippage to the practicable minimum.

T. Tolerances

T.1. Tolerance Values. – Maintenance and acceptance tolerances shall be as shown in Table 1. Maintenance and Acceptance Tolerances for Fabric-Measuring Devices.

Table 1. Maintenance and Acceptance Tolerances for Fabric-Measuring Devices				
Indication of Device (yards)	Maintenance Tolerance		Acceptance Tolerance	
	On Under- registration (inches)	On Over- registration (inches)	On Under- registration (inches)	On Over- registration (inches)
2 or less	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{8}$
3	$\frac{3}{8}$	$\frac{5}{16}$	$\frac{1}{4}$	$\frac{5}{32}$
4	$\frac{1}{2}$	$\frac{5}{16}$	$\frac{1}{4}$	$\frac{5}{32}$
5	$\frac{5}{8}$	$\frac{3}{8}$	$\frac{5}{16}$	$\frac{3}{16}$
6	$\frac{3}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{16}$
7 and 8	1	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$
9	$1\frac{1}{4}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{16}$
10 and 11	$1\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{8}$
12 and 13	$1\frac{3}{4}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{16}$
14 and 15	2	1	1	$\frac{1}{2}$
Over 15	Add $\frac{1}{8}$ inch per indicated yard	Add $\frac{1}{16}$ inch per indicated yard	Add $\frac{1}{16}$ inch per indicated yard	Add $\frac{1}{32}$ inch per indicated yard

UR. User Requirements

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.

UR.2.2. Return of Indicating Elements to Zero. – The primary indicating elements shall be returned to zero before each measurement.

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Table of Contents

	Page
Section 5.51. Wire- and Cordage-Measuring Devices.....	5-11
A. Application	5-11
A.1. General.....	5-11
A.2. Additional Code Requirements	5-11
S. Specifications.....	5-11
S.1. Units.....	5-11
S.2. Design of Indicating Elements.....	5-11
S.2.1. Graduations.....	5-11
S.2.2. Indicator	5-11
S.2.3. Zero Indication.....	5-11
S.3. Design of Measuring Elements.....	5-12
S.3.1. Sensitiveness.....	5-12
S.3.2. Slippage	5-12
S.3.3. Accessibility.....	5-12
S.4. Marking Requirements.....	5-12
S.4.1. Limitation of Use.....	5-12
S.4.2. Operating Instructions.....	5-12
S.4.3. Indications.....	5-12
S.5. Design Accuracy.....	5-12
N. Notes.....	5-12
N.1. Testing Medium.....	5-12
N.2. Minimum Test.....	5-12
T. Tolerances.....	5-12
T.1. Tolerance Values.....	5-12
UR. User Requirements.....	5-13
UR.1. Installation Requirements.....	5-13
UR.1.1. Installation.....	5-13
UR.2. Use Requirements.....	5-13
UR.2.1. Limitation of Use.....	5-13
UR.2.2. Return to Zero.....	5-13
UR.2.3. Operation of Device.....	5-13
UR.2.4. Cleanliness.....	5-13

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Section 5.51. Wire- and Cordage-Measuring Devices

A. Application

A.1. General. – 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.

A.2. Additional Code Requirements. – In addition to the requirements of this code, Wire- and Cordage-Measuring Devices shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1. Units. – A wire- or cordage-measuring device shall indicate lengths in terms of feet, yards, or meters, or combinations of units of the same measurement system, and shall have minimum increments with values that do not exceed the equivalent of 0.1 meter or 0.1 yard.

(Amended 1989)

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 % greater than the width of subordinate graduations. Graduations shall in no case be less than 0.2 mm (0.008 in), nor more than 1.0 mm (0.04 in), 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 0.8 mm (0.03 in).

S.2.2. Indicator.

S.2.2.1. Symmetry. – The index of an indicator shall be symmetrical with respect to the graduations, at least throughout that portion of its length associated with the graduations.

S.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 1.0 mm (0.04 in).

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 0.4 mm (0.015 in).

S.2.2.4. Clearance. – The clearance between the index of an indicator and the graduations shall in no case be more than 1.5 mm (0.06 in).

S.2.2.5. Parallax. – Parallax effects shall be reduced to the practicable minimum.

S.2.3. Zero Indication. – Primary indicating elements shall be readily returnable to a definite zero indication.

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 30 cm (1 ft) shall be not less than 6 mm ($\frac{1}{4}$ in).

S.3.2. Slippage. – The measuring elements of a wire- or 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.3.3. Accessibility. – A wire- or cordage-measuring device shall be so constructed that the measuring elements are readily visible and accessible, without disassembly of any supporting frame or section of the main body, for purposes of cleaning or removing any foreign matter carried into the mechanism by the material being measured.

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, all 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

N.1. Testing Medium. – Wherever feasible, a wire- or cordage-measuring device shall be tested with a steel tape not less than 10 mm ($\frac{3}{8}$ in) in width and at least 15 m (50 ft) in length. When a device cannot be tested in this manner because of the design of the device, it shall be tested with a dimensionally stable material appropriately marked and compared at frequent periodic intervals with a steel tape in order to assure that any marked interval is not in error by more than $\frac{1}{3}$ of the tolerance of the device at that particular interval.

(Amended 1981)

N.2. Minimum Test. – Tests shall be conducted at a minimum initial increment of 5 m (20 ft) and appropriate increments up to at least 15 m (50 ft).

T. Tolerances

T.1. Tolerance Values. – Maintenance and acceptance tolerances shall be as shown in Table 1. Maintenance and Acceptance Tolerances for Wire- and Cordage-Measuring Devices.

Table 1. Maintenance and Acceptance Tolerances for Wire- and Cordage-Measuring Devices		
Indication of Device (feet)	Acceptance and Maintenance Tolerances	
	On Underregistration (inches)	On Overregistration (inches)
20	6	3
Over 20 to 30	8	4
Over 30 to 40	10	5
Over 40 to 50	12	6
Over 50	Add 2 inches per indicated 10 feet	Add 1 inch per indicated 10 feet

UR. User Requirements

UR.1. Installation Requirements.

UR.1.1. Installation. – A wire- or cordage-measuring device shall be securely supported and firmly fixed in position.

UR.2. Use Requirements.

UR.2.1. Limitation of Use. – A wire- or 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.

UR.2.2. Return to Zero. – The primary indicating elements of a wire- or cordage-measuring device shall be returned to zero before each measurement.

UR.2.3. Operation of Device. – A wire- or cordage-measuring device shall not be operated in such a manner as to cause slippage or inaccurate measurement.

UR.2.4. Cleanliness. – The measuring elements of a wire- or cordage-measuring device shall be kept clean to prevent buildup of dirt and foreign material that would adversely affect the measuring capability of the device.

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Table of Contents

	Page
Section 5.52. Linear Measures	5-17
A. Application	5-17
A.1. General.....	5-17
A.2. Additional Code Requirements.....	5-17
S. Specifications.....	5-17
S.1.M.Units.....	5-17
S.1. Units.....	5-17
S.2. Material.....	5-17
S.2.1. Flexible Tape.....	5-17
S.2.2. End Measure.....	5-17
S.3. Finish.....	5-17
S.4. Design.....	5-17
S.4.1. Rigid Measure.....	5-17
S.4.2. Folding Measure.....	5-17
S.5. Graduations.....	5-18
S.5.1. General.....	5-18
S.5.2. Width.....	5-18
T. Tolerances.....	5-18
T.1. For Measures Except Metal Tapes.....	5-18
T.2. For Metal Tapes.....	5-18

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Section 5.52. Linear Measures

A. Application

A.1. General. – This code applies to any linear measure or measure of length, whether flexible or inflexible, permanently installed or portable.

A.2. Additional Code Requirements. – In addition to the requirements of this code, Linear Measures shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1.M. Units. – A linear measure may be in total length, and the total length may be subdivided in any or all of the following:

- (a) centimeters and tenths of the centimeter;
- (b) meters; and
- (c) multiples of meters.

A one-meter measure may be graduated, in addition, to show 0.1 m and multiples of 0.1 m subdivisions.

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 $\frac{1}{3}$ yd and $\frac{2}{3}$ yd subdivisions. A flexible tape may be graduated in tenths or hundredths of a foot, or both tenths and hundredths of a foot. (Any other subdivisions are allowable only on measures of special purposes and when required for such purposes.)

S.2. Material.

S.2.1. Flexible Tape. – A flexible tape shall be made of metal.

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-half the width of the smallest graduated interval on the measure, and in no case shall be wider than 0.75 mm (0.03 in).

(Amended 1982)

T. Tolerances

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. Maintenance Tolerances, in Excess and in Deficiency, for Linear Measures Except Metal Tapes. 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
$\frac{1}{2}$ or less	$\frac{1}{64}$
1	$\frac{1}{32}$
2	$\frac{1}{16}$
3	$\frac{3}{32}$
4	$\frac{1}{8}$
5	$\frac{5}{32}$
6	$\frac{3}{16}$

T.2. For Metal Tapes. – Maintenance and acceptance tolerances in excess and in deficiency for metal tapes shall be as shown in Table 2. Maintenance and Acceptance Tolerances, in Excess and in Deficiency, for Metal Tapes. Tapes of 10 m (25 ft) or over shall be tested at a tension resulting from a load of 5 kg (10 lb). Tapes less than 10 m (25 ft) shall be tested at a tension resulting from a load of 2.5 kg (5 lb). However, flexible metal tapes of 10 m (25 ft) or less that are not normally used under tension shall be tested with no tension applied. All tapes shall be supported throughout on a horizontal flat surface whenever tested.

(Amended 1972)

Table 2. Maintenance and Acceptance Tolerances, in Excess and in Deficiency, for Metal Tapes	
Nominal Interval from Zero	Tolerance
Feet	Inch
6 or less	$\frac{1}{32}$
7 to 30, inclusive	$\frac{1}{16}$
31 to 55, inclusive	$\frac{1}{8}$
56 to 80, inclusive	$\frac{3}{16}$
81 to 100, inclusive	$\frac{1}{4}$

Table of Contents

	Page
Section 5.53. Odometers	5-21
A. Application	5-21
A.1. General.....	5-21
A.2. Exceptions.....	5-21
A.3. Additional Code Requirements.	5-21
S. Specifications.....	5-21
S.1. Design of Indicating Elements.	5-21
S.1.1. General.....	5-21
S.1.2. Units.....	5-21
S.1.3. Minimum Indicated Value.	5-21
S.1.4. Advancement of Indicating Elements.	5-21
S.1.5. Readability.	5-21
S.1.6. Digital Indications and Representation.	5-22
N. Notes.....	5-22
N.1. Testing Procedures.....	5-22
N.1.1. Test Methods.....	5-22
N.1.2. Test Runs.	5-22
N.1.3. Test Conditions.	5-22
T. Tolerances.....	5-23
T.1. To Underregistration and to Overregistration.	5-23
T.2. Tolerance Values.	5-23
T.2.1. Tolerances for Unloaded Trucks.	5-23
UR. User Requirements.....	5-23
UR.1. Inflation of Vehicle Tires.....	5-23

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Section 5.53. Odometers

A. Application

A.1. General. – This code applies to odometers that are used or are to be used to determine the charges for rent or hire of passenger vehicles and trucks and buses. (When official examinations are undertaken on odometers that 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.)

(Amended 1977)

A.2. Exceptions. – This code does not apply to taximeters (for which see Section 5.54. Code for Taximeters).

(Amended 1977)

A.3. Additional Code Requirements. – In addition to the requirements of this code, Odometers shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1. Design of Indicating Elements.

S.1.1. General. – The primary indicating element of an odometer may be:

- (a) the distance-traveled portion of the “speedometer” assembly of a motor vehicle;
- (b) a special cable-driven distance-indicating device; or
- (c) a hub odometer attached to the hub of a wheel on a motor vehicle.

(Amended 1977)

S.1.2. Units. – An odometer shall indicate in terms of miles or kilometers.

(Amended 1977)

S.1.3. Minimum Indicated Value. – The value of the interval of indicated distance shall be:

- (a) for odometers indicating in kilometers, 0.1 km; or
- (b) for odometers indicating in miles, 0.1 mi.

(Amended 1977)

S.1.4. Advancement of Indicating Elements. – The most sensitive indicating elements of an odometer may advance continuously or intermittently; all other elements shall advance intermittently. Except when the indications are being returned to zero, the indications of an installed odometer shall be susceptible to advancement only by the rotation of the vehicle wheel or wheels.

(Amended 1977)

S.1.5. Readability. – Distance figures and their background shall be of sharply contrasting colors. Figures indicating tenth units shall be differentiated from other figures with different colors, or with a decimal point, or by other equally effective means. Except during the period of advance of any decade to the next higher indication,

only one figure in each decade 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.

(Amended 1977)

S.1.6. Digital Indications and Representation. – Digital indicating odometers (discontinuous registration) shall “round off” indications to the nearest minimum division or truncate indications to the lower minimum division.

(Added 1990)

N. Notes

N.1. Testing Procedures.

N.1.1. Test Methods. – To determine compliance with distance tolerances, a distance test of an odometer shall be conducted using 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 consists of determining the distance traveled by use of a roller device, or by computation from rolling circumference and wheel-turn data.

(Amended 1977)

N.1.2. Test Runs. – Not less than two test runs shall be conducted. Acceleration and deceleration shall be carefully controlled to avoid spinning or skidding the wheels.

(Amended 1977)

N.1.2.1. For Devices Indicating in Miles. – The test runs shall be 2 mi in length, shall start from, and finish at, a dead stop with a minimum of 80 % of the run between 30 mi/h and 45 mi/h.

(Added 1977)

N.1.2.2. For Devices Indicating in Kilometers. – The test runs shall be 3 km in length, shall start from, and finish at, a dead stop with a minimum of 80 % of the run between 50 km/h and 75 km/h.

(Added 1977)

N.1.3. Test Conditions.

N.1.3.1. Tire Stabilization. – Road tests or fifth-wheel tests shall be preceded by a run of at least 8 km or 5 mi, for the purpose of stabilizing tire pressures. Simulated road tests on a roller device shall be made at stable tire pressures.

(Amended 1977)

N.1.3.2. Tire Pressure. – At the completion of the test run or runs, the tires of the vehicle under test shall be checked to determine that the tire pressure is that operating tire pressure posted in the vehicle. If not, the tire pressure should be adjusted to the posted tire pressure and further tests may be conducted to determine the operating characteristics of the odometer.

(Amended 1977)

N.1.3.3. Vehicle Loading.

- (a) **Passenger Load.** – During the distance test of an odometer, the vehicle may carry two persons.
 - (b) **Truck Cargo Load.** – Truck odometers shall be tested by one of the following methods:
 - (1) the truck is loaded with one-half of the maximum cargo load; or
 - (2) unloaded if unloaded test tolerances are applied.
- (Amended 1977 and 1987)

T. Tolerances

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. – Except for unloaded trucks, maintenance and acceptance tolerances on odometers shall be 4 % of the interval under test.
(Amended 1977 and 1987)

T.2.1. Tolerances for Unloaded Trucks. – Maintenance and acceptance tolerances on truck odometers shall be 5 % for underregistration and 3 % for overregistration of the interval under test.
(Added 1987)

UR. User Requirements

UR.1. Inflation of Vehicle Tires. – The operational tire pressure of passenger vehicle and truck tires shall be posted in the vehicle and tires shall be maintained at the posted pressure.
(Amended 1977)

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Table of Contents

	Page
Section 5.54. Taximeters.....	5-27
A. Application	5-27
A.1. General.....	5-27
A.2. Exceptions.....	5-27
A.3. Additional Code Requirements.	5-27
S. Specifications	5-27
S.1. Design of Indicating and Recording Elements.	5-27
S.1.1. General.....	5-27
S.1.2. Advancement of Indicating Elements.	5-27
S.1.3. Visibility of Indications.	5-28
S.1.4. Actuation of Fare-Indicating Mechanism.....	5-28
S.1.5. Operating Condition.....	5-29
S.1.6. Fare Identification.	5-29
S.1.7. Extras.	5-29
S.1.8. Protection of Indications.	5-29
S.1.9. <i>Recorded Representation</i>	5-29
S.1.10. <i>Non-fare Information</i>	5-30
S.2. Basis of Fare Calculations.	5-30
S.2.1. Initial Time and Distance Intervals.	5-31
S.3. Design of Operating Control.	5-31
S.3.1. Positions of Control.	5-31
S.3.2. Control for Extras Mechanism.	5-31
S.4. Interference.....	5-31
S.5. Provision for Security Seals.....	5-31
S.5.1. Taximeter Connected to Networked Systems.	5-32
S.5.2. Taximeters Calibrated to Specific Vehicles.	5-33
S.6. Power Interruption, Electronic Taximeters.....	5-33
S.7. Measurement Signal Loss.....	5-33
S.7.1. Intermittent Trip Data Loss.	5-33
S.7.2. Significant Trip Data Loss.	5-33
S.8. Anti-Fraud Provisions, Electronic Taximeters.	5-33
N. Notes.....	5-34
N.1. Distance Tests.	5-34
N.1.1. Test Methods.	5-34
N.1.2. Test Procedures.	5-34
N.1.3. Test Conditions.....	5-35
N.2. Time Test	5-35
N.3. Interference Test.	5-35
T. Tolerances.....	5-36
T.1. Tolerance Values.....	5-36
T.1.1. On Distance Tests.	5-36
T.1.2. On Time Tests.....	5-36
T.1.3. On Interference Tests.....	5-36
T.2. Tests Using Transfer Standards.....	5-36
UR. User Requirements.....	5-36

UR.1. Inflation of Vehicle Tires.	5-36
UR.2. Position and Illumination of Taximeter.....	5-36
UR.3. Statement of Rates.....	5-37

Section 5.54. Taximeters

A. Application

A.1. General. – 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. Exceptions. – This code does not apply to the following:

- (a) odometers on vehicles that are rented on a distance basis. (Also see Section 5.53. Code for Odometers.)
- (b) devices that only display a flat rate or negotiated rate; or
- (c) Transportation Network Measurement Systems. (Also see Section 5.60. Transportation Network Measurement Systems.)

(Amended 1977, 2016, and 2017)

A.3. Additional Code Requirements. – In addition to the requirements of this code, Taximeters shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1. Design of Indicating and Recording Elements.

S.1.1. General. – A taximeter shall be equipped with a primary indicating element.

(Amended 1988 and 2015)

S.1.1.1. Recording Elements. – *A receipt providing information as required in S.1.9. Recorded Representations shall be available from a taximeter or taximeter system through an integral or separate recording element for all transactions conducted.*

[Nonretroactive January 1, 2016]

(Added 2015)

S.1.2. Advancement of Indicating Elements. – Except when a taximeter is being cleared, the primary indicating and recording elements shall be susceptible of advancement only by the movement of the vehicle or by the time mechanism.

At the conclusion of a transaction (e.g., following the totalizing of all accrued charges and having a customer receipt made available), no other advancement of fare, extras, or other charges shall occur until the taximeter has been cleared.

[Nonretroactive as of January 1, 2017]

Where permitted, a flat rate or negotiated rate shall be displayed in the “fare” indicating mechanism, provided that once a flat rate or negotiated rate is entered the fare may no longer be advanced by movement of the vehicle or the time mechanism.

(Amended 1988 and 2016)

S.1.2.1. Time Mechanism. – Means shall be provided on all taximeters designed to calculate fares based on a combination of time elapsed and distance traveled, to enable the vehicle operator to render the time mechanism either operative or inoperative with respect to the fare-indicating mechanism.

(Added 2017)

S.1.2.2. Distance Mechanism. – Means shall be provided on all taximeters designed to calculate fare based on a combination of time elapsed and/or distance traveled to enable the vehicle operator to render the distance mechanism either operative or inoperative with respect to the fare-indicating mechanism.

[Nonretroactive as of January 1, 2020]

(Added 2017) (Amended 2018)

S.1.3. Visibility of Indications.

S.1.3.1. Taximeter Indications. – The indications of fare, including extras, and the mode of operation, such as “time” or “hired,” shall be constantly displayed whenever the meter is in operation. All indications of passenger interest shall be easily read from a distance of 1.2 m (4 ft) under any condition of normal operation. This includes any necessary lighting, shading, or other means necessary to make displayed indications clearly visible to operator and passenger.

(Amended 1977, 1986, 1988, and 2017)

S.1.3.2. Minimum Height of Figures, Words, and Symbols. – The minimum height of the figures used to indicate the fare shall be 10 mm and for extras, 8 mm. The minimum height of the figures, words, or symbols used for other indications, including those used to identify or define, shall be 3.5 mm.

(Added 1986)

S.1.3.3. Passenger’s Indications. – A supplementary indicating element installed in a taxi to provide information regarding the taxi service to the passenger (i.e., Passenger Information Monitor or PIM), shall clearly display the current total of all charges incurred for the transaction. The accruing total of all charges must remain clearly visible on the passenger’s display (unless disabled by the passenger) at all times during the transaction.

[Nonretroactive as of January 1, 2016]

(Added 2015) (Amended 2017)

S.1.3.3.1. Additional Information. – Additional information shall be displayed or made available through a passenger’s indicating element (as described in S.1.3.3. Passenger’s Indications) and shall be current and reflect any charges that have accrued. This additional information shall include:

- (a) an itemized account of all charges incurred including fare, extras, and other additional charges; and
- (b) the rate(s) in use at which any fare is calculated.

Any additional information made available must not obscure the accruing total of charges for the taxi service. This additional information may be made accessible through clearly identified operational controls (e.g., keypad, button, menu, touch-screen).

[Nonretroactive as of January 1, 2016]

(Added 2015)

S.1.3.3.2. Fare and Extras Charges. – The indication of fare and extras charges on a passenger’s indicating element shall agree with similar indications displayed on all other indicating elements in the system.

[Nonretroactive as of January 1, 2016]

(Added 2015)

S.1.4. Actuation of Fare-Indicating Mechanism. – When a taximeter designed to calculate fares upon the basis of a combination of distance traveled and time elapsed, but not both time and distance used concurrently to calculate fare, is operative with respect to fare indication, the fare-indicating mechanism shall be actuated by the distance mechanism whenever the vehicle is in motion at such a speed that the rate of distance 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.

(Amended 1977 and 2017)

S.1.5. Operating Condition.

S.1.5.1. General. – When a taximeter is cleared, the indication “Not Registering,” “Vacant,” or an equivalent expression shall be shown. Whenever a taximeter is set to register charges, it shall indicate “Registering,” “Hired,” or an equivalent expression and the rate at which it is set shall be automatically indicated (Rate 1 or Rate A, for example).

(Amended 1988)

S.1.5.2. Time not Recording. – When a taximeter is set for fare registration with the time mechanism inoperative, it shall indicate “Time Not Recording” or an equivalent expression.

(Amended 1988)

S.1.5.3. Distance Not Recording. – *When a taximeter is set for fare registration with the distance mechanism inoperative, it shall indicate “Distance Not Recording” or an equivalent expression.*

[Nonretroactive as of January 1, 2020]

(Added 2017) (Amended 2018)

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. – 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. Means may be provided to totalize the fare and extras if the totalized amount returns to separate indications of fare and extras within 5 seconds or less.

(Amended 1988)

S.1.7.1. Nonuse of Extras. – If and when taximeter extras are prohibited by legal authority or are discontinued by a vehicle operator, the extras mechanisms shall be rendered inoperable or the extras indications shall be effectively obscured by permanent means.

S.1.8. Protection of Indications. – All indications of fare and extras shall be protected from unauthorized alteration or manipulation.

(Amended 2015)

S.1.9. Recorded Representation. – *A printed or electronic receipt issued from a taximeter, whether through an integral or separate recording element, shall include as a minimum, the following information when processed through the taximeter system:*

(a) *date;*

(b) *unique vehicle identification number, such as the medallion number, taxi number, vehicle identification number (VIN), permit number, or other identifying information as specified by the statutory authority;**

(c) *start and end time of the trip;**

(d) *distance traveled, maximum increment of 0.1 km (0.1 mi);**

(e) *fare in \$;*

- (f) *each rate at which the fare was computed and the associated fare at that rate;**
- (g) *additional charges (in \$) where permitted such as extras, any surcharges, telecommunication charges, and taxes shall be identified and itemized;**
- (h) *total charge for service in \$ (inclusive of fare, extras, and all additional charges);**
- (i) *trip number, if available;***
- (j) *telephone number (or other contract information) for customer assistance;**and*
- (k) *a statement of chargeable time and chargeable distance for taximeters that calculate fare using time and distance concurrently.****

Note: When processed through the taximeter or taximeter system, any adjustments (in \$) to the total charge for service including discounts, credits, and tips shall also be included on the receipt.**

[Nonretroactive as of January 1, 1989]

*[Nonretroactive as of January 1, 2000]

**[Nonretroactive as of January 1, 2016]

***[Nonretroactive as of January 1, 2018]

(Added 1988) (Amended 1999, 2015, and 2017)

S.1.9.1. Multiple Recorded Representations - Duplicate Receipts. – A recording element may produce a duplicate receipt for the previous transaction provided the information printed is identical to the original with the exception of time issued. The duplicate receipt shall include the words “duplicate” or “copy.” The feature to print a duplicate receipt shall be deactivated at the time the meter is hired for the next fare.

[Nonretroactive as of January 1, 2000]

(Added 1999)

S.1.10. Non-fare Information. – The fare and extras displays may be used to display auxiliary information provided the meter is in the vacant condition and such information is only displayed for 10 seconds, or less. If the information consists of a list of information, the list may be displayed one item after another, provided that each item is displayed for 10 seconds, or less.

[Nonretroactive as of January 1, 2002]

(Added 2000)

S.2. Basis of Fare Calculations. – A taximeter shall calculate fares only upon the basis of:

- (a) distance traveled;
- (b) time elapsed; or
- (c) a combination of distance traveled and time elapsed.

A taximeter may utilize more than one rate to calculate the fare during a trip. Any change in the applied rate must occur at the completion of the current interval.

(Amended 1977 and 2016)

S.2.1. Initial Time and Distance Intervals. – The time and distance intervals of a taximeter that does not calculate fares based on distance traveled and time elapsed used concurrently shall be directly proportional as expressed in the following formula:

$$\frac{\text{Seconds of Initial Time Interval}}{\text{Seconds per Non – Initial Time Interval}} = \frac{\text{Distance of Initial Mileage Interval}}{\text{Distance per Non – Initial Mileage Interval}}$$

(Added 1990) (Amended 2017)

S.3. Design of Operating Control.

S.3.1. Positions of Control. – The several positions of the operating controls shall be clearly defined and shall be so constructed that accidental or inadvertent changing of the operating condition of the taximeter is improbable. Movement of the operating controls to an operating position immediately following movement to the cleared position shall be delayed enough to permit the taximeter to come to a complete rest in the cleared position.

(Amended 1988)

S.3.2. 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.4. Interference. – The design of a taximeter shall be such that when a fare is calculated by using time and/or by using distance (but not used concurrently) there will be no interference between the time and the distance portions of the mechanism device at any speed of operation.

(Amended 1977, 1988, and 2017)

S.5. Provision for Security Seals. – Adequate provision shall be made for an approved means of security (e.g., data change audit trail) or physically applying security seals in such a manner that requires the security seal to be broken before an adjustment or interchange can be made of:

- (a) any metrological parameter affecting the metrological integrity of the taximeter and associated equipment;
or
- (b) any metrological parameter controlled by software residing in the taximeter or an associated external computer network.

When applicable, the adjusting mechanism shall be readily accessible for purposes of affixing a security seal. (Audit trails shall use the format set forth in Table S.5. Categories of Device and Methods of Sealing)

(Amended 1988, 2000, and 2017)

Table S.5. Categories of Device and Methods of Sealing	
Categories of Device	Methods of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode. The device shall not operate as normal when in the remote configuration mode.	The hardware enabling access for remote access to calibration functions must be at the device and sealed using a physical seal and the device shall include an event logger. An event logger must be used to record changes to configuration parameters made through remote access. The event logger must include event counters (000 to 999 with a minimum count of 1000 events), the parameter ID, the date and time of the change, and the new value of the parameter. A printed or electronic copy of the information must be available through the device. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: Does not require 1000 changes to be stored for each parameter.
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode. The device shall not operate as normal when in the remote configuration mode.	An event logger must be used to record changes to adjustable parameters that are made through remote access and which is accessible only by authorized persons (using an Internet web browser or other such secure software). The event logger shall include event counters, the date and time of the change, the parameter ID, and the new value of the parameter. A printed or electronic copy of the information must be available through the device. The event loggers shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: Does not require 1000 change to be stored for each parameter.) The device shall become inoperable when access to the system's metrological parameters is made through unapproved or unauthorized means. The device shall remain inoperable until cleared by the official having statutory authority.

[Nonretroactive as of January 1, 2018]

(Table Added 2017) (Amended 2022)

S.5.1. Taximeter Connected to Networked Systems. – Metrological features that are not located on the taximeter device installed in the vehicle (i.e., accessed through a computer network, server, or “cloud”) shall be secured by means that will:

- (a) protect the integrity of metrological data and algorithms used to compute fares from such data against unauthorized modifications; and

- (b) use software-based access controls or equivalent technological protections that limit access to metrological data and algorithms used to compute fares from such data only to authorized persons.

(Added 2017)

S.5.2. Taximeters Calibrated to Specific Vehicles. – In the case of taximeters where the proper performance and calibration of the device has been verified when used in a specific vehicle and which may be removed from the vehicle (e.g., slide mounting the taximeter), means shall be provided through a physical seal or electronic link between components affecting accuracy or indications of the device to ensure that its performance is not affected and operation is permitted only with those components having the same unique properties.

(Added 2017)

S.6. Power Interruption, Electronic Taximeters.

- (a) After a power interruption of three seconds or less, the fare and extras indications shall return to the previously displayed indications and may be susceptible to advancement without the taximeter being cleared.
- (b) After a power interruption exceeding three seconds, the fare and extras indications shall return to the previously displayed indications and shall not be susceptible to advancement until the taximeter is cleared.

After restoration of power following an interruption exceeding three seconds, the previously displayed fare shall be displayed for a maximum of one minute at which time the fare shall automatically clear and the taximeter shall return to the vacant condition.

[Nonretroactive as of January 1, 2002]

(Added 1988) (Amended 1989, 1990, and 2000)

S.7. Measurement Signal Loss. – If the measurement signal is interrupted, the taximeter shall be capable of determining any information needed to complete a transaction in progress at the time of signal loss/interruption.

Note: If the meter ceases to increment fare based on distance, the taximeter may continue to increment fare based on elapsed time provided the time mechanism is not affected by signal loss.

(Added 2017)

S.7.1. Intermittent Trip Data Loss. – When the measurement signal is lost intermittently during a trip (e.g., traveling through a tunnel), but recovered prior to the end of the trip, the taximeter shall be capable of calculating an accurate fare in accordance with T.1. Tolerance Values.

(Added 2017)

S.7.2. Significant Trip Data Loss. – When the signal is lost for a significant portion of the trip, the taximeter shall calculate the total charge utilizing recorded time and distance measurements and other charges (e.g., tolls and airport fees), and may also include other means in accordance with the terms of service (or other agreement) the passenger has agreed to.

Note: Significant trip data loss refers to instances when the measurement signal is lost to the extent that the taximeter cannot perform an accurate measurement or when the signal is not regained by the end of the trip.

(Added 2017)

S.8. Anti-Fraud Provisions, Electronic Taximeters. – An electronic taximeter may have provisions to detect and eliminate distance input that is inconsistent with the taximeter’s source(s) of distance measurement data. When a taximeter equipped with this feature detects input inconsistent with the distance measurement data source(s):

- (a) the meter shall either filter out the inconsistent distance input signals or cease to increment fare based on distance until the distance input signal is restored to normal operation. If the meter ceases to increment fare based on distance, the taximeter may continue to increment fare based on elapsed time when (1) permitted by the statutory authority; and (2) the time mechanism is not affected by inconsistent signals;

- (b) the taximeter shall provide a visible or audible signal that inconsistent input signals are being detected; and
- (c) the taximeter shall record the occurrence in an event logger. The event logger shall include an event counter, the date, and the time of at least the last 1000 occurrences.

(Added 2001) (Amended 2017)

N. Notes

N.1. Distance Tests.

N.1.1. Test Methods. – To determine compliance with distance tolerances, a distance 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 independently measures and indicates the distance.
- (c) **Simulated-Road Test.*** – A simulated road test consists of determining the distance traveled by use of a roller device, or by computation from rolling circumference and wheel-turn data.

*Simulated-road testing is not appropriate for taximeters using measurement data from sources other than signal(s) generated by rotation of the wheels of the vehicle.

(Amended 1977 and 2017)

N.1.2. Test Procedures. – The distance 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 1 mi, whichever is greater, and shall be at a speed approximating the average speed traveled by the vehicle in normal service. In the case of metric-calibrated taximeters, the test should cover at least the third money drop or 2 km, whichever is greater.

(Amended 1977)

N.1.2.1. Taximeters Using Measurement Data Sources from Other Than Rotation of the Wheels.

N.1.2.1.1. Testing, General. – Testing of taximeters with metrologically significant parameters that do not completely reside within the taximeter device shall include tests performed under variable conditions to verify that any non-compliant issue is generated from a network system rather than a single taximeter device. The variability tests shall include a minimum of three consecutive tests of varying lengths, locations, and/or environment conditions.

(Added 2017)

N.1.2.1.2. Repeatability Testing, Taximeters Using Measurement Data Sources From Other Than Rotation of the Wheels. – Repeatability testing shall be conducted if, during testing, a taximeter registers a distance measurement that does not comply with the tolerance values in T.1.1. Distance Tests. A minimum of three additional tests shall be conducted at the same location and where all test variables are reduced to the greatest extent practicable to verify the system’s ability to repeat transaction indications. Repeatability testing performed in excess of these three additional tests is done at the discretion of the official with statutory authority.

(Added 2017)

N.1.3. Test Conditions.

N.1.3.1. Measurement Data Based on the Rotation of the Vehicle's Wheels. – For taximeters that receive input of measurement data generated (directly or indirectly) from rotation of the vehicle's wheels, the test of the taximeter shall be performed under the following conditions.

(Added 2017)

N.1.3.1.1. Vehicle Lading. – During the distance test of a taximeter, the vehicle shall carry two persons, or in the case of a simulated-road test, 70 kg or 150 lb of test weights may be substituted in lieu of the second person.

N.1.3.1.2. Tire Pressure. – At the completion of test run or runs, the tires of the vehicle under test shall be checked to determine that the tire pressure is that operating tire pressure posted in the vehicle. If not, the tire pressure should be adjusted to the posted tire pressure and further tests may be conducted to determine the operating characteristics of the taximeter.

(Amended 1977)

N.1.3.2. Taximeters Using Other Measurement Data Sources. – Except during type evaluation, all tests shall be performed under conditions that are considered usual and customary for the location(s) where the system is normally operated and as deemed necessary by the statutory authority.

(Added 2017)

N.1.3.2.1. Testing for Environmental Influences. – During type evaluation, the distance test may be performed on a route traveled by the vehicle that exposes the system to conditions possibly contributing to the loss of, or interference with, the signal(s) providing measurement data. This may include:

- (a) objects that may obstruct or reflect signals such as tall buildings/structures, forestation, tunnels, etc.;
- (b) routes that do not follow a straight-line path;
- (c) significant changes in altitude; and
- (d) any other relevant environmental conditions.

(Added 2017)

N.2. Time Test. – If a taximeter is equipped with a timing device through which charges are made for time intervals, the timer shall be tested at the initial interval, four separate subsequent intervals, and an average time test of at least four consecutive subsequent time intervals.

(Amended 1988)

N.3. Interference Test. – For taximeters that calculate fares based on time and/or distance but not simultaneously, a test shall be conducted to determine whether there is interference between the time and distance elements. During the interference test, the vehicle's operating speed shall be 3 km/h or 4 km/h (2 mi/h or 3 mi/h) faster, and then 3 km/h or 4 km/h (2 mi/h or 3 mi/h) slower than the speed at which the basic distance rate equals the basic time rate. The basic rate per hour divided by the basic rate per mile is the speed (km/h or mi/h) at which the basic time rate and basic distance rate are equal.

Note: Performance of the interference test may not be considered appropriate as a field test while travelling in a vehicle equipped with a taximeter. This test may be performed during type evaluation under controlled conditions for practicality and for safety concerns.

(Amended 1988 and 2017)

T. Tolerances

T.1. Tolerance Values.

T.1.1. On Distance Tests. – Maintenance and acceptance tolerances for taximeters shall be as follows:

- (a) On Overregistration: 1 % of the interval under test.
- (b) On Underregistration: 4 % of the interval under test, with an added tolerance of 30 m or 100 ft 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 %).
- (b) On Underregistration: 9 seconds per minute (15 %) on the initial interval, and 6 seconds per minute (10 %) on subsequent intervals.

T.1.2.2. On Average Time Interval Computed After the Initial Interval. – Except for the initial interval, maintenance and acceptance tolerances on the average time interval shall be as follows:

- (a) On Overregistration: 0.2 second per minute (0.33 %).
 - (b) On Underregistration: 3 seconds per minute (5 %).
- (Amended 1991)

T.1.3. On Interference Tests. – For taximeters designed to calculate fares upon the basis of a combination of distance traveled and time elapsed (but not using both simultaneously), the distance registration of a taximeter in the “time on” position shall agree within 1 % of its distance registration in the “time off” position.

(Added 1988) (Amended 2017)

T.2. Tests Using Transfer Standards. – To the basic tolerance values that would otherwise be applied, there shall be added an amount equal to two times the standard deviation of the applicable transfer standard (i.e., fifth-wheel) when compared to the basic reference standard.

(Added 2017)

UR. User Requirements

UR.1. Inflation of Vehicle Tires. – For taximeters that receive input of measurement data generated (directly or indirectly) from rotation of the vehicle’s wheels, the operational tire pressure of passenger vehicles and truck tires shall be posted in the vehicle and shall be maintained at the posted pressure.

(Amended 1977 and 2017)

UR.2. Position and Illumination of Taximeter. – A taximeter shall be so positioned and illuminated that its indications, operational markings, and controls of passenger interest can be conveniently read by a passenger seated in a position of up to 1.2 m (4 ft) away from the taximeter under any condition of normal operation.

(Amended 1985, 1986, and 2017)

UR.3. Statement of Rates. – The distance and time rates for which a taximeter is set, including the initial distance interval and the initial time interval, the local tax rate, and the schedule of extras when an extras indication is provided shall be conspicuously displayed inside the front and rear passenger compartments. 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.

(Amended 1977, 1988, 1990, and 1999)

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Table of Contents

	Page
Section 5.55. Timing Devices.....	5-41
A. Application	5-41
A.1. General.....	5-41
A.2. Additional Code Requirements.....	5-41
S. Specifications.....	5-41
S.1. Design of Indicating and Recording Elements and of Recorded Representations.	5-41
S.1.1. Primary Elements.....	5-41
S.1.2. Graduations.....	5-42
S.1.3. Indicators.	5-42
S.1.4. Recorded Representations.....	5-42
S.2. Marking Requirements, Operating Instructions.	5-43
S.3. Interference.	5-43
S.4. Provisions for Sealing.....	5-43
S.5. Power Interruption.	5-43
S.5.1. Transaction Termination.	5-43
S.5.2. User Information.....	5-44
N. Notes.....	5-44
N.1. Test Method.	5-44
N.2. Broadcast Times and Frequencies.....	5-44
N.3. Interference Tests, EVSE.....	5-44
T. Tolerances.....	5-45
T.1. Tolerance Values.	5-45
T.1.1. For Timing Devices Other Than Those Specified in T.1.2. For Time Clocks and Time Recorders and T.1.3. On Parking Meters.....	5-45
T.1.2. For Time Clocks and Time Recorders.	5-45
T.1.3. On Parking Meters and Other Timing Devices Used to Assess Charges for Parking.	5-45
T.2. Tests Involving Digital Indications or Representations.	5-45
UR. User Requirements	5-45
UR.1. Statement of Rates.	5-45
UR.2. Time Representations.....	5-46

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Section 5.55. Timing Devices

A. Application

A.1. General. – This code applies to devices used to measure time during which services are being dispensed (such as vehicle parking, laundry drying, and car washing). This code also applies to Electric Vehicle Supply Equipment (EVSE) when used to assess charges for time-based services in addition to those charged for electrical energy.
(Amended 2015)

A.2. Additional Code Requirements. – In addition to the requirements of this code, Timing Devices shall meet the requirements of Section 1.10. General Code.

S. Specifications

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

S.1.1. Primary Elements.

S.1.1.1. General. – A timing device shall be equipped with a primary indicating element, and may also be equipped with a primary recording element. A timing device incorporated into an Electric Vehicle Supply Equipment system for use in assessing charges for timing separate from charges for electrical energy shall be equipped with the capability to provide a recorded representation of the transaction through a built-in or separate recording element. A readily observable in-service light or other equally effective means that automatically indicates when laundry driers, vacuum cleaners, and car washes are in operation shall be deemed an appropriate primary indicating element.

(Amended 1979 and 2015)

S.1.1.2. Units. – A timing device shall indicate and record, if the device is equipped to record, the time in terms of minutes for time intervals of 60 minutes or less and in hours and minutes for time intervals greater than 60 minutes.

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

(a) For parking meters:

- (1) one-half hour on parking meters indicating time in excess of two hours; or
- (2) six minutes on parking meters indicating time in excess of one but not greater than two hours.

(b) For an EVSE equipped with an integral time-based feature:

- (1) one minute on an EVSE indicating time not greater than or equal to 60 minutes; or
- (2) hours and minutes on an EVSE indicating time intervals in excess of 60 minutes.

(c) For all other devices five minutes, except those equipped with an in-service light.

(Amended 1975 and 2021)

S.1.1.4. Advancement of Indicating and Recording Elements. – Primary indicating and recording elements shall be susceptible to advancement only during the mechanical operation of the device, except that clocks may be equipped to manually reset the time.

S.1.1.5. Operation of In-Service Indicator Light. – For devices equipped with an in-service indicator light, the indicator shall be operative only during the time the device is in operation.
(Amended 2015)

S.1.1.6. Discontinuous Indicating Parking Meters. – An indication of the time purchased shall be provided at the time the meter is activated in units of no more than one minute for times less than one hour and not more than two minutes for times of one hour or more. Convenient means shall be provided to indicate to the purchaser the unexpired time.
(Added 1975) (Amended 1976)

S.1.2. Graduations.

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

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

S.1.2.3. Clear Interval Between Graduations. – The clear interval shall be not less than 0.75 mm (0.03 in). If the graduations are not parallel, the measurement shall be made:

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

S.1.3. Indicators.

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

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

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

- (a) the width of the widest graduation; and
- (b) the width of the minimum clear interval between the graduations.

S.1.3.4. Parallax. – Parallax effect shall be reduced to a practicable minimum.

S.1.4. Recorded Representations.

S.1.4.1. Recorded Representations, Electric Vehicle Supply Equipment (EVSE) Timing Devices. – A timing device incorporated into an EVSE for use in assessing charges for timing separate from charges for

electrical energy shall issue a recorded representation itemizing the charges for these services as defined in Section 3.40. Electric Vehicle Fueling Systems.

(Added 2015)

S.1.4.1.1. Duplicate Receipts. – Duplicate receipts are permissible, provided the word “duplicate” or “copy” is included on the receipt.

(Added 2015)

S.1.4.2. Recorded Representations, All Other Timing Devices. – A printed ticket issued or stamped by a timing device shall have printed clearly thereon:

- (a) the time and day when the service ends and the time and day when the service begins, except that a self-service money-operated device that clearly displays the time of day need not record the time and day when the service begins; or
- (b) the time interval purchased, and the time and day that the service either begins or ends.

(Added 2015)

(Amended 1983 and 2015)

S.2. Marking Requirements, Operating Instructions. – Operating instructions shall be clearly stated on the device.

S.3. Interference. – The design of the EVSE shall be such that there will be no interference between the time and electrical energy measurement elements of the system.

(Added 2015)

S.4. Provisions for Sealing. – For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices. For parameters adjusted using other means adequate provisions shall be made to provide security for the timing element.

(Added 2015) (Amended 2019)

S.5. Power Interruption. – In the event of a power loss, the information needed to complete any transaction (i.e., delivery is complete and payment is settled) in progress at the time of the power loss (such as the quantity and unit price, or sales price) shall be determinable through one of the means listed below or the transaction shall be terminated without any charge for the electrical energy transfer to the vehicle:

- (a) at the EVSE;
- (b) at the console, if the console is accessible to the customer;
- (c) via on site Internet access; or
- (d) through toll-free phone access.

For EVSEs in parking areas where vehicles are commonly left for extended periods, the information needed to complete any transaction in progress at the time of the power loss shall be determinable through one of the above means for at least eight hours.

(Added 2015)

S.5.1. Transaction Termination. – In the event of a power loss, either:

- (a) the transaction shall terminate at the time of the power loss; or

- (b) the EVSE may continue charging without additional authorization if the EVSE is able to determine it is connected to the same vehicle before and after the supply power outage.

In either case, there must be a clear indication on the receipt provided to the customer of the interruption, including the date and time of the interruption along with other information required under S.1.4.2. Recorded Representations, All Other Timing Devices.

(Added 2015)

S.5.2. User Information. – The EVSE memory, or equipment on the network supporting the EVSE, shall retain information on the quantity of time and the sales price totals during a power loss.

(Added 2015)

N. Notes

N.1. Test Method. – A timing device shall be tested with a timepiece with an error of not greater than plus or minus 15 seconds per 24-hour period. In the test of timing devices with a nominal capacity of 1 hour or less, stopwatches with a minimum division of not greater than one-fifth second shall be used. In the test of timing devices with a nominal capacity of more than one hour, the value of the minimum division on the timepiece shall be not greater than one second. Time pieces and stopwatches shall be calibrated with standard time signals as described in National Institute of Standards and Technology Special Publication 432, NIST Time and Frequency Dissemination Services, or any superseding publication.

(Amended 1978)

N.2. Broadcast Times and Frequencies. – Time and frequency standards are broadcast by the stations listed in Table N.2. Broadcast Times and Frequencies.

Table N.2.* Broadcast Times and Frequencies			
Station	Location, Latitude, Longitude	Frequency (MHz)	Times of Transmission (UTC)
WWV	Fort Collins, Colorado 40E41' N 105E02' W	2.5 5.0 10.0 15.0 20.0	Continuous
WWVH	Kauai, Hawaii 21E59' N 159E46' W	2.5 5.0 10.0 15.0	Continuous
CHU	Ottawa, Canada 45E18' N 75E45' W	3.330 7.335 14.670 14.670	Continuous

*From NIST Special Publication 559, "Time and Frequency Users' Manual," 1990.

(Added 1988)

N.3. Interference Tests, EVSE. – On an EVSE equipped with a timing device used to calculate time-based charges in addition to any charges assessed for electrical energy, a test shall be conducted to ensure that there is no interference between time and electrical energy measuring elements.

(Added 2015)

T. Tolerances

T.1. Tolerance Values. – Maintenance and acceptance tolerances for timing devices shall be as follows:

T.1.1. For Timing Devices Other Than Those Specified in T.1.2. For Time Clocks and Time Recorders and T.1.3. On Parking Meters. – The maintenance and acceptance tolerances shall be:

(a) On Overregistration: five seconds for any time interval of one minute or more; and
(Amended 1986)

(b) On Underregistration: six seconds per indicated minute.
(Amended 1975 and 1986)

T.1.2. For Time Clocks and Time Recorders. – The maintenance and acceptance tolerances on overregistration and underregistration shall be three seconds per hour, but not to exceed one minute per day.
(Amended 1975)

T.1.3. On Parking Meters and Other Timing Devices Used to Assess Charges for Parking. – The maintenance and acceptance tolerances are shown in Table T.1.3. Maintenance and Acceptance Tolerances for Parking Meters and Other Timing Devices Used to Assess Charges For Parking.
(Amended 2015)

(Amended 2015)

Table T.1.3. Maintenance and Acceptance Tolerances for Parking Meters and Other Timing Devices Used to Assess Charges for Parking		
Maintenance and Acceptance Tolerances		
Nominal Time Capacity	On Overregistration	On Underregistration
30 minutes or less	No tolerance	10 seconds per minute, but not less than 2 minutes
Over 30 minutes to and including 1 hour	No tolerance	5 minutes plus 4 seconds per minute over 30 minutes
Over 1 hour	No tolerance	7 minutes plus 2 minutes per hour over 1 hour

T.2. 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.

UR. User Requirements

UR.1. Statement of Rates. – The following information shall be clearly, prominently, and conspicuously displayed:

(a) the price in terms of money per unit or units of time for the service dispensed; and

(b) for a timing device other than an EVSE, the number of coins the device will accept and be activated by at one time.

(Amended 1976 and 2015)

UR.2. Time Representations. – Any time representation shall be within plus or minus two minutes of the correct time in effect in the area, except on an individual clock used only for “time out”; in addition, the time indication of the “time-out” clock shall be the same as or less than that of the “time-in” clock.

(Amended 1975)

Table of Contents

	Page
Section 5.56.(a) Grain Moisture Meters	5-49
A. Application	5-49
A.1. General Code	5-49
A.2. Exceptions	5-49
A.3. Type Evaluation	5-49
A.4. Additional Code Requirements	5-49
S. Specifications	5-49
S.1. Design of Indicating, Recording, and Measuring Elements	5-49
S.1.1. Digital Indications and Recording Elements	5-49
S.1.2. Selecting or Recording Grain or Seed Type and Class	5-50
S.1.3. Operating Range	5-51
S.1.4. Value of Smallest Unit	5-51
S.1.5. Operating Temperature	5-51
S.2. Design of Grain Moisture Meters	5-51
S.2.1. Minimum Sample Size	5-51
S.2.2. Electric Power Supply	5-52
S.2.3. Level Indicating Means	5-52
S.2.4. Calibration Integrity	5-52
S.2.5. Provision for Sealing	5-52
S.2.6. Determination of Quantity and Temperature	5-54
S.3. Accessory Equipment	5-54
S.4. Operating Instructions and Use Limitations	5-54
N. Notes	5-55
N.1. Testing Procedures	5-55
N.1.1. Air Oven Reference Method Transfer Standards	5-55
N.1.2. Minimum Test	5-55
N.1.3. Meter to Like-Type Meter Method Transfer Standards	5-55
T. Tolerances	5-55
T.1. To Underregistration and to Overregistration	5-55
T.2. Tolerances	5-55
T.2.1. Air Oven Reference Method	5-55
T.2.2. Meter to Like-Type Meter Method	5-56
T.3. For Test Weight Per Bushel Indications or Recorded Representations	5-56
UR. User Requirements	5-57
UR.1. Selection Requirements	5-57
UR.1.1. Value of the Smallest Unit on Primary Indicating and Recording Elements	5-57
UR.1.2. See G-UR.1.2. Environment	5-57
UR.2. Installation Requirements	5-57
UR.3. Use Requirements	5-57
UR.3.1. Operating Instructions	5-57
UR.3.2. Other Devices Not Used for Commercial Measurement	5-57
UR.3.3. Maintaining Integrity of Grain Samples	5-57
UR.3.4. Printed Tickets	5-57
UR.3.5. Accessory Devices	5-57
UR.3.6. Sampling	5-57
UR.3.7. Location	5-58

UR.3.8. Level Condition.....	5-58
UR.3.9. Current Calibration Data.....	5-58
UR.3.10. Posting of Meter Operating Range.	5-58

Section 5.56.(a) Grain Moisture Meters

Section 5.56. was reorganized into two sections beginning with the 1997 Edition of NIST Handbook 44. This Section, 5.56.(a), applies to all NTEP grain moisture meters. It also applies to any grain moisture meter manufactured or placed into service on or after January 1, 1998.

(Code reorganized and renumbered 1996)

A. Application

A.1. General Code. – This code applies to grain moisture meters, that is, devices used to indicate directly the moisture content of cereal grain and oil seeds. The code consists of general requirements applicable to all moisture meters and specific requirements applicable only to certain types of moisture meters. Requirements cited for “test weight per bushel” indications or recorded representations are applicable only to devices incorporating an automatic test weight per bushel measuring feature.

(Amended 2003)

A.2. Exceptions. – This code does not apply to devices used for in-motion measurement of grain moisture content or seed moisture content.

A.3. Type Evaluation. – The National Type Evaluation Program (NTEP) will accept for type evaluation only those devices that comply with this code. State enforcement will be based upon the effective dates identified with each requirement when specific dates are shown.

(Added 1993)

A.4. Additional Code Requirements. – In addition to the requirements of this code, 5.56.(a) Grain Moisture Meters shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1. Design of Indicating, Recording, and Measuring Elements.

S.1.1. Digital Indications and Recording Elements.

- (a) Meters shall be equipped with a digital indicating element.
- (b) The minimum height for the digits used to display moisture content shall be 10 mm.
- (c) Meters shall be equipped with a communication interface that permits interfacing with a recording element and transmitting the date, grain type, grain moisture results, test weight per volume results, and calibration version identification.
- (d) A digital indicating element shall not display, and a recording element shall not record, any moisture content values or test weight per volume values before the end of the measurement cycle.
- (e) Moisture content results shall be displayed and recorded as percent moisture content, wet basis. Test weight per bushel results shall be displayed and recorded as pounds per bushel. Subdivisions of these units shall be in terms of decimal subdivisions (not fractions).
- (f) A meter shall not display or record any moisture content or test weight per volume values when the moisture content of the grain sample is beyond the operating range of the device, unless the moisture and test weight representations include a clear error indication (and recorded error message with the recorded representation).

- (g) On multi-constituent meters (e.g., meters which also measure grain protein), provision shall be made for displaying and recording the constituent label (such as moisture, protein, etc.) to make it clear which constituent is associated with each of the displayed and recorded values.

(Added 1995)

(Amended 1993, 1994, 1995, 1996, and 2003)

S.1.2. Selecting or Recording Grain or Seed Type and Class. – Provision shall be made for selecting and recording the type and class or multi-class group (as appropriate) of grain or seed to be measured. The means to select the type and class or multi-class group of grain or seed shall be readily visible and the type and class or multi-class group of grain or seed selected shall be clearly and definitely identified. Abbreviations for grain types and multi-class groups indicated on the meter must meet the minimum acceptable abbreviations listed in Table S.1.2. Grain Types and Multi-Class Groups Considered for Type Evaluation and Calibration and Their Minimum Acceptable Abbreviations.

(Amended 1993, 1995, and 2007)

Table S.1.2. Grain Types and Multi-Class Groups Considered for Type Evaluation and Calibration and Their Minimum Acceptable Abbreviations		
Grain Type	Grain Class	Minimum Acceptable Abbreviation
Barley	All-Class Barley*	BARLEY
	Six-Rowed Barley	SRB
	Two-Rowed Barley	TRB
Corn	---	CORN
Grain Sorghum	---	SORG or MILO
Oats	---	OATS
Rice	All-Class Rough Rice*	RGHRICE
	Long Grain Rough Rice	LFRR
	Medium Grain Rough Rice	MGRR
Small Oil Seeds (under consideration)	---	---
Soybeans	---	SOYB
Sunflower seed (Oil)	---	SUNF
Wheat	All-Class Wheat*	WHEAT
	Durum Wheat	DURW
	Hard Red Spring Wheat	HRSW
	Hard Red Winter Wheat	HRWW
	Hard White Wheat	HDWW
	Soft Red Winter Wheat	SRWW
	Soft White Wheat	SWW
	Wheat Excluding Durum*	WHTXDUR
Note: Grain Types marked with an asterisk (*) are “Multi-Class Calibrations.”		

[Nonretroactive as of January 1, 1998]

(Table Added 1993) (Amended 1995, 1998, and 2007)

S.1.3. Operating Range. – A meter shall automatically and clearly indicate when the operating range of the meter has been exceeded. The operating range shall specify the following:

- (a) **Temperature Range of the Meter.** – The temperature range over which the meter may be used and still comply with the applicable requirements shall be specified. The minimum temperature range shall be 10 °C to 30 °C. No moisture value may be displayed when the temperature range is exceeded. An appropriate message shall be displayed when the temperature of the meter is outside its specified operating range.
- (b) **Temperature Range of each Grain or Seed.** – The temperature range for each grain or seed for which the meter is to be used shall be specified. The minimum temperature range for each grain shall be 0 °C to 40 °C. No moisture value may be displayed when the temperature range is exceeded. An appropriate error message shall be displayed when the temperature of the grain sample exceeds the specified temperature range for the grain.
- (c) **Moisture Range of the Grain or Seed.** – The moisture range for each grain or seed for which the meter is to be used shall be specified. Moisture and test weight per bushel values may be displayed when the moisture range is exceeded if accompanied by a clear indication that the moisture range has been exceeded.
(Amended 2003)
- (d) **Maximum Allowable Meter/Grain Temperature Difference.** – The maximum allowable difference in temperature between the meter and the sample for which an accurate moisture determination can be made shall be specified. The minimum temperature difference shall be 10 °C. No moisture value may be displayed when the maximum allowable temperature difference is exceeded. An appropriate error message shall be displayed when the difference in temperature between the meter and the sample exceeds the specified difference.

(Added 1993) (Amended 1995)

S.1.4. Value of Smallest Unit. – The display shall permit moisture value determination to both 0.01 % and 0.1 % resolution. The 0.1 % resolution is for commercial transactions; the 0.01 % resolution is for type evaluation and calibration purposes only, not for commercial purposes. Test weight per bushel values shall be determined to the nearest 0.1 pound per bushel.

(Amended 2003)

S.1.5. Operating Temperature.

- (a) Warm-up period: When a meter is turned on it shall not display or record any usable values until the operating temperature necessary for accurate determination has been attained, or the meter shall bear a conspicuous statement adjacent to the indication stating that the meter shall be turned on for a time period specified by the manufacturer prior to use.
- (b) A meter shall meet the requirements of T.2. Tolerances when operated in the temperature range of 10 °C to 30 °C (50 °F to 86 °F) or within the range specified by the meter manufacturer.
- (c) If the manufacturer specifies a temperature range, the range shall be at least 20 °C (36 °F).

(Added 1993) (Amended 1995 and 1996)

S.2. Design of Grain Moisture Meters.

S.2.1. Minimum Sample Size. – Meters shall be designed to measure the moisture content of representative-size grain samples. The minimum allowable sample size used in analysis shall be 100 g or 400 kernels or seeds, whichever is smaller.

(Added 1993) (Amended 1995)

S.2.2. Electric Power Supply.**S.2.2.1. Power Supply, Voltage and Frequency.**

- (a) A meter that operates using alternating current must perform within the tolerances defined in Section T.2. Tolerances over the line voltage range 100 V to 130 V, or 200 V to 250 V rms as designed, and over the frequency range of 59.5 Hz to 60.5 Hz.
- (b) Battery-operated instruments shall not indicate or record values outside the applicable tolerance limits when battery power output is excessive or deficient.

S.2.2.2. Power Interruption. – A power interruption shall not cause an indicating or recording element to display or record any values outside the applicable tolerance limits.

(Added 1988)

S.2.3. Level Indicating Means. – A meter shall be equipped with a level indicator and leveling adjustments if its performance is changed by an amount greater than the applicable tolerance when the meter is moved from a level position to a position that is out of level in any upright direction by up to 5 % (approximately three degrees). The level-indicating means shall be readable without removing any meter parts requiring a tool.

(Added 1988) (Amended 1994)

S.2.4. Calibration Integrity.

S.2.4.1. Calibration Version. – A meter must be capable of displaying either calibration constants, a unique calibration name, or a unique calibration version number for use in verifying that the latest version of the calibration is being used to make moisture content and test weight per bushel determinations.

(Added 1993) (Amended 1995 and 2003)

S.2.4.2. Calibration Corruption. – If calibration constants are digitally stored in an electronically alterable form, the meter shall be designed to make automatic checks to detect corruption of calibration constants. An error message must be displayed if calibration constants have been electronically altered.

(Added 1993) (Amended 1995)

S.2.4.3. Calibration Transfer. – *The instrument hardware/software design and calibration procedures shall permit calibration development and the transfer of calibrations between instruments of like models without requiring user slope or bias adjustments.*

[Note: Only the manufacturer or the manufacturer's designated service agency may make standardization adjustments on moisture meters. This does not preclude the possibility of the operator installing manufacturer-specified calibration constants under the instructions of the manufacturer or its designated service agency.] Standardization adjustments (not to be confused with grain calibrations) are those physical adjustments or software parameters which make meters of like type respond identically to the grain(s) being measured.

[Nonretroactive as of January 1, 1999]

(Added 1994) (Amended 1998)

S.2.5. Provision for Sealing. – For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. For parameters adjusted using other means, the following applies:

An approved means of security shall be provided (as defined in Table S.2.5. Categories of Device and Methods of Sealing for Devices Manufactured Between January 1, 1999 and January 1, 2020 and paragraph S.2.5.1. Sealing

Requirements for Devices Manufactured on or after January 1, 2020) before any change that affects the metrological integrity of the device can be made to any mechanism.

(Amended 2019 and 2021)

Table S.2.5. Categories of Device and Methods of Sealing For Devices Manufactured Between January 1, 1999 and January 1, 2020	
Categories of Device	Methods of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters (000 to 999) and one for configuration parameters (000 to 999). If equipped with event counters, the device must be capable of displaying, or printing through the device or through another on-site device, the contents of the counters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. A device shall clearly indicate that it is in the remote configuration mode and shall not be capable of operating in the measure mode while enabled for remote configuration.	The hardware enabling access for remote communication must be at the device and sealed using a physical seal or two event counters: one for calibration parameters (000 to 999) and one for configuration parameters (000 to 999). If equipped with event counters, the device must be capable of displaying, or printing through the device or through another on-site device, the contents of the counters.
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). When accessed for the purpose of modifying sealable parameters, the device shall clearly indicate that it is in the configuration mode and shall not be capable of operating in the measuring mode.	An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter (for calibration changes consisting of multiple constants, the calibration version number may be used rather than the calibration constants). A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to 25 times the number of sealable parameters in the device, but not more than 1 000 records are required. (Note: Does not require 1 000 changes to be stored for each parameter.)
Category 3a: No remote capability, but operator is able to make changes that affect the metrological integrity of the device (e.g., slope, bias, etc.) in normal operation. *When accessed for the purpose of modifying sealable parameters, the device shall clearly indicate that it is in the configuration mode and shall not be capable of operating in the measuring mode.	Same as Category 3
Category 3b: No remote capability, but access to metrological parameters is controlled through a software switch (e.g., password). *When accessed for the purpose of modifying sealable parameters, the device shall clearly indicate that it is in the configuration mode and shall not be capable of operating in the measuring mode.	Same as Category 3

[Nonretroactive as of January 1, 1999]

[*Nonretroactive as of January 1, 2014]

(Amended 1998, 2013, 2019, and 2021)

Note: Zero-setting and test point adjustments are considered to affect metrological characteristics and must be sealed.

(Added 1993) (Amended 1995 and 1997)

S.2.5.1. Sealing Requirements for Devices Manufactured on or after January 1, 2020. – An event logger is required in the device. The event logger must include an event counter (000 to 999); the parameter ID; the date and time of the change; and the new value of the parameter (for calibration changes consisting of multiple constants, the calibration version number may be used rather than the calibration constants).

A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to 25 times the number of sealable parameters in the device, but not more than 1 000 records are required. (Note: Does not require 1 000 changes to be stored for each parameter.)

(Added 2021)

S.2.6. Determination of Quantity and Temperature. – The moisture meter system shall not require the operator to judge the precise volume or weight and temperature needed to make an accurate moisture determination. External grinding, weighing, and temperature measurement operations are not permitted. In addition, if the meter is capable of measuring test weight per bushel, determination of sample volume and weight for this measurement shall be fully automatic *and means shall be provided to ensure that measurements of test weight per volume are not allowed to be displayed or printed when an insufficient sample volume is available to provide an accurate measurement.**

[*Nonretroactive as of January 1, 2004]

(Added 1994) (Amended 1995 and 2003)

S.3. Accessory Equipment. – When the operating instructions for a moisture meter require accessory equipment separate from and external to the moisture meter, such equipment shall be appropriate and complete for the measurement.

S.4. Operating Instructions and Use Limitations. – The manufacturer shall furnish operating instructions for the device and accessories that include complete information concerning the accuracy, sensitivity, and use of accessory equipment necessary in obtaining a moisture content. Operating instructions shall include the following information:

- (a) name and address or trademark of the manufacturer;
- (b) the type or design of the device with which it is intended to be used;
- (c) date of issue;
- (d) the kinds or classes of grain or seed for which the device is designed to measure moisture content and test weight per bushel; and
(Amended 2003)
- (e) the limitations of use, including but not confined to the moisture measurement range, grain or seed temperature, maximum allowable temperature difference between grain sample and meter, kind or class of grain or seed, moisture meter temperature, voltage and frequency ranges, electromagnetic interferences, and necessary accessory equipment.

(Added 1984)

N. Notes

N.1. Testing Procedures. – Field evaluation of grain moisture meters shall be performed by one of the following methods:

N.1.1. Air Oven Reference Method Transfer Standards. – Official grain samples shall be used as the official transfer standards with moisture content and test weight per bushel values assigned by the reference methods. The reference methods for moisture shall be the oven drying methods as specified by the USDA GIPSA. The test weight per bushel value assigned to a test weight transfer standard shall be the average of 10 test weight per bushel determinations using the quart kettle test weight per bushel apparatus as specified by the USDA GIPSA. Tolerances shall be applied to the average of at least three measurements on each official grain sample. Official grain samples shall be clean and naturally moist, but not tempered (i.e., water not added).

(Amended 1992, 2001, and 2003)

N.1.2. Minimum Test. – A minimum test of a grain moisture meter shall consist of tests using samples (need not exceed three) of each grain or seed type for which the device is used, and for each grain or seed type shall include the following:

- (a) tests of moisture indications, using samples having at least two different moisture content values within the operating range of the device; and
- (b) if applicable, tests of test weight per volume indications, with at least the lowest moisture samples used in (a) above.

(Added 2003)

(Amended 1986, 1989, and 2003)

N.1.3. Meter to Like-Type Meter Method Transfer Standards. – Properly standardized reference meters using National Type Evaluation Program (NTEP) approved calibrations shall be used as transfer standards. A reference meter shall be of the same model family, as defined by the NTEP Certificate of Conformance, as the meter under test. Tests shall be conducted side-by-side using, as a comparison medium, grain samples that are clean and naturally moist, but not tempered (i.e., water not added).

(Added 2001) (Amended 2023)

T. Tolerances

T.1. To Underregistration and to Overregistration. – The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration.

T.2. Tolerances.

T.2.1. Air Oven Reference Method. – Maintenance and acceptance tolerances shall be as shown in Table T.2.1. Acceptance and Maintenance Tolerances Air Oven Reference Method. Tolerances are expressed as a fraction of the percent moisture content of the official grain sample, together with a minimum tolerance.

(Amended 2001)

Table T.2.1. Acceptance and Maintenance Tolerances Air Oven Reference Method		
Type of Grain, Class, or Seed	Tolerance	Minimum Tolerance
Corn, oats, rice, sorghum, sunflower	0.05 of the percent moisture content	0.8 % in moisture content
All other cereal grains and oil seeds	0.04 of the percent moisture content	0.7 % in moisture content

(Amended 2001)

T.2.2. Meter to Like-Type Meter Method. – Maintenance and acceptance tolerances shall be as shown in Table T.2.2. Acceptance and Maintenance Tolerances Meter to Like-Type Meter Method. The tolerances shall apply to all types of grain and seed.

(Added 2001)

Table T.2.2. Acceptance and Maintenance Tolerances Meter to Like-Type Meter Method	
Sample Reference Moisture	Tolerance
Up to 22 %	0.5 % in moisture content

(Added 2001)

Note: Like-type as described in paragraph N.1.3. Meter to Like-Type Meter Method Transfer Standards.

(Note Added 2023)

T.3. For Test Weight Per Bushel Indications or Recorded Representations. – The maintenance and acceptance tolerances on test weight per bushel indications or recorded representations shall be as shown in Table T.3. Acceptance and Maintenance Tolerances Test Weight per Bushel. Tolerances are (+) positive or (–) negative with respect to the value assigned to the official grain sample.

(Amended 1992 and 2003)

Table T.3. Acceptance and Maintenance Tolerances Test Weight per Bushel	
Type of Grain or Seed	Tolerance (Pounds Per Bushel)
Corn, oats	0.8
All wheat classes	0.5
Soybeans, all barley classes, all rice classes, sunflower, sorghum	0.7

(Added 2003)

UR. User Requirements

UR.1. Selection Requirements.

UR.1.1. Value of the Smallest Unit on Primary Indicating and Recording Elements. – The resolution of the moisture meter display shall be 0.1 % moisture and 0.1 pounds per bushel test weight during commercial use. (Amended 2003)

UR.1.2. See G-UR.1.2. Environment.

UR.2. Installation Requirements. – The grain moisture meter shall be installed in an environment within the range of temperature and/or other environmental factors specified in the operating instructions.

UR.3. Use Requirements.

UR.3.1. Operating Instructions. – The operating instructions for the use of the grain moisture meter shall be readily available to the user, service technician, and weights and measures official at the place of installation. It shall include a list of accessory equipment and the kinds of grain or seed to be measured with the moisture meter. (Amended 1988)

UR.3.2. Other Devices Not Used for Commercial Measurement. – If there are other moisture meters on the premises not used for trade or determining other charges for services, these devices shall be clearly and conspicuously marked “Not for Use in Trade or Commerce.”

UR.3.3. Maintaining Integrity of Grain Samples. – Whenever there is a time lapse (temperature change) between taking the sample and testing the sample, means to prevent condensation of moisture or loss of moisture from grain samples shall be used. For example, a cold grain sample may be kept in a closed container in order to permit the cold grain to come to the operating temperature range of the meter before the grain moisture measurements are made.

UR.3.4. Printed Tickets.

- (a) Printed tickets shall be free from any previous indication of moisture content or type of grain or seed selected.
- (b) The customer shall be given a printed ticket at the time of the transaction or as otherwise specified by the customer. The printed ticket shall include the date, grain type, grain moisture results, test weight per bushel, and calibration version identification. The ticket information shall be generated by the grain moisture meter system.

(Amended 1993, 1995, 2003, and 2013)

UR.3.5. Accessory Devices. – Accessory devices, if necessary in the determination of a moisture content value, shall be in close proximity to the moisture meter and allow immediate use.

UR.3.6. Sampling. – A grain sample shall be obtained by following appropriate sampling methods and equipment. These include, but are not limited to grain probes of appropriate length used at random locations in the bulk, the use of a pelican sampler, or other techniques and equipment giving equivalent results. The grain sample shall be taken such that it is representative of the lot.

UR.3.7. Location. – Also see G-UR.3.3. Position of Equipment.

UR.3.8. Level Condition. – If equipped with a level indicator, a meter shall be maintained in a level condition.
(Added 1988)

UR.3.9. Current Calibration Data. – Grain moisture determinations shall be made using only the most recently published calibration data.
(Added 1988)

UR.3.10. Posting of Meter Operating Range. – The operating range of the grain moisture meter shall be clearly and conspicuously posted in the place of business such that the information is readily visible from a reasonable customer position. The posted information shall include the following:

- (a) The temperature range over which the meter may be used and still comply with the applicable requirements. If the temperature range varies for different grains or seed, the range shall be specified for each.
- (b) The moisture range for each grain or seed for which the meter is to be used.
- (c) The temperature range for each grain or seed for which the meter is to be used.
- (d) The maximum allowable difference in temperature that may exist between the meter and the sample for which an accurate moisture determination can be made.

(Added 1988)

Table of Contents

	Page
Section 5.56.(b) Grain Moisture Meters	5-61
A. Application	5-61
A.1. General.....	5-61
A.2. Exceptions.....	5-61
A.3. Additional Code Requirements.....	5-61
S. Specifications.....	5-61
S.1. Design of Indicating and Recording Elements and of Recorded Representations.....	5-61
S.1.1. Primary Elements, General.....	5-61
S.1.2. Digital Indications.....	5-61
S.1.3. Graduations.....	5-61
S.1.4. Indicators.....	5-62
S.1.5. Recording Elements.....	5-62
S.1.6. Design of Direct Reading Grain Moisture Meters.....	5-62
S.1.7. <i>Electric Power Supply</i>	5-63
S.1.8. <i>Level Indicating Means</i>	5-63
S.1.9. <i>Operating Temperature</i>	5-63
S.2. Design of Measuring Elements.....	5-64
S.2.1. Design of Zero-Setting and Test Point Mechanisms.....	5-64
S.2.2. Provision for Sealing.....	5-64
S.3. Accessory Equipment.....	5-64
S.3.1. Grain-Test Scale.....	5-64
S.3.2. Thermometers or Other Temperature Sensing Equipment.....	5-64
S.3.3. Conversion and Correction Tables.....	5-64
S.3.4. Operating Instructions and Use Limitations.....	5-65
N. Notes.....	5-65
N.1. Testing Procedures.....	5-65
N.1.1. Transfer Standards.....	5-65
N.1.2. Minimum Test.....	5-65
N.1.3. Temperature Measuring Equipment.....	5-65
T. Tolerances.....	5-65
T.1. To Underregistration and to Overregistration.....	5-65
T.2. Tolerance Values.....	5-65
T.3. For Test Weight Per Bushel Devices.....	5-66
T.4. Thermometers or Other Temperature Sensing Equipment.....	5-66
UR. User Requirements	5-66
UR.1. Selection Requirements.....	5-66
UR.1.1. Value of the Smallest Unit on Primary Indicating and Recording Elements.....	5-66
UR.1.2. Environment.....	5-66
UR.2. Installation Requirements.....	5-66
UR.3. Use Requirements.....	5-66
UR.3.1. Operating Instructions.....	5-66
UR.3.2. Other Devices not used for Commercial Measurement.....	5-66
UR.3.3. Maintaining Integrity of Grain Samples.....	5-66
UR.3.4. Printed Tickets.....	5-66
UR.3.5. Accessory Devices.....	5-66
UR.3.6. Sampling.....	5-67

UR.3.7. Location.	5-67
UR.3.8. Level Condition.	5-67
UR.3.9. Operating Limitation.....	5-67
UR.3.10. Current Calibration Chart or Data.....	5-67
UR.3.11. Posting of Meter Operating Range.....	5-67

Section 5.56.(b) Grain Moisture Meters

Section 5.56. was reorganized into two sections beginning with the 1997 Edition of NIST Handbook 44. This Section, 5.56.(b), applies to all non-NTEP grain moisture meters manufactured or placed into service before January 1, 1998.

(Code reorganized and renumbered 1996)

A. Application

A.1. General. – This code applies to grain moisture meters; that is, devices used to indicate directly or through conversion and/or correction tables the moisture content of cereal grain and oil seeds. The code consists of general requirements applicable to all moisture meters and specific requirements applicable only to certain types of moisture meters.

A.2. Exceptions. – This code does not apply to devices used for in-motion measurement of grain moisture content or seed moisture content.

A.3. Additional Code Requirements. – In addition to the requirements of this code, 5.56.(b) Grain Moisture Meters shall meet the requirements of Section 1.10. General Code.

S. Specifications

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

S.1.1. Primary Elements, General. – A meter shall be equipped with a primary indicating element and may also be equipped with a primary recording element. If the meter indicates directly and/or is equipped to record, the meter shall indicate and/or record its measurements in terms of percent moisture content, wet basis. Subdivisions of this unit shall be in terms of decimal subdivisions (not fractions). If the meter indicates in the conventional scale and requires conversion or correction tables, the resulting values after use of such tables shall be in terms of percent moisture content, wet basis. Subdivisions of this unit shall be in terms of decimal subdivisions (not fractions).

S.1.2. Digital Indications.

S.1.2.1. Measurement Completion. – A digital indicating element shall not display any values (either moisture content or conventional scale) before the end of the measurement cycle.

S.1.3. Graduations.

S.1.3.1. Length. – Graduations shall be so varied in length that they may be conveniently read.

S.1.3.2. 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 the main graduations shall be not more than 50 % greater than the width of subordinate graduations. Graduations shall in no case be less than 0.2 mm (0.008 in) in width.

S.1.3.3. Clear Interval between Graduations. – The clear interval shall be not less than 0.75 mm (0.03 in) between graduations. If the graduations are not parallel, the measurement shall be made:

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

S.1.4. Indicators.

S.1.4.1. Symmetry. – The index of an indicator shall be symmetrical with respect to the graduations, at least throughout that portion of its length associated with the graduations.

S.1.4.2. Length. – The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case the distance between the end of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 1.0 mm (0.04 in).

S.1.4.3. 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; nor
- (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 as the graduation throughout the length of the index that coincides with the graduation.

S.1.4.4. Clearance. – The clearance between the index of an indicator and the graduations shall in no case be more than 1.5 mm (0.06 in).

S.1.4.5. Parallax. – Parallax effects shall be reduced to the practicable minimum.

S.1.5. Recording Elements.

S.1.5.1. General. – If a meter is equipped with a recording element, it shall record in terms of percent moisture content, wet basis only, and not in terms of conventional scale.

S.1.5.2. Measurement Completion. – A recording element shall not record any values before the end of the measurement cycle.

S.1.5.3. Range of Moisture Content. – A recording element shall not record any values when the moisture content of the grain sample is beyond the operating range of the device.

S.1.6. Design of Direct Reading Grain Moisture Meters.

S.1.6.1. Grain or Seed Kind and Class Selection and Recording. – Provision shall be made for selecting and recording, if equipped to record, the kind and class (as appropriate) of grain or seed to be measured. The means to select the kind and class of grain or seed shall be readily visible and the kind and class of grain or seed selected shall be clearly and definitely identified in letters (such as Wheat or WHT, HRWW, etc.).

S.1.6.2. Operating Range. – *A meter shall automatically and clearly indicate when the operating range of the meter has been exceeded or the manufacturer shall:*

- (a) *clearly and conspicuously mark the operating ranges on the meter; or*
- (b) *furnish the operating ranges of the meter and the means to clearly and conspicuously display this information on or immediately adjacent to the device.*

The operating range shall specify the following:

- (a) the temperature range over which the meter may be used and still comply with the applicable requirements;*
- (b) the moisture range for each grain or seed for which the meter is to be used;*
- (c) the temperature range for each grain or seed for which the meter is to be used; and*
- (d) the maximum allowable difference in temperature between the meter and the sample for which an accurate moisture determination can be made.*

Examples of clearly indicating these conditions include an error indication, flashing the displayed moisture value, or blanking the display.

[Nonretroactive as of January 1, 1989]

(Amended 1986 and 1988)

S.1.6.3. Value of Smallest Unit. – The value of the minimum indicated or recorded moisture indication shall not be greater than 0.1 %.

S.1.7. Electric Power Supply.

S.1.7.1. Power Supply, Voltage and Frequency.

- (a) A meter that operates using alternating current must perform within the tolerances defined in Section T.2. Tolerance Values over the line voltage range 100 V to 130 V, or 200 V to 250 V rms as designed, and over the frequency range of 59.5 Hz to 60.5 Hz.*
- (b) Battery-operated instruments shall not indicate or record values outside the applicable tolerance limits when battery power output is excessive or deficient.*

[Nonretroactive as of January 1, 1989]

S.1.7.2. Power Interruption. – A power interruption shall not cause an indicating or recording element to display or record any values outside the applicable tolerance limits.

[Nonretroactive as of January 1, 1989]

(Added 1988)

S.1.8. Level Indicating Means. – A meter shall be equipped with a level indicator and leveling adjustments if its performance is changed by an amount greater than the applicable tolerance when the meter is moved from a level position to a position that is out of level in any upright direction by up to 5 % (approximately 3 degrees). The level-indicating means shall be readable without removing any meter parts requiring a tool.

[Nonretroactive as of January 1, 1989]

(Added 1988) (Amended 1994)

S.1.9. Operating Temperature.

- (a) A meter shall not display or record any usable values until the operating temperature necessary for accurate determination has been attained, or the meter shall bear a conspicuous statement adjacent to the indication stating that the meter shall be turned on for a time period specified by the manufacturer prior to use.*
- (b) A meter shall meet the requirements of T.2. Tolerance Values when operated in the temperature range of 2 °C to 40 °C (35 °F to 104 °F) or within the range specified by the meter manufacturer.*

- (c) *If the manufacturer specifies a temperature range, the range shall be at least 10 °C (20 °F) and shall be marked on the device.*

[Nonretroactive as of January 1, 1989]

(Added 1988)

S.2. Design of Measuring Elements.

S.2.1. Design of Zero-Setting and Test Point Mechanisms. – If a grain moisture meter is equipped with a zero setting and/or test point mechanism(s), this (these) mechanism(s) shall be adjustable only with a tool outside and entirely separate from this mechanism or enclosed in a cabinet. This requirement shall not apply to manual operations that the operator must make (following operating instructions) in order to obtain a meter reading on a grain sample.

S.2.2. Provision for Sealing. – Provision shall be made for applying a security seal in a manner that requires the security seal to be broken before an adjustment can be made to any component of the grain moisture meter that is set by the manufacturer or authorized service representative and not intended to be adjusted by the user.

S.3. Accessory Equipment. – When the operating instructions for a moisture meter require accessory equipment separate from and external to the moisture meter, such equipment shall be appropriate and complete for the measurement.

S.3.1. Grain-Test Scale. – If the moisture meter requires the weighing of the grain sample, the weighing device shall meet the requirements of the General Code and those applicable portions of the Scales Code.

S.3.2. Thermometers or Other Temperature Sensing Equipment.

- (a) The temperature sensing equipment or thermometer shall be designed to be in direct contact with a grain sample in a closed container. It is acceptable to insert thermometer through a small hole in the lid of the container used to hold the grain sample.
- (b) A separate thermometer or other temperature sensing equipment shall have temperature divisions not greater than the temperature increments used by the manufacturer in the correction table.

(Amended 1988)

S.3.3. Conversion and Correction Tables. – Conversion and correction tables, charts, graphs, slide rules, or other apparatus to convert the conventional scale values read from a moisture meter to moisture content values, if such apparatus is required, shall be appropriate and correct for the moisture meter being used and shall be marked with the following information:

- (a) name and address or trademark of the manufacturer;
- (b) the type or design of the device with which it is intended to be used;
- (c) date of issue;
- (d) the kinds or classes of grain or seed for which the device is designed to measure moisture content;
- (e) the limitations of use, including but not confined to the moisture measurement range, grain or seed temperature, kind or class of grain or seed, moisture meter temperature, voltage and frequency ranges, electromagnetic interferences, and necessary accessory equipment; but
- (f) values exceeding any measurement range shall not be included.

(Added 1984)

S.3.4. Operating Instructions and Use Limitations. – Operating instructions shall be furnished by the manufacturer with each device with all of the information required by paragraph S.3.3. Conversion and Correction Tables. Complete information concerning the accuracy, sensitivity, and use of accessory equipment (e.g., test weight per bushel equipment, thermometer, etc.) necessary in obtaining moisture content shall be included.

N. Notes

N.1. Testing Procedures.

N.1.1. Transfer Standards. – Official grain samples shall be used as the official transfer standards with moisture content values assigned by the reference methods. The reference methods shall be the oven drying methods as specified by the USDA GIPSA. Tolerances shall be applied to the average of at least three measurements on each official grain sample. Official grain samples shall be clean and naturally moist, but not tempered (i.e., water not added).

(Amended 1992)

N.1.2. Minimum Test. – A minimum test of a grain moisture meter shall consist of tests with:

- (a) samples (need not exceed three) of each grain or seed for which the device is used; and
- (b) samples having at least two different moisture content values within the operating range of the device.

(Amended 1986 and 1989)

N.1.3. Temperature Measuring Equipment. – The accuracy of accessory temperature measuring equipment shall be determined by comparison with a calibrated temperature sensor, such as a total immersion thermometer with 0.1 °C (0.2 °F) subdivisions, indicating over a range of from 0 °C to 40 °C (32 °F to 104 °F) with a maximum error of ± 0.1 °C (0.2 °F). Tests shall be conducted at two temperatures using liquid baths (e.g., ice water and room temperature water). The two temperatures selected shall not exceed the range of temperatures identified in the moisture meter operating instructions.

(Amended 1988)

T. Tolerances¹

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 shall be as shown in Table T.2. Acceptance and Maintenance Tolerances for Grain Moisture Meters. Tolerances are expressed as a fraction of the percent moisture content of the official grain sample, together with a minimum tolerance.

Table T.2. Acceptance and Maintenance Tolerances for Grain Moisture Meters		
Type of Grain or Seed	Tolerance	Minimum Tolerance
Corn, oats, rice, sorghum, sunflower	0.05 of the percent moisture content	0.8 % in moisture content
All other cereal grains and oil seeds	0.04 of the percent moisture content	0.7 % in moisture content

¹ These tolerances do not apply to tests in which grain moisture meters are the transfer standards.

T.3. For Test Weight Per Bushel Devices. – The maintenance and acceptance tolerances on separate test weight per bushel devices used to determine the test weight per bushel of grain samples for the purposes of making density corrections in moisture determination shall be 0.193 kg/hL or 0.15 lb/bu. The test methods used shall be those specified by the USDA GIPSA using a dockage-free sample of dry hard red winter wheat.

(Amended 1992 and 2003)

T.4. Thermometers or Other Temperature-Sensing Equipment. – The tolerance for a separate thermometer or temperature-sensing equipment used to determine the temperature of grain samples for the purpose of making temperature corrections in moisture determinations shall be ± 0.5 °C (1 °F).

(Added 1988)

UR. User Requirements

UR.1. Selection Requirements.

UR.1.1. Value of the Smallest Unit on Primary Indicating and Recording Elements. – The value of the smallest unit on a moisture meter, whether the moisture meter reads directly in terms of moisture content, or when the conventional scale unit is converted or corrected to moisture content, shall be equal to or less than 0.1 %.

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

UR.2. Installation Requirements. – The grain moisture meter shall be installed in an environment within the range of temperature and/or other environmental factors specified:

- (a) in the operating manual; and
- (b) on the conversion or correction tables if such tables are necessary for the operation of the device.

UR.3. Use Requirements.

UR.3.1. Operating Instructions. – The operating instructions for the use of the grain moisture meter shall be readily available to the user, service technician, and weights and measures official at the place of installation. It shall include a list of accessory equipment, conversion and correction charts if any are required to obtain moisture content values, and the kinds of grain or seed to be measured with the moisture meter.

(Amended 1988)

UR.3.2. Other Devices not used for Commercial Measurement. – If there are other moisture meters on the premises not used for trade or determining other charges for services, these devices shall be clearly and conspicuously marked “Not for Use in Trade or Commerce.”

UR.3.3. Maintaining Integrity of Grain Samples. – Whenever there is a time lapse (temperature change) between taking the sample and testing the sample, means to prevent condensation of moisture or loss of moisture from grain samples shall be used. For example, a cold grain sample may be kept in a closed container in order to permit the cold grain to come to the operating temperature range of the meter before the grain moisture measurements are made.

UR.3.4. Printed Tickets. – Printed tickets shall be free from any previous indication of moisture content or type of grain or seed selected.

UR.3.5. Accessory Devices. – Accessory devices, if necessary in the determination of a moisture content value, shall be in close proximity to the moisture meter and allow immediate use.

UR.3.6. Sampling. – A grain sample shall be obtained by following appropriate sampling methods and equipment. These include, but are not limited to, grain probes of appropriate length used at random locations in the bulk, the use of a pelican sampler, or other techniques and equipment giving equivalent results. The grain sample shall be taken such that it is representative of the lot.

UR.3.7. Location. – See G-UR.3.3. Position of Equipment.

UR.3.8. Level Condition. – If equipped with a level indicator, a meter shall be maintained in a level condition.
(Added 1988)

UR.3.9. Operating Limitation. – Unless otherwise specified by the meter manufacturer, moisture determinations shall not be made when the difference in temperatures between the grain sample and the meter exceeds 10 °C (20 °F).

(Added 1988)

UR.3.10. Current Calibration Chart or Data. – Grain moisture determinations shall be made using only the most recently published calibration charts or calibration data.

(Added 1988)

UR.3.11. Posting of Meter Operating Range. – The operating range of the grain moisture meter shall be clearly and conspicuously posted in the place of business such that the information is readily visible from a reasonable customer position. The posted information shall include the following:

- (a) The temperature range over which the meter may be used and still comply with the applicable requirements. If the temperature range varies for different grains or seed, the range shall be specified for each.
- (b) The moisture range for each grain or seed for which the meter is to be used.
- (c) The temperature range for each grain or seed for which the meter is to be used.
- (d) The maximum allowable difference in temperature that may exist between the meter and the sample for which an accurate moisture determination can be made.

(Added 1988)

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Table of Contents

	Page
Section 5.57. Near-Infrared Grain Analyzers.....	5-71
A. Application	5-71
A.1. General.....	5-71
A.2. Exceptions.....	5-71
A.3. Calibrations.....	5-71
A.4. Additional Code Requirements	5-71
S. Specifications.....	5-71
S.1. Design of Indicating, Recording, and Measuring Elements.....	5-71
S.1.1. <i>Digital Indications and Recording Elements.</i>	5-71
S.1.2. <i>Selecting and Recording Grain Class and Constituent.</i>	5-72
S.1.3. <i>Operating Range.</i>	5-73
S.1.4. <i>Operating Temperature.</i>	5-74
S.1.5. <i>Value of Smallest Unit.</i>	5-74
S.2. Design of NIR Analyzers.....	5-74
S.2.1. <i>Minimum Sample Size.</i>	5-74
S.2.2. <i>Electric Power Supply</i>	5-74
S.2.3. <i>Level Indicating Means.</i>	5-74
S.2.4. <i>Environmental Conditions.</i>	5-74
S.2.5. <i>Calibration Transfer and Verification.</i>	5-74
S.2.6. <i>Provision for Sealing.</i>	5-75
S.3. <i>Accessory Equipment.</i>	5-75
S.3.1. <i>Grinders.</i>	5-75
S.4. <i>Operating Instructions and Use Limitations.</i>	5-75
N. Notes.....	5-76
N.1. Testing Procedures.....	5-76
N.1.1. <i>Field Inspection.</i>	5-76
N.1.2. <i>Standard Reference Samples.</i>	5-76
T. Tolerances.....	5-77
T.1. <i>To Underregistration and to Overregistration.</i>	5-77
T.2. <i>Tolerance Values.</i>	5-77
UR. User Requirements	5-77
UR.1. <i>Installation Requirements.</i>	5-77
UR.2. <i>User Requirements.</i>	5-77
UR.2.1. <i>Operating Instructions.</i>	5-77
UR.2.2. <i>Other Devices Not Used for Commercial Measurement.</i>	5-77
UR.2.3. <i>Printed Tickets.</i>	5-78
UR.2.4. <i>Grinders.</i>	5-78
UR.2.5. <i>Sampling.</i>	5-78
UR.2.6. <i>Level Condition.</i>	5-78
UR.2.7. <i>Operating Limitation.</i>	5-78
UR.2.8. <i>Slope and Bias Adjustments.</i>	5-78

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Section 5.57. Near-Infrared Grain Analyzers

A. Application

A.1. General. – This code applies to near-infrared (NIR) grain analyzers; that is, devices used to indicate the constituent values (other than moisture content) of grain using near-infrared reflectance or transmittance technology. These instruments may analyze either whole grain or ground grain samples. The code consists of general requirements applicable to all NIR analyzers and specific requirements applicable only to certain types of NIR analyzers, grain types, or grain constituents. In addition to meeting the requirements of this code, a whole grain NIR analyzer that displays a measured moisture value must also comply with the requirements of the Grain Moisture Meters Code.

(Added 2001)

A.2. Exceptions. – This code does not apply to devices used for in-motion measurement of grain constituent values.

A.3. Calibrations. – The National Type Evaluation Program (NTEP) Certificate of Conformance (CC) shall indicate the native moisture basis of each calibration. The “native” moisture basis is the default moisture basis of the sealable constituent calibration (or constituent calibration pair when a non-displayed moisture calibration is also involved). If an NIR analyzer uses a self-generated moisture measurement internally but does NOT display or record a moisture value, the moisture calibration shall be considered to be a part of the constituent calibration. For such calibrations, the CC shall state: “Includes non-displayed moisture calibration.” Changes to any part of such calibrations shall require changes to the CC.

(Added 2001)

A.4. Additional Code Requirements. – In addition to the requirements of this code, Near-Infrared Grain Analyzers shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1. Design of Indicating, Recording, and Measuring Elements.

S.1.1. Digital Indications and Recording Elements.

- (a) *Analyzers shall be equipped with a digital indicating element.*
 - (b) *The minimum height for the digits used to display constituent values shall be 10 mm.*
 - (c) *Analyzers shall be equipped with a communication interface that permits interfacing with a recording element and transmitting the date, grain type or class, constituent values, the moisture basis for each constituent value (except moisture), and calibration version identification. If the analyzer converts constituent results to a manually entered moisture basis, the “native” concentration and the “native” moisture basis must appear on the printed ticket in addition to the converted results and the manually entered moisture basis.*
- (Amended 2001 and 2003)
- (d) *A digital indicating element shall not display, and a recording element shall not record, any constituent value before the end of the measurement cycle.*
 - (e) *Constituent content shall be recorded and displayed as percent of total mass at the specified moisture basis. The moisture basis shall also be recorded and displayed for each constituent content result (except moisture). If a whole grain analyzer that is calibrated to display results on an “as is” moisture basis does NOT display or record a moisture value, it must clearly indicate that results are expressed*

on an “as is” moisture basis. Ground grain analyzers must ALWAYS display and record a moisture measurement for “as is” content results (except moisture).

(Amended 2001 and 2003)

- (f) An analyzer shall not display or record any constituent value that is beyond the operating range of the device unless the constituent value representation includes a clear error indication (and recorded error message with the recorded representation).*
- (g) If an NIR analyzer is used to determine a moisture value, either to determine the moisture of an “as is” constituent content measurement or to convert from one moisture basis to another, the moisture measurement must be concurrent with the measurement of other constituents.*
- (h) If the analyzer incorporates a built-in printer, or if a printer is available as an accessory to the analyzer, the information appearing on the printout shall be arranged in a consistent and unambiguous manner.*

(Added 2003)

[Nonretroactive as of January 1, 2003]

(Added 2001 and 2003)

S.1.2. Selecting and Recording Grain Class and Constituent. – Provision shall be made for selecting and recording the type or class or multi-class group of grain and the constituent(s) to be measured. The means to select the grain type or class or multi-class group and the constituent(s) shall be readily visible and the type or class or multi-class group of grain and the constituent(s) selected shall be clearly and definitely identified in letters (such as HRWW, HRSW, WHEAT, etc., or PROT, etc.). A symbol to identify the display of the type or class or multi-class group of grain and constituent(s) selected is permitted provided that it is clearly defined adjacent to the display. Minimum acceptable abbreviations are listed in Table S.1.2. Grain Types and Multi-Class Groups Considered for Type Evaluation and Calibration and Their Minimum Acceptable Abbreviations.

[Nonretroactive as of January 1, 2003]

If more than one calibration is included for a given grain type, the calibrations must be clearly distinguished from one another.

[Nonretroactive as of January 1, 2004]

(Amended 2003 and 2007)

Table S.1.2. Grain Types and Multi-Class Groups Considered for Type Evaluation and Calibration and Their Minimum Acceptable Abbreviations		
Grain Type	Grain Class	Minimum Acceptable Abbreviation
Barley	Two-Rowed Barley	TRB
	Six-Rowed Barley	SRB
	All-Class Barley*	BARLEY
Corn	---	CORN
Soybeans	---	SOYB
Wheat	All-Class Wheat*	WHEAT
	Durum Wheat	DURW
	Hard Red Spring Wheat	HRSW
	Hard Red Winter Wheat	HRWW
	Hard White Wheat	HDWW
	Soft Red Winter Wheat	SRWW
	Soft White Wheat	SWW
	Wheat Excluding Durum*	WHTXDUR
Note: Grain Types marked with an asterisk (*) are “Multi-Class Calibrations”		

[Nonretroactive as of January 1, 2003]

(Table Amended 2001 and 2007)

S.1.3. Operating Range. – An analyzer shall automatically and clearly indicate when the operating range of the device has been exceeded. The statement of the operating range shall be specified in the operator’s manual and shall operate as follows:

- (a) The ambient temperature range over which the analyzer may be used and still comply with the applicable requirements shall be specified. The minimum temperature range shall be 10 °C to 30 °C. No constituent value may be displayed when the temperature range is exceeded. An appropriate error message shall be displayed when the temperature of the analyzer is outside its specified operating range.
- (b) The constituent range at the moisture basis specified in Table N.1.1. Constant Moisture Basis for Type Evaluation and Field Inspections shall be specified for each grain or seed for which the analyzer is to be used. A constituent value may be displayed when the constituent range is exceeded if accompanied by a clear indication that the constituent range has been exceeded.
(Amended 2001)
- (c) For whole grain analyzers only, the temperature range shall be specified for each grain or seed for which an analyzer is to be used. The minimum temperature range for each grain shall be 10 °C to 30 °C. No constituent value may be displayed when the temperature range is exceeded. An appropriate error message shall be displayed when the temperature of the grain sample exceeds the temperature range for the grain. The requirements of this subsection (c) are not applicable to ground grain analyzers.
- (d) For whole grain analyzers, the maximum allowable difference in temperature between the instrument environment (ambient temperature) and the sample for which an accurate constituent determination can be made shall be specified. The minimum temperature range shall cover at least 10 °C. No constituent value may be displayed when the maximum allowable temperature difference is exceeded. An

appropriate error message shall be displayed when the difference between the ambient temperature and the sample temperature exceeds the specified difference. The requirements of this subsection (d) are not applicable to ground grain analyzers.

[Nonretroactive as of January 1, 2003]

S.1.4. Operating Temperature.

- (a) *An analyzer shall not display or record any usable values until the internal operating temperature necessary to meet tolerance requirements has been attained, or the analyzer shall bear a conspicuous statement adjacent to the indication stating that the analyzer shall be turned on for a time period specified by the manufacturer prior to use.*
- (b) *If an instrument does not meet tolerance requirements because there is an upper internal operating temperature limit that could be exceeded when operating within the ambient temperature range specified by the manufacturer, then a means of sensing and indicating an over-temperature condition must be provided.*

[Nonretroactive as of January 1, 2003]

S.1.5. Value of Smallest Unit. – *The display shall permit constituent value determination to both 0.01 % and 0.1 % resolution. The 0.1 % resolution is for commercial transactions; the 0.01 % resolution is for calibration purposes only, not for commercial purposes.*

[Nonretroactive as of January 1, 2003]

S.2. Design of NIR Analyzers.

S.2.1. Minimum Sample Size. – *Analyzers shall be designed to measure constituent values of representative size grain samples. The minimum allowable sample size used in analysis shall be 20 g.*

[Nonretroactive as of January 1, 2003]

S.2.2. Electric Power Supply.

S.2.2.1. Power Supply, Voltage and Frequency. – *An analyzer that operates using alternating current must perform within tolerance requirements over the line voltage range 100 V to 130 V and over the frequency range of 59.5 Hz to 60.5 Hz.*

[Nonretroactive as of January 1, 2003]

S.2.2.2. Power Interruption. – *A power interruption shall not cause an indicating or recording element to display or record any values outside the applicable tolerance limits.*

[Nonretroactive as of January 1, 2003]

S.2.3. Level Indicating Means. – *Analyzers shall be equipped with a level indicator and leveling adjustments if its performance is changed by an amount greater than the tolerance requirement when the instrument is moved from a level position into a position that is out of level in any upright direction by up to 5 % (approximately three degrees). The level-indicating means shall be readable without removing any instrument parts requiring a tool.*

[Nonretroactive as of January 1, 2003]

S.2.4. Environmental Conditions. – *Instrument optics and electronics must be protected from exposure to dust by either sealing these areas or by protecting them with a dust filtration system suitable for the removal of air-borne grain dust.*

[Nonretroactive as of January 1, 2003]

S.2.5. Calibration Transfer and Verification.

S.2.5.1. Calibration Transfer. – *The instrument hardware/software design and calibration procedures shall permit calibration development and the mathematical transfer of calibrations between instruments of like models.*

Note: *Only the manufacturer or the manufacturer's designated service agency may make calibration transfer or slope adjustments on near-infrared grain analyzers and, except for instrument failure and repair, only during a prescribed period of time during the year. This does not preclude the possibility of the operator installing the manufacturer-specified calibration constants or standardization parameters under the instructions of the manufacturer or the manufacturer's designated service agency. Nor does it preclude operator bias adjustments when made under the conditions specified in UR.2.8. Slope and Bias Adjustments.*

[Nonretroactive as of January 1, 2003]

(Note added 1995) (Amended 1995)

S.2.5.2. Calibration Version. – *An instrument must be capable of displaying either calibration constants, a unique calibration name, or a unique calibration version number for use in verifying that the latest version of the calibration is being used to make constituent determinations, and that the appropriate instrument settings have been made for the calibration being used.*

[Nonretroactive as of January 1, 2003]

(Amended 2001)

S.2.5.3. Calibration Corruption. – *If calibration constants are digitally stored in an electronically alterable form, the analyzer shall be designed to make automatic checks to detect corruption of calibration constants. An error message must be displayed if calibration constants have been electronically altered.*

[Nonretroactive as of January 1, 2003].

S.2.6. Provision for Sealing. – *An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter (for calibration changes consisting of multiple constants, the calibration version number may be used rather than the calibration constants.)*

A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to 25 times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: Does not require 1000 changes to be stored for each parameter.)

[Nonretroactive as of January 1, 2003]

(Amended 1997)

S.3. Accessory Equipment. – *When the operating instructions for an NIR analyzer require accessory equipment separate from and external to the analyzer, such equipment shall be appropriate and complete for the measurement.*
[Nonretroactive as of January 1, 2003]

S.3.1. Grinders. – *The make and model of grinder used for ground grain NIR analyzers must be specified by the manufacturer and required as auxiliary equipment in the determination of constituent values for applicable grain types.*

[Nonretroactive as of January 1, 2003]

S.4. Operating Instructions and Use Limitations. – *The manufacturer shall furnish operating instructions for the device and accessories that include complete information concerning the accuracy, sensitivity, and use of accessory equipment necessary in obtaining a constituent value. Operating instructions shall include the following information:*

- (a) *name and address or trademark of the manufacturer;*
- (b) *the type or design of the device for which the operating instructions are intended to be used;*
- (c) *date of issue;*

- (d) *the kind or classes of grain or seed for which the device is designed to measure constituent values; and*
- (e) *the limitations of use, including but not limited to constituent range, grain or seed temperature, kind or class of grain or seed, instrument temperature, voltage and frequency ranges, electromagnetic interferences, and necessary accessory equipment.*

[Nonretroactive as of January 1, 2003]

N. Notes

N.1. Testing Procedures.

N.1.1. Field Inspection. – Whole grain samples shall be used as the official field inspection standards. Five samples per grain type or class shall be used to check instrument performance. Each sample will be analyzed once. One of the samples will be analyzed an additional four times to test instrument repeatability. For ground grain instruments, the ground sample will be repacked four times. A new grind is not required. Test results must be converted to the standard moisture bases shown in Table N.1.1. Constant Moisture Basis for Type Evaluation and Field Inspection before applying the tolerances of Table T.2. Acceptance and Maintenance Tolerances for NIR Grain Analyzers. Test results on whole grain analyzers that produce results on an “as is” basis without displaying or recording a moisture value shall be converted to the standard moisture bases shown in Table N.1.1. Constant Moisture Basis for Type Evaluation and Field Inspection using sample moisture values determined with the facility’s moisture meter (which must be certified for commercial use).

(Amended 2001)

Table N.1.1. Constant Moisture Basis for Type Evaluation and Field Inspection		
Grain Type or Class	Constituents(s)	Moisture Basis
<i>Durum Wheat, Hard Red Spring Wheat, Hard Red Winter Wheat, Hard White Wheat, Soft Red Winter Wheat, Soft White Wheat</i>	<i>Protein</i>	<i>12 %</i>
<i>Soybeans</i>	<i>Protein Oil</i>	<i>13 %</i>
<i>Two-rowed Barley Six-rowed Barley</i>	<i>Protein</i>	<i>0 % (dry basis)</i>
<i>Corn</i>	<i>Protein Oil Starch</i>	<i>0 % (dry basis)</i>

[Nonretroactive as of January 1, 2003]

(Table Added 2001)

Constituent values shall be assigned to test samples by the Grain Inspection, Packers and Stockyards Administration (GIPSA). Tolerances shall be applied to individual sample measurements, the average of individual measurements on each of the five test samples, and the maximum difference (range) in results for five analyses on one of the test samples.

(Amended 2001)

N.1.2. Standard Reference Samples. – Reference samples used for field inspection purposes shall be clean and selected to reasonably represent the constituent range. These samples shall be selected such that the difference between constituent values obtained using the GIPSA standard reference method and an official GIPSA NIR grain analyzer does not exceed one-half of the acceptance tolerance shown in Table T.2. Acceptance and Maintenance Tolerances for NIR Grain Analyzers for individual test samples or 0.375 times the acceptance tolerance shown for the average of five samples.

(Amended 2001 and 2003)

T. Tolerances

T.1. To Underregistration and to Overregistration. – The tolerances hereinafter prescribed shall be applied to errors of underregistration and errors of overregistration and shall be based on constituent values expressed at the moisture bases shown in Table N.1.1. Constant Moisture Basis for Type Evaluation and Field Inspection.

(Amended 2001)

T.2. Tolerance Values. – Acceptance and maintenance tolerances shall be equal. Tolerances for individual samples and the average for five samples are as shown in Table T.2. Acceptance and Maintenance Tolerances for NIR Grain Analyzers.

Table T.2. Acceptance and Maintenance Tolerances for NIR Grain Analyzers				
Type or Class of Grain	Constituent	Individual Samples (percent)	Average for Five Samples (percent)	Range for Five Retests (percent)
Durum Wheat, Hard Red Spring Wheat, Hard Red Winter Wheat, Hard White Wheat, Soft Red Winter Wheat, Soft White Wheat	protein	0.60	0.40	0.40
Soybeans	protein	0.80	0.60	0.60
	oil	0.70	0.50	0.50
Two-rowed Barley Six-rowed Barley	protein	0.70	0.50	0.50
Corn	protein	0.80	0.60	0.60
	oil	0.70	0.50	0.50
	starch	1.00	0.80	0.80

(Amended 2001)

UR. User Requirements

UR.1. Installation Requirements. – The NIR analyzer shall be installed in an environment within the range of temperature and/or other environmental factors specified in the operating manual.

UR.2. User Requirements.

UR.2.1. Operating Instructions. – The operating instructions for the NIR analyzer shall be readily available to the user, service technician, and weights and measures official at the place of installation. It shall include a list of accessory equipment if any are required to obtain constituent values, and the type or class of grain to be measured with the NIR analyzer. If an NIR analyzer has the capability, the user is permitted to select the moisture basis to be used on any measurement.

(Amended 2001)

UR.2.2. Other Devices Not Used for Commercial Measurement. – If there are other NIR analyzers on the premises not used for trade or determining other charges for services, these devices shall be clearly and conspicuously marked “Not for Use in Trade or Commerce.”

UR.2.3. Printed Tickets.

- (a) *Printed tickets shall be free from any previous indication of constituent or grain type selected. The printed ticket shall indicate constituent values and the moisture basis associated with each constituent value (except moisture). If the analyzer is calibrated to display results on an “as is” moisture basis and does NOT display or record a moisture value, the ticket must clearly indicate that results are expressed on an “as is” moisture basis.*

(Amended 2001)

- (b) *The customer shall be given a printed ticket showing the date, grain type or class, constituent results, and calibration version identification. If the analyzer converts constituent results to a manually entered moisture basis, the “native” concentration and the “native” moisture basis must appear on the printed ticket in addition to the converted results and the manually entered moisture basis. If the manually entered moisture basis is intended to be the moisture value for an “as is” constituent concentration measurement, that moisture value must have been obtained on the same sample and must have been measured on a moisture meter certified for commercial use. The information presented on the ticket shall be arranged in a consistent and unambiguous manner. The ticket shall be generated by the near-infrared grain analyzer system.*

[Nonretroactive as of January 1, 2003]

(Amended 2001)

UR.2.4. Grinders. – Place grinders in a separate room from the NIR analyzer to avoid instrument contamination. If a separate room is not available, the grinder may be in the same room with the NIR analyzer provided the grinder is not placed within one meter of the air intake on the NIR.

UR.2.5. Sampling. – Samples shall be obtained by following appropriate sampling methods and equipment. These include, but are not limited to grain probes of appropriate length used at random locations in the bulk, the use of a pelican sampler, or other techniques and equipment giving equivalent results. The sample shall be taken such that it is representative of the lot. If an NIR analyzer permits user entry of the moisture value for an “as is” constituent measurement, that moisture value must have been obtained on the same sample and must have been measured on a moisture meter certified for commercial use.

(Amended 2001)

UR.2.6. Level Condition. – If equipped with a level indicator, an analyzer shall be maintained in a level condition.

UR.2.7. Operating Limitation. – Constituent determinations shall not be made when the difference in temperatures between the grain sample and the instrument environment (ambient temperature) exceeds manufacturer recommendations.

UR.2.8. Slope and Bias Adjustments. – Bias changes shall be made only on the basis of tests run on a current set of Standard Reference Samples (SRS) traceable to GIPSA Master Instruments.¹ A written explanation and record of all calibration changes, including those changes made by a manufacturer or the manufacturer’s designated service agency, shall be maintained. The log shall indicate the date and magnitude of changes in bias and slope constants and the instrument serial number. A Calibration Adjustment Data Sheet for each log entry shall be available for inspection upon request by the field inspector. Data Sheets shall be retained by the user for a period of no less than 18 months following any calibration adjustment. The Data Sheet must show: date of test and adjustment, serial number of the instrument, calibration identification, the nature of the adjustment, the unique identification number and source of sample sets used, and, for each sample in the set, reference values, initial instrument results (except in the cases of instrument failure and repair), and instrument results after calibration adjustment or instrument repair.

(Amended 1995)

¹ Established error must be known.

Table of Contents

	Page
Section 5.58. Multiple Dimension Measuring Devices	5-81
A. Application	5-81
A.1. General.....	5-81
A.2. Other Devices Designed to Make Multiple Measurements Automatically to Determine a Volume...5-81	5-81
A.3. Additional Code Requirements.	5-81
A.4. Exceptions.....	5-81
A.5. Type Evaluation.....	5-81
S. Specifications	5-81
S.1. Design of Indicating and Recording Elements and of Recorded Representations.	5-81
S.1.1. Zero or Ready Indication.	5-81
S.1.2. Digital Indications.....	5-81
S.1.3. Negative Values.	5-82
S.1.4. Dimensions Indication.	5-82
S.1.5. Value of Dimension/Volume Division Units.	5-82
S.1.6. Customer Indications and Recorded Representations.	5-82
S.1.7. Minimum Measurement.....	5-83
S.1.8. Indications Below Minimum and Above Maximum.....	5-83
S.1.9. Operating Temperature.	5-84
S.1.10. Adjustable Components.	5-84
S.1.11. Provision for Sealing.....	5-84
S.2. Design of Zero and Dimensional Offset.	5-85
S.2.1. Zero or Ready Adjustment.	5-85
S.2.2. Dimensional Offset.	5-85
S.3. Systems with Two or More Measuring Elements.....	5-85
S.4. Marking Requirements.	5-85
S.4.1. Multiple Dimension Measuring Devices, Main Elements, and Components of Measuring Devices.	5-85
S.4.2. Location of Marking Information.	5-87
N. Notes.....	5-87
N.1. Test Procedures.....	5-87
N.1.1. General.....	5-87
N.1.2. Position Test.....	5-87
N.1.3. Disturbance Tests, Field Evaluation.....	5-87
N.1.4. Test Object Size.....	5-88
N.1.5. Digital Zero Stability.....	5-88
T. Tolerances.....	5-88
T.1. Design.	5-88
T.2. Tolerance Application.	5-88
T.2.1. Type Evaluation.....	5-88
T.2.2. Subsequent Verification.....	5-88
T.2.3. Multi-interval (Variable Division-Value) Devices.	5-88
T.2.4. Mixed-Interval Devices.	5-88
T.3. Tolerance Values.....	5-88
T.3.1. For Volumetric Measuring Devices.....	5-88
T.4. Position Tests.	5-89

T.5.	Influence Factors.	5-89
T.5.1.	Temperature.	5-89
T.5.2.	Power Supply Voltage.	5-89
T.6.	Disturbances, Field Evaluation.	5-89
UR.	User Requirements.....	5-89
UR.1.	Selection Requirements.	5-89
UR.1.1.	Value of the Indicated and Recorded Division.	5-89
UR.2.	Installation Requirements.	5-90
UR.2.1.	Supports.	5-90
UR.2.2.	Foundation, Supports, and Clearance.	5-90
UR.2.3.	Protection from Environmental Factors.	5-90
UR.3.	Use Requirements.	5-90
UR.3.1.	Minimum and Maximum Measuring Ranges.	5-90
UR.3.2.	Special Designs.	5-90
UR.3.3.	Object Placement.	5-90
UR.4.	Maintenance Requirements.	5-90
UR.4.1.	Zero or Ready Condition.	5-90
UR.4.2.	Level Condition.	5-90
UR.4.3.	Device Modification.	5-90
UR.5.	Customer Information Provided.	5-90

Section 5.58. Multiple Dimension Measuring Devices

A. Application

A.1. General. – This code applies to dimension and volume measuring devices used for determining the dimensions and/or volume of objects for the purpose of calculating freight, storage, or postal charges based on the dimensions and/or volume occupied by the object. A multiple dimension measuring device:

(a) is generally used to measure hexahedron-shaped objects; and
(Added 2008)

(b) may be used to measure irregularly-shaped objects.
(Added 2008)

(Amended 2008)

A.2. Other Devices Designed to Make Multiple Measurements Automatically to Determine a Volume. – Insofar as they are clearly applicable, the provisions of this code apply also to devices designed to make multiple measurements automatically to determine a volume for other applications as defined by Section 1.10. General Code Paragraph G-A.1. Commercial and Law-Enforcement Equipment.

A.3. Additional Code Requirements. – In addition to the requirements of this code, Multiple Dimension Measuring Devices shall meet the requirements of Section 1.10. General Code.

A.4. Exceptions. – This code does not apply to:

- (a) devices designed to indicate automatically (with or without value-computing capabilities) the length of fabric passed through the measuring elements (also see Section 5.50. for Fabric-Measuring Devices);
- (b) devices designed to indicate automatically the length of cordage, rope, wire, cable, or similar flexible material passed through the measuring elements (also see Section 5.51. for Wire- and Cordage-Measuring Devices);
or
- (c) any linear measure, measure of length, or devices used to measure individual dimensions for the purpose of assessing a charge per unit of measurement of the individual dimension (also see Section 5.52. for Linear Measures).

A.5. Type Evaluation. – The National Type Evaluation Program (NTEP) will accept for type evaluation only those devices that comply with all requirements of this code.

S. Specifications

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

S.1.1. Zero or Ready Indication.

- (a) Provision shall be made to indicate or record either a zero or ready condition.
- (b) A zero or ready condition may be indicated by other than a continuous digital zero indication, provided that an effective automatic means is provided to inhibit a measuring operation when the device is in an out-of-zero or non-ready condition.

S.1.2. Digital Indications. – Indicated and recorded values shall be presented digitally.

S.1.3. Negative Values. – Negative values shall not be indicated or recorded.

(Amended 2021)

S.1.4. Dimensions Indication. – If in normal operation the device indicates or records only volume, a testing mode shall be provided to indicate dimensions for all objects measured.

S.1.5. Value of Dimension/Volume Division Units. – The value of a device division “d” expressed in a unit of dimension shall be presented in a decimal format. The value of “d” for each measurement axis shall be in the same unit of measure and expressed as:

- (a) 1, 2, or 5;
- (b) a decimal multiple or submultiple of 1, 2, or 5; or
- (c) a binary submultiple of a specific U.S. customary unit of measure.

Examples: device divisions may be 0.01, 0.02, 0.05; 0.1, 0.2, or 0.5; 1, 2, or 5; 10, 20, 50, or 100; 0.5, 0.25, 0.125, 0.0625, etc.

(Amended 2016)

S.1.5.1. For Indirect Sales. – In addition to the values specified in S.1.5. Value of Dimension/Volume Division Units, the value of the division may be 0.3 inch and 0.4 inch.

S.1.5.2. Devices Capable of Measuring Irregularly-Shaped Objects. – For devices capable of measuring irregularly shaped objects, the value of the division size (d) shall be the same for the length axis (x) and the width axis (y) and may be different for the height axis (z), provided that electronic rotation of the object to determine the smallest hexahedron is calculated in only a two-dimension horizontal plane, retaining the stable side plane as the bottom of the hexahedron.

(Added 2008)

S.1.6. Customer Indications and Recorded Representations. – Multiple dimension measuring devices or systems must provide information as specified in Table S.1.6. Required Information to be Provided by Multiple Dimension Measuring Systems. As a minimum, all devices or systems must be able to meet either column I or column II in Table S.1.6. Required Information to be Provided by Multiple Dimension Measuring Systems.

(Amended 2004)

Table S.1.6. Required Information to be Provided by Multiple Dimension Measuring Systems				
Information	Column I ¹	Column II ¹		Column III
	Provided by device	Provided by invoice or other means		Provided by invoice or other means as specified in contractual agreement
		Customer present	Customer not present	
1. Device identification ²	D or P	P	P	P or A
2. Error message (when applicable)	D or P	P	N/A	N/A
3. Hexahedron dimensions ³	D or P	P	P	P or A
4. Hexahedron volume (if used) ³	D or P	P	P	P or A
5. Actual weight (if used) ³	D or P	P	P	P or A
6. Dimensional Offset (if used) ³	D or P	N/A	N/A	N/A
7. Hexahedron measurement statement ⁴	D or P or M	P	P	P or G
A = AVAILABLE UPON REQUEST BY CUSTOMER⁵ D = DISPLAYED G = PUBLISHED GUIDELINES OR CONTRACTS M = MARKED N/A = NOT APPLICABLE P = PRINTED or RECORDED IN A MEMORY DEVICE and AVAILABLE UPON REQUEST BY CUSTOMER⁵				
Notes: ¹ As a minimum all devices or systems must be able to meet either column I or column II. ² This is only required in systems where more than one device or measuring element is being used. ³ Some devices or systems may not utilize all of these values; however, as a minimum either hexahedron dimensions or hexahedron volume must be displayed or printed. ⁴ This is an explanation that the dimensions and/or volume shown are those of the smallest hexahedron in which the object that was measured may be enclosed rather than those of the object itself. ⁵ The information “available upon request by customer” shall be retained by the party having issued the invoice for at least 30 calendar days after the date of invoicing.				

(Amended 2004 and 2021)

S.1.7. Minimum Measurement. – Except for entries of dimensional offset, the minimum measurement by a device is 12 d. The manufacturer may specify a longer minimum measurement. For multi-interval devices, this applies only to the first measuring range (or segment) of each measurement axis (length, width, and height).

(Amended) (Amended 2017, and 2021)

S.1.8. Indications Below Minimum and Above Maximum. – When objects are smaller than the minimum dimensions identified in paragraph S.1.7. Minimum Measurement or larger than any of the maximum dimensions plus 9 d, and/or maximum volume marked on the device plus 9 d, or when a combination of dimensions, including dimensional offset, for the object being measured exceeds the measurement capability of the device, the indicating or recording element shall either:

(a) not indicate or record any usable values; or

(b) identify the indicated or recorded representation with an error indication.

(Amended 2004, 2017, and 2021)

S.1.9. Operating Temperature. – An indicating or recording element shall not indicate nor record any usable values until the operating temperature necessary for accurate measuring and a stable zero reference or ready condition has been attained.

S.1.10. Adjustable Components. – Adjustable components shall be held securely in adjustment and, except for a zeroing mechanism (when applicable), shall be located within the housing of the element.

S.1.11. Provision for Sealing. – For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices. For parameters adjusted using other means, the following applies.

- (a) The device or system shall be designed with provision(s) for applying a security seal that must be broken, or for using other approved means of providing security (e.g., data change audit trail available at the time of inspection), before any change that detrimentally affects the metrological integrity can be made to any measuring element.
- (b) Audit trails shall use the format set forth in Table S.1.11. Categories of Devices and Methods of Sealing for Multiple Dimension Measuring Systems.

(Amended 2019)

Table S.1.11. Categories of Devices and Methods of Sealing for Multiple Dimension Measuring Systems	
Categories of Devices	Methods of Sealing
Category 1: No remote configuration.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. Device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode.	The hardware enabling access for remote communication must be at the device and sealed using a physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).	An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1000 records are required. (Note: Does not require 1000 changes to be stored for each parameter.)

S.2. Design of Zero and Dimensional Offset.

S.2.1. Zero or Ready Adjustment. – A device shall be equipped with means by which the zero reference or ready condition can be adjusted, or the zero reference or ready condition shall be automatically maintained. The zero reference or ready control circuits shall be interlocked so that their use is prohibited during measurement operations.

S.2.2. Dimensional Offset. – The dimensional offset shall eliminate the effect of the conveyance method resulting in the measurement of only the object intended to be measured.

(Amended 2021)

S.2.2.1. Maximum Value of Dimensional Offset for Multi-Interval (Variable Division-Value Devices). – A multi-interval device shall not accept any dimensional offset value greater than the maximum capacity of the lowest range of the height axis.

(Added 2016) (Amended 2021)

(Added 2016)

S.3. Systems with Two or More Measuring Elements. – A multiple dimension measuring system with a single indicating or recording element, or a combination indicating-recording element, that is coupled to two or more measuring elements with independent measuring systems, shall be provided with means to prohibit the activation of any measuring element (or elements) not in use, and shall be provided with automatic means to indicate clearly and definitely which measuring element is in use.

Note: This requirement does not apply to individual devices that use multiple emitters/sensors within a device in combination to measure objects in the same measurement field.

(Amended 2004)

S.4. Marking Requirements. – (Also see G-S.1. Identification, G-S.4. Interchange or Reversal of Parts, G-S.5.2.5. Permanence, G-S.6. Marking Operational Controls, Indications, and Features, G-S.7. Lettering, G-UR.2.1.1. Visibility of Identification, and G-UR.3.1. Method of Operation.)

S.4.1. Multiple Dimension Measuring Devices, Main Elements, and Components of Measuring Devices. – Multiple dimension measuring devices, main elements of multiple dimension measuring devices when not contained in a single enclosure for the entire dimension/volume measuring device, and other components shall be marked as specified in Table S.4.1.a. Marking Requirements for Multiple Dimension Measuring Systems and explained in the accompanying notes, Table S.4.1.b. Multiple Dimension Measuring Systems Notes for Table S.4.1.a.

Table S.4.1.a. Marking Requirements for Multiple Dimension Measuring Systems				
To Be Marked With ↓	Multiple Dimension Measuring Equipment			
	Multiple Dimension Measuring Device and Indicating Element in Same Housing	Indicating Element not Permanently Attached to Multiple Dimension Measuring Element	Multiple Dimension Measuring Element Not Permanently Attached to the Indicating Element	Other Equipment (1)
Manufacturer's ID	x	x	x	x
Model Designation	x	x	x	x
Serial Number and Prefix	x	x	x	x (2)
Certificate of Conformance Number (8)	x	x	x	x (8)
Minimum and Maximum Dimensions for Each Axis for Each Range in Each Axis (3)(9)	x	x	x	
Value of Measuring Division, d (for each axis and range) (9)	x	x	x	
Temperature Limits (4)(9)	x	x	x	
Minimum and Maximum speed (5)(9)	x	x	x	
Special Application (6)(9)	x	x	x	
Limitation of Use (7)(9)	x	x	x	

(Amended 2016)

<p align="center">Table S.4.1.b. Multiple Dimension Measuring Systems Notes for Table S.4.1.a.</p>	
1.	Necessary to the dimension and/or volume measuring system, but having no effect on the measuring value, e.g., auxiliary remote display, keyboard, etc.
2.	Modules without “intelligence” on a modular system (e.g., printer, keyboard module, etc.) are not required to have serial numbers.
3.	The minimum and maximum dimensions (using upper or lower case type) shall be marked. For example: Length: min _____ max _____ Width: min _____ max _____ Height: min _____ max _____
4.	Required if the range is other than – 10 °C to 40 °C (14 °F to 104 °F).
5.	Multiple dimension measuring devices, which require that the object or device be moved relative to one another, shall be marked with the minimum and maximum speeds at which the device is capable of making measurements that are within the applicable tolerances.
6.	A device designed for a special application rather than general use shall be conspicuously marked with suitable words visible to the operator and the customer restricting its use to that application.
7.	Materials, shapes, structures, combination of object dimensions, speed, spacing, minimum protrusion size, or object orientations that are inappropriate for the device or those that are appropriate.
8.	Required only if a Certificate of Conformance has been issued for the equipment.
9.	This marking information may be readily accessible via the display. Instructions for displaying the information shall be described in the NTEP CC.

(Amended 2004, 2008, and 2016)

S.4.2. Location of Marking Information. – The required marking information shall be so located that it is readily observable without the necessity of the disassembly of a part requiring the use of any means separate from the device.

N. Notes

N.1. Test Procedures.

N.1.1. General. – The device shall be tested using test standards and objects of known and stable dimensions.

N.1.2. Position Test. – Measurements are made using different positions of the test object and consistent with the manufacturer’s specified use for the device.

N.1.2.1. Irregularly-Shaped Test Object Placement. – Irregularly-shaped test objects must be measured while placed on a stable side. The rotation of the object to determine the smallest hexahedron should be calculated in a two-dimensional plane, retaining the stable side plane as the bottom of the hexahedron.

(Added 2008)

N.1.3. Disturbance Tests, Field Evaluation. – A disturbance test shall be conducted at a given installation when the presence of disturbances specified in T.6. Disturbances, Field Evaluation has been verified and characterized if those conditions are considered “usual and customary.”

N.1.4. Test Object Size. – Test objects may vary in size from the smallest dimension to the largest dimension marked on the device, and for field verification examinations, shall be an integer multiple of “d.”

N.1.4.1. Test Objects. – Verification of devices may be conducted using appropriate test objects of various sizes and of stable dimensions. Test object dimensions must be known to an expanded uncertainty (coverage factor $k = 2$) of not more than one-third of the applicable device tolerance. The dimensions shall also be checked to the same uncertainty when used at the extreme values of the influence factors.

The dimension of all test objects shall be verified using a reference standard that is traceable to NIST (or equivalent national laboratory) and meet the tolerances expressed in NIST Handbook 44 Fundamental Considerations, paragraph 3.2. (i.e., one-third of the smallest tolerance applied to the device).

(Added 2004)

N.1.4.2. Irregularly-Shaped Test Objects. – For irregularly-shaped test objects, at least one angle shall be obtuse and the smallest dimension for an axis shall be equal to or greater than the minimum dimension for that axis.

(Added 2008)

(Amended 2008 and 2012)

N.1.5. Digital Zero Stability. – A zero indication change test shall be conducted on all devices which show a digital zero. After the removal of any test object, the zero indication shall not change. (Also see G-UR.4.2. Abnormal Performance.)

T. Tolerances

T.1. Design. – The tolerance for a multiple dimension measuring device is a performance requirement independent of the design principle used.

T.2. Tolerance Application.

T.2.1. Type Evaluation. – For type evaluations, the tolerance values apply to tests within the influence factor limits of temperature and power supply voltage specified in T.5.1. Temperature and T.5.2. Power Supply Voltage.

T.2.2. Subsequent Verification. – For subsequent verifications, the tolerance values apply regardless of the influence factors in effect at the time of the verification. (Also see G-N.2. Testing with Nonassociated Equipment.)

T.2.3. Multi-interval (Variable Division-Value) Devices. – When there exist two or more partial measuring ranges (or segments) specified for any of the “dimensioning” axes (length (x), width (y), or height (z)) and the division values corresponding to those partial measuring ranges (or segments) within the same “dimensioning” axis differ, the tolerance values shall be based on the value of the division of the range in use.

(Amended 2016)

T.2.4. Mixed-Interval Devices. – For devices that measure to a different division value in at least one dimensioning axes and all axes are single range, the tolerance values shall be based on the value of the division of the axis in use.

(Added 2016)

T.3. Tolerance Values. – The maintenance and acceptance tolerance values shall be ± 1 division.

T.3.1. For Volumetric Measuring Devices.

(Amended 2004)

T.4. Position Tests. – For a test standard measured several times in different positions by the device all indications shall be within applicable tolerances.

T.5. Influence Factors. – The following factors are applicable to tests conducted under controlled conditions only.

T.5.1. Temperature. – Devices shall satisfy the tolerance requirements under the following temperature conditions.

T.5.1.1. Temperature Limits. – If not marked on the device, the temperature limits shall be – 10 °C to 40 °C (14 °F to 104 °F).

T.5.1.2. Minimum Temperature Range. – If temperature limits are specified for the device, the range shall be at least 30 °C or 54 °F.

T.5.1.3. Temperature Effect on Zero Indication. – The zero indication shall not vary by more than one division per 5 °C (9 °F) change in temperature.

T.5.2. Power Supply Voltage.

T.5.2.1. Alternating Current Power Supply. – Devices that operate using alternating current must perform within the conditions defined in paragraphs T.3. through T.6., inclusive, from – 15 % to + 10 % of the marked nominal line voltage(s) at 60 Hz, or the voltage range marked by the manufacturer, at 60 Hz.
(Added 2004)

T.5.2.2. Direct Current Power Supply. – Devices that operate using direct current shall operate and perform within the applicable tolerance at any voltage level at which the device is capable of displaying metrological registrations.
(Added 2004)

(Amended 2004)

T.6. Disturbances, Field Evaluation. – The following requirements apply to devices when subjected to disturbances which may normally exist in the surrounding environment. These disturbances include radio frequency interference (RFI), electromagnetic interference (EMI), acoustic changes, ambient light emissions, etc. The difference between the measurement indication with the disturbance and the measurement indication without the disturbance shall not exceed one division “d” or the equipment shall:

- (a) blank the indication;
- (b) provide an error message; or
- (c) the indication shall be so completely unstable that it could not be interpreted, or transmitted into memory or to a recording element, as a correct measurement value.

UR. User Requirements

UR.1. Selection Requirements. – 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 maximum capacity, value of the division, minimum capacity, and computing capability.

UR.1.1. Value of the Indicated and Recorded Division. – The value of the division recorded shall be the same as the division value indicated.

UR.2. Installation Requirements.

UR.2.1. Supports. – A device that is portable and is being used on a counter, table, or the floor shall be so positioned that it is firmly and securely supported.

UR.2.2. Foundation, Supports, and Clearance. – The foundations and support of a device 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 measuring element is empty, nor throughout the performance range of the device such that the operation or performance of the device is adversely affected.

UR.2.3. Protection from Environmental Factors. – The indicating and measuring elements of a device shall be adequately protected from environmental factors such as wind, weather, and RFI that may adversely affect the operation or performance of the device.

UR.3. Use Requirements.

UR.3.1. Minimum and Maximum Measuring Ranges. – A device shall not be used to measure objects smaller than the minimum or larger than the maximum dimensions marked on the device.

UR.3.2. Special Designs. – A multiple dimension measuring device designed and marked for a special application shall not be used for other than its intended purpose.

UR.3.3. Object Placement. – If the object being measured must be transported (e.g., shipped) on a stable side, that irregularly-shaped object must be measured while placed on that stable side. The electronic rotation of the object to determine the smallest hexahedron shall be calculated in a two-dimensional horizontal plane, retaining the stable side plane as the bottom of the hexahedron.

(Added 2008)

(Amended 2008)

UR.4. Maintenance Requirements.

UR.4.1. Zero or Ready Condition. – The zero-setting adjustment of a multiple dimension measuring device shall be maintained so that, with no object in or on the measuring element, the device shall indicate or record a zero or ready condition.

UR.4.2. Level Condition. – If a multiple dimension measuring device is equipped with a level-condition indicator, the device shall be maintained in a level condition.

UR.4.3. Device Modification. – The measuring capabilities of a device shall not be changed from the manufacturer's design unless the modification has been approved by the manufacturer and the weights and measures authority having jurisdiction over the device.

UR.5. Customer Information Provided. – The user of a multiple dimension measuring device or system shall provide transaction information to the customer as specified in Table UR.5. Customer Information Provided.

(Added 2004)

Table UR.5. Customer Information Provided			
Information	No Contractual Agreement		Contractual Agreement
	Customer Present	Customer not Present	
1. Object identification	N/A	P	P or A
2. Billing method (scale or dimensional weight if used)	D or P	P	P or A
3. Billing rate or rate chart	D or P or A	P or G or A	P or A
4. Dimensional weight (if used)	P	P	P or A
5. Conversion factor (if dimensional weight is used)	D or P or A	P	P or G
6. Dimensional weight statement ¹ (if dimensional weight is used)	D or P	P	P or G
7. Total price	P	P	P or A
A = Available upon Request by Customer ² D = Displayed G = Published Guidelines or Contracts M = Marked N/A = Not Applicable P = Printed Notes: ¹ This is an explanation that the dimensional weight is not a true weight but is a calculated value obtained by applying a conversion factor to the hexahedron dimensions or volume of the object. ² The information “available upon request by customer” shall be retained by the party having issued the invoice for at least 30 calendar days after the date of invoicing.			

(Added 2004)

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Table of Contents

	Page
Section 5.59. Electronic Livestock, Meat, and Poultry Evaluation Systems and/or Devices	95
A. Application	95
A.1. General.....	95
A.2. Additional Code Requirements.....	95
A.3. Exceptions.....	95
S. Specifications.....	95
S.1. Design and Manufacture.....	95
N. Notes.....	95
N.1. Method of Test.....	95
N.2. Testing Standards.....	95
N.3. Verification.....	95
N.3.1. Official Tests.....	95
T. Tolerances.....	96
T.1. Tolerances on Individual Measurements.....	96
UR. User Requirements	96
UR.1. Installation Requirements.....	96
UR.1.1. Installation.....	96
UR.2. Maintenance of Equipment.....	96
UR.2.1. Maintenance.....	96
UR.3. Use Requirements.....	96
UR.3.1. Limitation of Use.....	96
UR.4. Testing Standards.....	96

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Section 5.59. Electronic Livestock, Meat, and Poultry Evaluation Systems and/or Devices

The status of Section 5.59. Electronic Livestock, Meat, and Poultry Evaluation Systems and/or Devices was changed from “tentative” to “permanent” effective January 1, 2013.

(Added 2005) (Amended 2012)

A. Application

A.1. General. – This code applies to electronic devices or systems for measuring the composition or quality constituents of live animals, livestock and poultry carcasses, and individual cuts of meat or a combination thereof for the purpose of determining value.

A.2. Additional Code Requirements. – In addition to the requirements of this code, Electronic Livestock, Meat, and Poultry Evaluation Systems shall meet the requirements of Section 1.10. General Code.

A.3. Exceptions. – This code does not apply to scales used to weigh live animals, livestock and poultry carcasses, and individual cuts of meat unless the scales are part of an integrated system designed to measure composition or quality constituents. Scales used in integrated systems must also meet NIST Handbook 44, Section 2.20. Scale requirements.

S. Specifications

S.1. Design and Manufacture. – All design and manufacturing specifications shall comply with American Society for Testing Materials (ASTM) International Standard F2342 Standard Specification for Design and Construction of Composition or Quality Constituent Measuring Devices or Systems.

N. Notes

N.1. Method of Test. – Performance tests shall be conducted in accordance with ASTM Standard F2343 Test Method for Livestock, Meat, and Poultry Evaluation Devices.

N.2. Testing Standards. – ASTM Standard F2343 requires device or system users to maintain accurate reference standards that meet the tolerance expressed in NIST Handbook 44 Fundamental Considerations, paragraph 3.2. Tolerances for Standards (i.e., one-third of the smallest tolerance applied).

N.3. Verification. – Device or system users are required to verify and document the accuracy of a device or system on each production day as specified by ASTM Standard F2341 Standard Practice of User Requirements for Livestock, Meat, and Poultry Evaluation Devices or Systems.

N.3.1. Official Tests. – Officials are encouraged to periodically witness the required “in house” verification of accuracy. Officials may also conduct official tests using the on-site testing standards or other appropriate standards belonging to the jurisdiction with statutory authority over the device or system.

T. Tolerances

T.1. Tolerances on Individual Measurements. – Maintenance and acceptance tolerances on an individual measurement shall be as shown in Table T.1. Tolerances.

Table T.1. Tolerances	
Individual linear measurement of a single constituent	± 1 mm (0.039 in)
Measurement of area	± 1.6 cm ² (0.25 in ²)
For measurements of other constituents	As specified in ASTM Standard F2343

UR. User Requirements

UR.1. Installation Requirements.

UR.1.1. Installation. – All devices and systems shall be installed in accordance with manufacturer's instructions.

UR.2. Maintenance of Equipment.

UR.2.1. Maintenance. – All devices and systems shall be continually maintained in an accurate condition and in accordance with the manufacturer's instructions and ASTM Standard F2341.

UR.3. Use Requirements.

UR.3.1. Limitation of Use. – All devices and systems shall be used to make measurements in a manner specified by the manufacturer.

UR.4. Testing Standards. – The user of a commercial device shall make available to the official with statutory authority over the device testing standards that meet the tolerance expressed in Fundamental Considerations, paragraph 3.2. Tolerances for Standards (i.e., one-third of the smallest tolerance applied). The accuracy of the testing standards shall be verified annually or on a frequency as required by the official with statutory authority and shall be traceable to the appropriate SI standard.

Table of Contents

	Page
Section 5.60. Transportation Network Measurement Systems – Tentative Code	5-99
A. Application	5-99
A.1. General.....	5-99
A.2. Exceptions.....	5-99
A.3. Additional Code Requirements.....	5-99
S. Specifications.....	5-99
S.1. Design of Indicating and Recording Elements.....	5-99
S.1.1. General Indicating Elements.....	5-99
S.1.2. General Recording Elements.	5-100
S.1.3. Identification.....	5-100
S.1.4. Location of Identification Information.....	5-100
S.1.5. Display of Rates and Additional Charges	5-100
S.1.6. Fare Estimates.....	5-100
S.1.7. Actuation of Measurement System.	5-100
S.1.8. <i>Fare Adjustment</i>	5-100
S.1.9. Fare Identification and Other Charges.	5-101
S.1.10. Receipt.....	5-101
S.1.11. Driver's Summary.....	5-101
S.2. Provision for Sealing.....	5-102
S.2.1. System Security.	5-102
S.2.2. System Audit.....	5-102
S.2.3. Change Tracking.....	5-102
S.3. Provision for Trip Data Loss.....	5-102
S.3.1. Intermittent Trip Data Loss.....	5-102
S.3.2. Significant Trip Data Loss.	5-102
S.3.3. Alternative Fare Structures	5-102
N. Notes.....	5-102
N.1. Distance Tests.	5-102
N.1.1. Test Methods.....	5-102
N.1.2. Test Procedures.....	5-103
N.1.3. Test Conditions.	5-103
N.2. Time Test	5-103
T. Tolerances.....	5-104
T.1. Tolerance Values.	5-104
T.1.1. Distance Tests.	5-104
T.1.2. Time Tests	5-104
T.2. Tests Using Transfer Standards	5-104
UR. User Requirements	5-104
UR.1. System Indications.	5-104
UR.1.1. Statement of Rates	5-104
UR.2. Change Tracking.....	5-104
UR.3. System Installation and Operation.	5-104
UR.4. Fare Estimates.....	5-104
UR.5. Determination of Total Charges When Location Service Data Is Lost.....	5-104
Appendix D. Definitions	5-105

digital network.....	5-105
network-arranged ride.....	5-105
transportation network company.....	5-105
transportation network company driver	5-105
transportation network company rider.	5-105
transportation network measurement system.	5-105

Section 5.60. Transportation Network Measurement Systems –Tentative Code

This tentative code has a trial or experimental status and is not intended to be enforced. The requirements are designed for study prior to the development and adoption of a final code. Officials wanting to conduct an official examination of a device or system are advised to see paragraph G-A.3. Special and Unclassified Equipment.

(Tentative Code Added 2017)

A. Application

A.1. General. – This code applies to a transportation network measurement system used in connection with a digital network that determines the actual time elapsed and/or distance travelled during a network-arranged ride to calculate a fare for transportation services.

Note: The fare is calculated by software services residing on the transportation network company servers using data transmitted by the indicating elements present in the vehicle, which are running software applications or services supplied by the transportation network company. The measurement data is generated from sources not physically connected to the vehicle (e.g., a navigation satellite system such as GPS and/or other location services).

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

- (a) Any system that charges a flat rate or fixed charge, and/or does not use a measurement of actual time elapsed or distance travelled to calculate a fare for transportation services.
- (b) Odometers on vehicles that are rented or hired on a distance basis. (Also see Section 5.53. Odometers.)
- (c) Taximeters. (Also see Section 5.54. Taximeters.)
- (d) Any system where the fare is calculated by equipment located in the vehicle.

A.3. Additional Code Requirements. – In addition to the requirements of this code, transportation network measurement systems shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1. Design of Indicating and Recording Elements. – Indicating and recording elements shall provide indications and recorded representations that are clear, definite, accurate, and easily read under any conditions of normal operation of the device(s).

All indicating and recording elements used in a transportation network measurement system shall operate correctly while using the online-enabled technology application service provided by the transportation network company.

S.1.1. General Indicating Elements. – A transportation network measurement system shall include, as a minimum:

- (a) an indicating element used by a transportation network company driver that displays information and facilitates the measurements during a network-arranged ride to calculate a fare for transportation services; and
- (b) an indicating element used by a transportation network company rider that displays information that allows the rider to review the current rate(s) for the transportation service and to request a ride.

S.1.2. General Recording Elements. – A transportation network measurement system shall be capable of:

- (a) recording all information necessary to generate a receipt specified in S.1.10. Receipt;
- (b) providing information to transportation network company drivers, including, but not limited to, a summary of rides given as specified in S.1.11. Driver’s Summary; and
- (c) providing a copy of all metrological data required by law to a weights and measures jurisdiction with statutory authority.

S.1.3. Identification. – All transportation network measurement system indicating elements shall display for the purposes of identification the following information:

- (a) the name, initials, or trademark of the transportation network measurement system manufacturer, distributor, or developer; and
- (b) the current version or revision identifier of the software application service provided by the transportation network company running on the indicating elements identified in S.1.1. General Indicating Elements.
 - (1) The version or revision identifier shall be prefaced by words or an abbreviation that clearly identifies the number as the required version or revision.
 - (2) Abbreviations for the word “Version” shall, as a minimum, begin with the letter “V” and may be followed by the word “Number.” Abbreviations for the word “Revision” shall, as a minimum, begin with the letter “R” and may be followed by the word “Number.” The abbreviation for the word “Number” shall, as a minimum, begin with the letter “N” (e.g., No or No.).

S.1.4. Location of Identification Information. – The information required by S.1.3. Identification shall be accessible through an easily recognized menu and, if necessary, a submenu or other appropriate means. Examples of menu and submenu identification include, but are not limited to, “Help,” “About,” “System Identification,” “Weights and Measures Identification,” or “Identification.”

S.1.5. Display of Rates and Additional Charges. – The transportation network measurement system shall be designed to make available to transportation network company riders the rate(s) for transportation services before the beginning of a network-arranged ride. The system shall be capable of providing an explanation of the basis for calculating a fare including, if applicable, the base fare, rates for time and distance, and the amount of a booking fee, platform fee, or other similar service fee, before a rider submits the request for a network-arranged ride.

S.1.6. Fare Estimates. – The transportation network measurement system shall be capable of displaying a fare estimate to the transportation network company rider before a request for a network-arranged ride is made.

S.1.7. Actuation of Measurement System. – Following the initiation of a network-arranged ride by the transportation network company driver, and prior to the conclusion of that network-arranged ride, the transportation network measurement system shall only indicate and/or record measurements resulting from the movement of the vehicle or by the time mechanism.

S.1.8. Fare Adjustment. – A transportation network measurement system shall be designed with:

- (a) a “time off” mechanism and a “distance off” mechanism provided for the transportation network system driver to render the measurement of time and distance either operative or inoperative during the ride; or

- (b) *the capability to make post-transaction fare adjustments to reduce the amount of the fare, provided the system creates a record of all location and time data from the time the ride request was accepted by the transportation network company driver.*

[Nonretroactive as of January 1, 2018]

S.1.9. Fare Identification and Other Charges.

S.1.9.1. Fare Identification. – Fare indications shall be identified by the word “Fare” or by an equivalent expression when displayed on the transportation network company system receipt required by S.1.10 Receipt. Values shall be defined by suitable words or monetary signs.

S.1.9.2. Other Charges. – Other charges shall be indicated as separate line items when displayed on the receipt required by S.1.10. Receipt. Other charges shall be identified using an appropriate descriptive term, including but not limited to “Booking Fee,” “Tolls,” “Airport Pickup/Drop-off Surcharge” or an equivalent expression. Values shall be defined by suitable words or monetary signs.

S.1.10. Receipt. – A transportation network measurement system shall issue a printed or electronic receipt to a transportation network company rider. This receipt shall include as a minimum the following:

- (a) date of the start of the trip;
- (b) unique identifying information sufficient for the transportation network company to identify the transaction, or other identifying information as specified by the statutory authority;
- (c) start and end time of trip, total time of trip (maximum increment of one second), and if applicable, the total elapsed time during any time-off period;
- (d) distance traveled, maximum increment of 0.01 km or 0.01 mi;
- (e) the associated fare in \$;
- (f) other charges where permitted shall be identified and itemized;
- (g) total charge in \$;
- (h) the start and end addresses or locations of the trip;
- (i) a map showing the route taken; and
- (j) a means to obtain transportation network company rider assistance.

S.1.11. Driver’s Summary. – A transportation network measurement system shall be capable of providing a summary of the driver’s activity regarding network-arranged rides. The summary shall include, but not be limited to, the following information about each ride:

- (a) date and time for start of trip;
- (b) unique identifying information sufficient for the transportation network company to identify the transaction, or other identifying information as specified by the statutory authority;
- (c) total time of trip, maximum increment of one second;
- (d) distance traveled, maximum increment of 0.01 km or 0.01 mi;
- (e) the total fare received;

- (f) other charges where permitted; and
- (g) a means to obtain transportation network company driver assistance.

S.2. Provision for Sealing.

S.2.1. System Security. – Adequate provision shall be made to provide security for a transportation network measurement system. The system shall be designed to:

- (a) protect the integrity of metrological data and algorithms used to compute fares from such data against unauthorized modification using industry-standard technological protection mechanisms such as data encryption; and
- (b) use software-based access controls or equivalent technological protections that limit access to metrological data and algorithms used to compute fares from such data only to authorized persons.

S.2.2. System Audit. – The transportation network measurement system shall be designed in a manner that permits officials having statutory authority to verify compliance with this transportation network measurement system code.

S.2.3. Change Tracking. – Changes made by the manufacturer, distributor, or developer of a transportation network measurement system to any algorithms or code, which have a metrological effect, shall be logged and recorded. The period covered by this change record is not required to exceed one year.

S.3. Provision for Trip Data Loss. – If a portion of the trip data is lost due to power or signal interruption by the transportation network company driver's indicating element, the transportation network measurement system shall be capable of determining the information needed to complete any transaction in progress at the time of the power or signal loss.

S.3.1. Intermittent Trip Data Loss. – When the location services signal is lost intermittently during a prearranged ride (e.g., traveling through a tunnel), but recovered prior to the end of the ride, the transportation network measurement system shall be capable of calculating an accurate fare in accordance with T.1. Tolerance Values.

S.3.2. Significant Trip Data Loss. – When the location services signal is lost for a significant portion of the network-arranged ride, the transportation network measurement system shall provide for alternative fare structures.

Note: Significant trip data loss refers to instances when the location services signal is lost to the extent the transportation network measurement system is not capable of calculating an accurate fare in accordance with T.1. Tolerance Values using actual time and actual distance, or when the signal is not regained by the end of the ride.

S.3.3. Alternative Fare Structures. – If the transportation network measuring system is not using actual time and actual distance for a particular trip (e.g., zone-based fares, signal loss), that portion of the fare not based on actual time and actual distance is not subject to this code. Charges not based on actual time and actual distance measurements may be based on the terms of service.

N. Notes

N.1. Distance Tests.

N.1.1. Test Methods. – To determine compliance with distance tolerances, distance test(s) of a transportation network measurement system shall be conducted. The distance test(s) shall consist of a road test unless safety or

other practical concerns prohibit road testing. A transfer standard test may be performed in the absence of a road test. At least one test shall be of a length sufficient to exceed the minimum fare.

N.1.1.1. Road Test. – The test consists of operating the conveyance over a precisely measured course calibrated to a traceable linear measure of at least one mile in length

N.1.1.2. Transfer Standard Test. – The test consists of operating the conveyance over an unmeasured course while using a calibrated transfer standard, such as a fifth-wheel, to measure the distance travelled.

Note: Field examinations of transportation network measurement systems need not include testing of all individual devices used as driver/passenger indicating elements in connection with the service provided. It is considered sufficient that a representative sample of various indicating elements be incorporated in testing to verify proper operation of the system.

N.1.2. Test Procedures.

N.1.2.1. Test Length. – All tests must be at least one mile in length. If a measured course or testing equipment is not readily available that will enable a test of a length sufficient to exceed the minimum fare, after completing the testing specified in N.1.1. Test Methods, an additional unmeasured test may be conducted. The purpose of this additional unmeasured test is to verify compliance with S.1.10. Receipt.

N.1.2.2. Additional Tests. – If during testing a transportation network measurement system produces a measurement that does not comply with the tolerance values in T.1.1. Distance Tests, a minimum of three additional tests shall be conducted at the same location where all test variables are reduced to the greatest extent practicable to verify the system's ability to repeat transaction indications. Repeatability testing performed in excess of these three additional tests is done at the discretion of the official with statutory authority.

To verify system-wide noncompliance, tests for variability shall be conducted, including a minimum of three consecutive tests of varying lengths, locations, and/or environmental conditions.

N.1.3. Test Conditions.

N.1.3.1. General. – Except during type evaluation, all tests shall be performed under the conditions that are considered usual and customary within the location(s) where the system is normally operated as deemed necessary by the statutory authority.

N.1.3.2. Roads. – All tests shall be conducted on public roads.

N.1.3.3. Testing for Environmental Influences. – During type evaluation, the distance test may include a route traveled by the vehicle that will expose the system to conditions that could contribute to the loss of, or interference with, the location service's signal. This may include:

- (a) objects that may obstruct or reflect signals such as tall buildings/structures, forestation, tunnels, etc.;
- (b) routes that do not follow a straight-line path;
- (c) significant changes in altitude; and
- (d) any other relevant environmental conditions.

N.2. Time Test. – A transportation network measurement system, which determines time elapsed, shall be tested for compliance with the tolerance values specified in T.1.2. Time Tests, using a certified, traceable standard.

T. Tolerances

T.1. Tolerance Values. – The tolerances will be as specified in T.1.1. Distance Tests and T.1.2. Time Tests. (The following proposed tolerance values will be confirmed based on performance data evaluated by the NIST U.S. National Work Group on Taximeters before the transportation network measurement systems code becomes a permanent code.)

T.1.1. Distance Tests. – Maintenance and acceptance tolerances shall be as follows:

- (a) On Overregistration: 2.5 %
- (b) On Underregistration: 2.5 %

T.1.2. Time Tests. – Maintenance and acceptance tolerances shall be as follows:

- (a) On Overregistration: 5 seconds or 0.5 %, whichever is greater
- (b) On Underregistration: 5 seconds or 0.5 %, whichever is greater

T.2. Tests Using Transfer Standards. – To the basic tolerance values that would otherwise be applied, there shall be added an amount equal to two times the standard deviation of the applicable transfer standard when compared to a basic reference standard.

UR. User Requirements

UR.1. System Indications. – The indicating elements identified in S.1.1. General Indicating Elements shall display indications and information in a manner such that they can be conveniently read by the user of the device, computer, website, or online-enabled technology application service.

UR.1.1. Statement of Rates. – The transportation network company rider shall be able to view the basis for calculating the fare including, if applicable, the base fare, rates for time and distance, and the amount of a booking fee, platform fee, or other similar service fees.

UR.2. Change Tracking. – Upon request by an official having statutory authority, the transportation network company shall provide an explanation of changes that are logged pursuant to S.2.3. Change Tracking requirement during the time period covered by the request. Any such request shall be answered within two business days, unless extended by the official having statutory authority. Records provided pursuant to S.2.3. Change Tracking shall be treated as confidential and proprietary to the extent permitted by any applicable law.

UR.3. System Installation and Operation. – The transportation network company driver shall use the indicating elements identified in S.1.1.(a) General Indicating Elements in accordance with the requirements of the manufacturer, distributor, or developer.

UR.4. Fare Estimates. – Estimates for fare charges shall be provided by the transportation network measurement system when requested by the transportation network company rider and following the input of a final destination for the trip being requested. The recipient of the fare estimate shall be able to access information about the fare estimate, including key variables that may lead to discrepancies between actual fare charged and the fare estimate provided as required by law.

UR.5. Determination of Total Charges When Location Service Data Is Lost. – At the conclusion of the trip, the transportation network company shall disclose to the transportation network measurement service rider and driver the manner in which total charges are determined when there is significant data loss from location services.

Appendix D. Definitions

D

digital network. – An online-enabled technology application service, website, or system offered or used by a transportation network company that enables a transportation network company rider to arrange a network-arranged ride with a transportation network company driver. [5.60]

N

network-arranged ride. – The provision of transportation by a transportation network company driver to a transportation network company rider, or other persons selected by the transportation network company rider, arranged through a digital network. [5.60]

T

transportation network company. – An entity that uses a digital network to connect transportation network company riders with transportation network company drivers who provide network-arranged rides, and offers or provides a transportation network measurement system, subject to an agreement or terms of service between the transportation network company and transportation network company rider or driver. [5.60]

transportation network company driver. – An individual authorized by the transportation network company to access the digital network and receive connections to transportation network company riders for the purpose of providing network-arranged rides. [5.60]

transportation network company rider. – An individual who has obtained an account with a transportation network company and uses the transportation network company’s digital network to connect with a transportation network company driver who can offer or provide a network-arranged ride to the transportation network company rider or other persons selected by the transportation network company rider. [5.60]

transportation network measurement system. – The information technology infrastructure and services offered or used by a transportation network company that receives data collected through a digital network and calculates a fare for a network-arranged ride. [5.60]

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Table of Contents

	Page
Appendix A. Fundamental Considerations Associated with the Enforcement of Handbook 44 Codes	A-3
1. Uniformity of Requirements	A-3
1.1. National Council Codes.	A-3
1.2. Form of Promulgation.	A-3
2. Tolerances for Commercial Equipment.....	A-4
2.1. Acceptance and Maintenance Tolerances.	A-4
2.2. Theory of Tolerances.	A-4
2.3. Tolerances and Adjustments.	A-4
3. Testing Apparatus	A-4
3.1. Adequacy.	A-4
3.1.1. Essential Elements of Traceability.....	A-4
3.1.2. Specifications for Standards.....	A-5
3.1.3. Authority for Approving Field Test Standards and/or Equipment.	A-5
3.2. Tolerances for Standards.....	A-5
3.3. Accuracy of Field Standards.	A-6
4. Inspection of Commercial Equipment	A-6
4.1. Inspection Versus Testing.....	A-6
4.2. Necessity for Inspection.....	A-6
4.3. Specification Requirements.	A-6
4.4. General Considerations.	A-7
4.5. Misuse of Equipment.	A-7
4.6. Recommendations.....	A-7
4.7. Accurate and Correct Equipment.	A-7
5. Correction of Commercial Equipment	A-7
5.1. Adjustable Elements.	A-7
5.2. When Corrections Should Be Made.....	A-8
5.3. Gauging.....	A-8
6. Rejection of Commercial Equipment.....	A-8
6.1. Rejection and Condemnation.	A-8
7. Tagging of Equipment.....	A-9
7.1. Rejected and Condemned.	A-9
7.2. Nonsealed and Noncommercial.	A-9
8. Records of Equipment.....	A-9
8.1. Records, General.....	A-9
9. Sealing of Equipment	A-10
9.1. Types of Seals and Their Locations.	A-10
9.2. Exceptions.....	A-10
10. Rounding Off Numerical Values	A-10
10.1. Definition.	A-10
10.2. General Rules.....	A-10
10.3. Rules for Reading of Indications.	A-11
10.4. Rules for Common Fractions.	A-11

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Appendix A. Fundamental Considerations Associated with the Enforcement of Handbook 44 Codes

1. Uniformity of Requirements

1.1. National Council Codes. – Weights and measures jurisdictions are urged to promulgate and adhere to the National Council 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 Council codes. Uniformity of specifications and tolerances is an important factor in the manufacture of commercial equipment. Deviations from standard designs to meet the special demands of individual weights and measures jurisdictions are expensive, and any increase in costs of manufacture is, of course, passed on to the purchaser of equipment. On the other hand, if designs can be standardized by the manufacturer to conform to a single set of technical requirements, production costs can be kept down, to the ultimate advantage of the general public. Moreover, it seems entirely logical that equipment that is suitable for commercial use in the “specification” states should be equally suitable for such use in other states.

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

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

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

The specifications, tolerances, and other technical requirements for weighing and measuring devices as recommended by the National Council on Weights and Measures and published in the National Institute of Standards and Technology Handbook 44, “Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices,” and supplements thereto or revisions thereof, shall apply to commercial weighing and measuring devices in the state.

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

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

2. Tolerances for Commercial Equipment

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

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

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

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

3. Testing Apparatus

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

(Amended 2023)

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

- Realization of SI Units
- Unbroken Chain of Comparisons
- Documented Calibration Program

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

- Documented Measurement Uncertainty
- Documented Measurement Procedure
- Accredited Technical Competence
- Measurement Assurance

3.1.2. Specifications for Standards. – Standards shall meet the specifications of the National Institute of Standards and Technology Handbook 105-Series standards or other appropriate designated documentary standards (e.g., ASTM, ASME, etc.). Recommendations regarding the specifications and tolerances for suitable field standards may be obtained from the Office of Weights and Measures of the National Institute of Standards and Technology.

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

(Added 2023)

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

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

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

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

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

The second category of transfer standard, which is referred to here as a “Type 2 transfer standard,” is one that does not meet the one-third requirement. The Type 2 transfer standard must be stable and valid under the environmental or operating conditions in which it can be reasonably anticipated to be used. The performance characteristics must be

confirmed with sufficient data to properly characterize the uncertainty associated with the Type 2 transfer standard. When a Type 2 transfer standard is used, the tolerances applicable to the commercial weighing and measuring device must be increased to recognize the large uncertainty associated with the Type 2 transfer standard. When commercial weighing and measuring devices are tested using a Type 2 transfer standard, the tolerance applied to the commercial weighing and measuring devices meter under test shall be determined as specified in Section 1.10. General Code, G-T.5. Tolerances on Tests When Type 2 Transfer Standards Are Used.

(Added 2023)

3.3. Accuracy of Field Standards. – Prior to the official use of testing apparatus, its accuracy should invariably be verified. Field standards should be calibrated as often as circumstances require. A field standard should be calibrated whenever damage is known or suspected to have occurred or significant repairs have been made. In addition, field standards should be calibrated with sufficient frequency to affirm their continued accuracy, so that the official may always be in an unassailable position with respect to the accuracy of his testing apparatus.

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

(Amended 2023)

4. Inspection of Commercial Equipment

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

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

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

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

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

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

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

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

4.5. Misuse of Equipment. – Inspection, coupled with judicious inquiry, will sometimes disclose that equipment is being improperly used, either through ignorance of the proper method of operation or because some other method is preferred by the operator. Equipment should be operated only in the manner that is obviously indicated by its construction or that is indicated by instructions on the equipment, and operation in any other manner should be prohibited.

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

4.7. Accurate and Correct Equipment. – Finally, the weights and measures official is reminded that commercial equipment may be accurate without being correct. A piece of equipment is accurate when its performance or value (that is, its indications, its deliveries, its recorded representations, or its capacity or actual value, etc., as determined by tests made with suitable standards) conforms to the standard within the applicable tolerances and other performance requirements. Equipment that fails so to conform is inaccurate. A piece of equipment is correct when, in addition to being accurate, it meets all applicable specification requirements. Equipment that fails to meet any of the requirements for correct equipment is incorrect. Only equipment that is correct should be sealed and approved for commercial use.²

5. Correction of Commercial Equipment

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

² See Section 1.10. General Code and Appendix D. Definitions.

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

5.2. When Corrections Should Be Made. – One of the primary duties of a weights and measures official is to determine whether equipment is suitable for commercial use. If a device conforms to all legal requirements, the official “marks” or “seals” it to indicate approval. If it does not conform to all official requirements, the official is required to take action to ensure that the device is corrected within a reasonable period of time. Devices with performance errors that could result in serious economic injury to either party in a transaction should be prohibited from use immediately and not allowed to be returned to service until necessary corrections have been made. The official should consider the most appropriate action, based on all available information and economic factors.

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

(Amended 1995)

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

6. Rejection of Commercial Equipment

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

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

On the other hand, rejection is clearly inappropriate for many items of measuring equipment. This is true for most linear measures, many liquid and dry measures, graduates, measure-containers, milk bottles, lubricating-oil bottles, and some scales. When such equipment is “incorrect,” it is either impractical or impossible to adjust or repair it, and the official has no alternative to outright condemnation. When only a few such items are involved, immediate destruction or confiscation is probably the best procedure. If a considerable number of items are involved (as, for example, a stock of measures in the hands of a dealer or a large shipment of bottles), return of these to the manufacturer

for credit or replacement should ordinarily be permitted provided that the official is assured that they will not get into commercial use. In rare instances, confiscation and destruction are justified as a method of control when less harsh methods have failed.

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

(Amended 1995)

7. Tagging of Equipment

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

(Amended 1995)

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

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

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

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

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

8. Records of Equipment

8.1. Records, General. - The official will be well advised to keep careful records of equipment that is rejected, so that he may follow up to ensure that the necessary repairs have been made. As soon as practicable following

completion of repairs, the equipment should be retested. Complete records should also be kept of equipment that has been tagged as nonsealed or noncommercial. Such records may be invaluable should it subsequently become necessary to take disciplinary steps because of improper use of such equipment.

9. Sealing of Equipment

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

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

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

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

10. Rounding Off Numerical Values

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

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

- (a) When the figure next beyond the last figure or place to be retained is less than 5, the figure in the last place retained is to be kept unchanged. When rounding off 4738 to the nearest hundred, it is noted that the figure 3 (next beyond the last figure to be retained) is less than 5. Thus, the rounded-off value would be 4700. Likewise, 47.382 rounded to two decimal places becomes 47.38.
- (b) When the figure next beyond the last figure or place to be retained is greater than 5, the figure in the last place retained is to be increased by 1. When rounding off 4738 to the nearest thousand, it is noted that the figure 7 (next beyond the last figure to be retained) is greater than 5. Thus, the rounded-off value would be 5000. Likewise, 47.382 rounded to one decimal place becomes 47.4.

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

It is important to remember that, when there are two or more figures to the right of the place where the last significant figure of the final result is to be, the entire series of such figures must be rounded off in one step and not in two or more successive rounding steps. [Expressed differently, when two or more such figures are involved, these are not to be rounded off individually, but are to be rounded off as a group.] Thus, when rounding off 47.3499 to the first decimal place, the result becomes 47.3. In arriving at this result, the figures “499” are treated as a group. Since the 4 next beyond the last figure to be retained is less than 5, the “499” is dropped (see subparagraph (a) above). It would be incorrect to round off these figures successively to the left so that 47.3499 would become 47.350 and then 47.35 and then 47.4.

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

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

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

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

For example, a series of values might be $1\frac{1}{32}$, $1\frac{2}{32}$, $1\frac{3}{32}$, $1\frac{4}{32}$, $1\frac{5}{32}$, $1\frac{6}{32}$, $1\frac{7}{32}$, $1\frac{8}{32}$, $1\frac{9}{32}$. 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 ($1\frac{1}{8}$).

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

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

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

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

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

Table of Contents

	Page
Appendix B. Units and Systems of Measurement: Their Origin, Development, and Present Status	B-3
1. Introduction	B-3
2. Units and Systems of Measurement	B-3
2.1. Origin and Early History of Units and Standards.	B-3
2.1.1. General Survey of Early History of Measurement Systems.....	B-3
2.1.2. Origin and Development of Some Common Customary Units.....	B-4
2.2. The Metric System.....	B-5
2.2.1. Definition, Origin, and Development.	B-5
2.2.2. International System of Units.	B-6
2.2.3. Units and Standards of the Metric System.	B-6
2.2.4. International Bureau of Weights and Measures.	B-7
2.2.5. Status of the Metric System in the United States.	B-7
2.3. British and United States Systems of Measurement.	B-9
2.4. Subdivision of Units.	B-10
2.5. Arithmetical Systems of Numbers.	B-11
3. Standards of Length, Mass, and Capacity or Volume	B-11
3.1. Standards of Length.	B-11
3.1.1. Calibration of Length Standards.	B-11
3.2. Standards of Mass.....	B-11
3.2.1. Mass and Weight.	B-12
3.2.2. Effect of Air Buoyancy.....	B-12
3.2.3. Calibrations of Mass Standards.....	B-13
3.3. Standards of Capacity.	B-13
3.3.1. Calibrations of Capacity Standards.....	B-13
3.4. Maintenance and Preservation of Fundamental Standard of Mass.	B-13
4. Specialized Use of the Terms “Ton” and “Tonnage”	B-13

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Appendix B. Units and Systems of Measurement: Their Origin, Development, and Present Status

1. Introduction

The National Institute of Standards and Technology (NIST) (formerly the National Bureau of Standards) was established by Act of Congress in 1901 to serve as a national scientific laboratory in the physical sciences, and to provide fundamental measurement standards for science and industry. In carrying out these related functions the Institute conducts research and development in many fields of physics, mathematics, chemistry, and engineering. At the time of its founding, the Institute had custody of two primary standards – the meter bar for length and the kilogram cylinder for mass. With the phenomenal growth of science and technology over the past century, the Institute has become a major research institution concerned not only with everyday weights and measures, but also with hundreds of other scientific and engineering standards that are necessary to the industrial progress of the nation. Nevertheless, the country still looks to NIST for information on the units of measurement, particularly their definitions and equivalents.

The subject of measurement systems and units can be treated from several different standpoints. Scientists and engineers are interested in the methods by which precision measurements are made. State weights and measures officials are concerned with laws and regulations that assure equity in the marketplace, protect public health and safety, and with methods for verifying commercial weighing and measuring devices. But a vastly larger group of people is interested in some general knowledge of the origin and development of measurement systems, of the present status of units and standards, and of miscellaneous facts that will be useful in everyday life. This material has been prepared to supply that information on measurement systems and units that experience has shown to be the common subject of inquiry.

2. Units and Systems of Measurement

The expression “weights and measures” is often used to refer to measurements of length, mass, and capacity or volume, thus excluding such quantities as electrical and time measurements and thermometry. This section on units and measurement systems presents some fundamental information to clarify the concepts of this subject and to eliminate erroneous and misleading use of terms.

It is essential that the distinction between the terms “units” and “standards” be established and kept in mind.

A unit is a special quantity in terms of which other quantities are expressed. In general, a unit is fixed by definition and is independent of such physical conditions as temperature. Examples: the meter, the liter, the gram, the yard, the pound, the gallon.

A standard is a physical realization or representation of a unit. In general, it is not entirely independent of physical conditions, and it is a representation of the unit only under specified conditions. For example, a meter standard has a length of one meter when at some definite temperature and supported in a certain manner. If supported in a different manner, it might have to be at a different temperature to have a length of one meter.

2.1. Origin and Early History of Units and Standards.

2.1.1. General Survey of Early History of Measurement Systems. – Weights and measures were among the earliest tools invented by humans. Primitive societies needed rudimentary measures for many tasks: constructing dwellings of an appropriate size and shape, fashioning clothing, or bartering food or raw materials.

Humans understandably turned first to parts of the body and the natural surroundings for measuring instruments. Early Babylonian and Egyptian records and the Bible indicate that length was first measured with the forearm, hand, or finger and that time was measured by the periods of the sun, moon, and other heavenly bodies. When it was necessary to compare the capacities of containers such as gourds or clay or metal vessels, they were filled

with plant seeds which were then counted to measure the volumes. When means for weighing were invented, seeds and stones served as standards. For instance, the “carat,” still used as a unit for gems, was derived from the carob seed.

Our present knowledge of early weights and measures comes from many sources. Archaeologists have recovered some rather early standards and preserved them in museums. The comparison of the dimensions of buildings with the descriptions of contemporary writers is another source of information. An interesting example of this is the comparison of the dimensions of the Greek Parthenon with the description given by Plutarch from which a fairly accurate idea of the size of the Attic foot is obtained. In some cases, we have only plausible theories and we must sometimes select the interpretation to be given to the evidence.

For example, does the fact that the length of the double-cubit of early Babylonia was equal (within two parts per thousand) to the length of the seconds pendulum at Babylon suggest a scientific knowledge of the pendulum at a very early date, or do we merely have a curious coincidence? By studying the evidence given by all available sources, and by correlating the relevant facts, we obtain some idea of the origin and development of the units. We find that they have changed more or less gradually with the passing of time in a complex manner because of a great variety of modifying influences. We find the units modified and grouped into measurement systems: the Babylonian system, the Egyptian system, the Phileterian system of the Ptolemaic age, the Olympic system of Greece, the Roman system, and the British system, to mention only a few.

2.1.2. Origin and Development of Some Common Customary Units. – The origin and development of units of measurement has been investigated in considerable detail and a number of books have been written on the subject. It is only possible to give here, somewhat sketchily, the story about a few units.

Units of length: The cubit was the first recorded unit used by ancient peoples to measure length. There were several cubits of different magnitudes that were used. The common cubit was the length of the forearm from the elbow to the tip of the middle finger. It was divided into the span of the hand (one-half cubit), the palm or width of the hand (one sixth), and the digit or width of a finger (one twenty-fourth). The Royal or Sacred Cubit, which was 7 palms or 28 digits long, was used in constructing buildings and monuments and in surveying. The inch, foot, and yard evolved from these units through a complicated transformation not yet fully understood. Some believe they evolved from cubic measures; others believe they were simple proportions or multiples of the cubit. In any case, the Greeks and Romans inherited the foot from the Egyptians. The Roman foot was divided into both 12 unciae (inches) and 16 digits. The Romans also introduced the mile of 1 000 paces or double steps, the pace being equal to five Roman feet. The Roman mile of 5 000 feet was introduced into England during the occupation. Queen Elizabeth, who reigned from 1558 to 1603, changed, by statute, the mile to 5 280 feet or 8 furlongs, a furlong being 40 rods of 5½ yards each.

The introduction of the yard as a unit of length came later, but its origin is not definitely known. Some believe the origin was the double cubit, others believe that it originated from cubic measure. Whatever its origin, the early yard was divided by the binary method into 2, 4, 8, and 16 parts called the half-yard, span, finger, and nail. The association of the yard with the “gird” or circumference of a person’s waist or with the distance from the tip of the nose to the end of the thumb of Henry I are probably standardizing actions, since several yards were in use in Great Britain.

The point, which is a unit for measuring print type, is recent. It originated with Pierre Simon Fournier in 1737. It was modified and developed by the Didot brothers, Francois Ambroise and Pierre Francois, in 1755. The point was first used in the United States in 1878 by a Chicago type foundry (Marder, Luse, and Company). Since 1886, a point has been exactly 0.351 459 8 millimeters, or about 1/72 inch.

Units of mass: The grain was the earliest unit of mass and is the smallest unit in the apothecary, avoirdupois, Tower, and Troy systems. The early unit was a grain of wheat or barleycorn used to weigh the precious metals silver and gold. Larger units preserved in stone standards were developed that were used as both units of mass and of monetary currency. The pound was derived from the mina used by ancient civilizations. A smaller unit was the shekel, and a larger unit was the talent. The magnitude of these units varied from place to place. The Babylonians and Sumerians had a system in which there were 60 shekels in a mina and 60 minas in a talent. The Roman talent consisted of 100 libra (pound) which were smaller in magnitude than the mina. The Troy pound

used in England and the United States for monetary purposes, like the Roman pound, was divided into 12 ounces, but the Roman uncia (ounce) was smaller. The carat is a unit for measuring gemstones that had its origin in the carob seed, which later was standardized at $\frac{1}{444}$ ounce and then 0.2 gram.

Goods of commerce were originally traded by number or volume. When weighing of goods began, units of mass based on a volume of grain or water were developed. For example, the talent in some places was approximately equal to the mass of one cubic foot of water. Was this a coincidence or by design? The diverse magnitudes of units having the same name, which still appear today in our dry and liquid measures, could have arisen from the various commodities traded. The larger avoirdupois pound for goods of commerce might have been based on volume of water, which has a higher bulk density than grain. For example, the Egyptian hon was a volume unit about 11 % larger than a cubic palm and corresponded to one mina of water. It was almost identical in volume to the present U.S. pint.

The stone, quarter, hundredweight, and ton were larger units of mass used in Great Britain. Today only the stone continues in customary use for measuring personal body weight. The present stone is 14 pounds, but an earlier unit appears to have been 16 pounds. The other units were multiples of 2, 8, and 160 times the stone, or 28, 112, and 2 240 pounds, respectively. The hundredweight was approximately equal to two talents. In the United States the ton of 2 240 pounds is called the “long ton.” The “short ton” is equal to 2 000 pounds.

Units of time and angle: We can trace the division of the circle into 360 degrees and the day into hours, minutes, and seconds to the Babylonians who had a sexagesimal system of numbers. The 360 degrees may have been related to a year of 360 days.

2.2. The Metric System.

2.2.1. Definition, Origin, and Development. – Metric systems of units have evolved since the adoption of the first well-defined system in France in 1791. During this evolution the use of these systems spread throughout the world, first to the non-English-speaking countries, and more recently to the English-speaking countries. The first metric system was based on the units centimeter, gram, and second (cgs) for the quantities of length, mass, and time. These units were particularly convenient in science and technology. Later metric systems were based on the meter, kilogram, and second (mks) to improve the value of the units for practical applications. The present metric system is the International System of Units (SI). It uses the historical base units of the meter, kilogram and second as well as additional base units for the quantities thermodynamic temperature, electric current, luminous intensity, and amount of substance. The International System of Units is referred to as the modern metric system.

The adoption of the metric system in France was slow, but its desirability as an international system was recognized by geodesists and others. On May 20, 1875, an international treaty known as the International Metric Convention or the Treaty of the Meter was signed by seventeen countries including the United States. This treaty established the following organizations to conduct international activities relating to a uniform system for measurements:

- (1) The General Conference on Weights and Measures (French initials: CGPM), an intergovernmental conference of official delegates of member nations and the supreme authority for all actions;
- (2) The International Committee of Weights and Measures (French initials: CIPM), consisting of selected scientists and metrologists, which prepares and executes the decisions of the CGPM and is responsible for the supervision of the International Bureau of Weights and Measures;
- (3) The International Bureau of Weights and Measures (French initials: BIPM), a permanent laboratory and world center of scientific metrology, the activities of which include the establishment of the basic standards and scales of the principal physical quantities and maintenance of the international prototype standards.

The National Institute of Standards and Technology provides official United States representation in these organizations. The CGPM, the CIPM, and the BIPM have been major factors in the continuing refinement of the metric system on a scientific basis and in the evolution of the International System of Units.

Multiples and submultiples of metric units are related by powers of ten. This relationship is compatible with the decimal system of numbers and it contributes greatly to the convenience of metric units.

2.2.2. International System of Units. – At the end of World War II, a number of different systems of measurement still existed throughout the world. Some of these systems were variations of the metric system, and others were based on the U.S. customary system of the English-speaking countries. It was recognized that additional steps were needed to promote a worldwide measurement system. As a result, the 9th CGPM, in 1948, asked the CIPM to conduct an international study of the measurement needs of the scientific, technical, and educational communities. Based on the findings of this study, the 10th CGPM in 1954 decided that an international system should be derived from six base units to provide for the measurement of temperature and optical radiation in addition to mechanical and electromagnetic quantities. The six base units recommended were the meter, kilogram, second, ampere, Kelvin degree (later renamed the kelvin), and the candela.

In 1960, the 11th CGPM named the system based on the six base quantities the International System of Units, abbreviated SI from the French name: Le Système International d’Unités. In 1971, the 14th CGPM adopted the mole for the quantity of substance as the seventh base unit. The SI, commonly known as the metric system, is now either obligatory or permissible throughout the world.

In 2018, the 26th CGPM approved the most significant change to the SI since its establishment in 1960, which is documented in NIST Special Publication 330.¹ SP 330 itself is based on the definitive international reference known as the BIPM SI Brochure (available at <https://www.bipm.org/en/publications/si-brochure/>). The SI is now established in terms of seven defining constants, some of which are fundamental constants of nature such as the Planck constant and the speed of light in a vacuum. The seven SI base units can be derived from the defining constants.

The definitions for the SI no longer make reference to any artifact standard, material property, or measurement description. These changes enable the realization of all units with an accuracy that is ultimately limited only by the quantum structure of nature and our technical abilities, but not by the definitions themselves.

2.2.3. Units and Standards of the Metric System. – In the early metric system there were two fundamental or base units, the meter and the kilogram, for length and mass. The other units of length and mass, and all units of area, volume, and compound units such as density were derived from these two fundamental units.

The meter was originally intended to be one ten-millionth part of a meridional quadrant of the earth. The Meter of the Archives, the platinum length standard which was the standard for most of the 19th century, at first was supposed to be exactly this fractional part of the quadrant. More refined measurements over the earth’s surface showed that this supposition was not correct. In 1889, a new international metric standard of length, the International Prototype Meter, a graduated line standard of platinum-iridium, was selected from a group of bars because precise measurements found it to have the same length as the Meter of the Archives. The meter was then defined as the distance, under specified conditions, between the lines on the International Prototype Meter without reference to any measurements of the earth or to the Meter of the Archives, which it superseded. Advances in science and technology have made it possible to improve the definition of the meter and reduce the uncertainties associated with artifacts. From 1960 to 1983, the meter was defined as the length equal to 1 650 763.73 wavelengths in a vacuum of the radiation corresponding to the transition between the specified energy levels of the krypton 86 atom. Since 1983 the meter has been defined as the length of the path traveled by light in a vacuum during an interval of $\frac{1}{299\,792\,458}$ of a second. With the decision of the 26th CGPM in 2018, the

¹ Newell, David B. and Tiesinga, Eite (2019) The International System of Units (SI). (National Institute of Standards and Technology, Gaithersburg, MD), NIST Special Publication (SP) 330. <https://doi.org/10.6028/NIST.SP.330-2019>.

wording of the meter definition was revised to include the fixed numerical value of the speed of light and the definition of the second in terms of the hyperfine transition frequency of the cesium 133 atom.

The kilogram, originally defined as the mass of one cubic decimeter of water at the temperature of maximum density, was known as the Kilogram of the Archives. After the International Metric Convention in 1875, in 1889 the definition of the kilogram was simply the mass of the International Prototype Kilogram (IPK), an artifact made of platinum-iridium (it took from 1875 until 1889 to fabricate the IPK). Each country that subscribed to the International Metric Convention was assigned one or more copies of the international standard, known as National Prototype Kilogram. That IPK artifact was the definition of the kilogram from 1889 until the decision of the 26th CGPM in 2018 noted earlier that redefines the SI. The fundamental revision to the SI now defines the kilogram from the fixed value of the Planck constant, along with definitions of the meter and second. The numerical value of the Planck constant is such that at the time of its adoption, the kilogram was equal to the mass of the IPK of 1 kg. Going forward, primary realizations of base units will be determined according to the relevant Consultative Committees published on the BIPM website.²

The liter is a unit of capacity or volume. In 1964, the 12th GCPM redefined the liter as being one cubic decimeter. By its previous definition – the volume occupied, under standard conditions, by a quantity of pure water having a mass of one kilogram – the liter was larger than the cubic decimeter by 28 parts per 1 000 000.

The International System of Units (SI) includes two classes of units:

- (a) base units for length, mass, time, temperature, electric current, luminous intensity, and amount of substance; and
- (b) derived units for all other quantities (e.g., area, volume, force, pressure, power, Celsius temperature) expressed in terms of the seven base units.

For details, see the current edition of NIST Special Publication 330 and NIST Special Publication 811.³

2.2.4. International Bureau of Weights and Measures. – The International Bureau of Weights and Measures (BIPM) was established at Sèvres, a suburb of Paris, France, by the International Metric Convention of May 20, 1875. The BIPM maintains the former International Prototype Kilogram (IPK), many secondary standards, and equipment for comparing standards and making precision measurements. The Bureau, funded by assessment of the signatory governments, is truly international. In recent years the scope of the work at the Bureau has been considerably broadened. It now carries on researches in the fields of electricity, photometry and radiometry, ionizing radiations, and time and frequency besides its work in mass, length, and thermometry.

2.2.5. Status of the Metric System in the United States. – The use of the metric system in this country was legalized by Act of Congress in 1866 and use is voluntary.⁴ Following the signing of the Convention of the Meter in 1875, the United States acquired national prototype standards for the meter and the kilogram. Up to 2019, mass measurements in the U.S. were traceable to U.S. national prototype kilograms which were in turn traceable to the IKP. From 2019 onward, mass measurements in the U.S. are traceable to Planck’s constant through the

² International Bureau of Weights and Measures (BIPM) (2022) Practical realization of the definition of some important units. Available at <https://www.bipm.org/en/publications/mises-en-pratique>.

³ Thompson, Ambler and Taylor, Barry N. (2008) The NIST Guide for the use of the International System of Units (SI). (National Institute of Standards and Technology, Gaithersburg, MD), NIST Special Publication (SP) 811. <https://www.nist.gov/pml/special-publication-811>.

⁴ Metric Act of 1866 (14 Stat 339) PDF legalized the use of the metric system in the United States. The law was amended by the America Competes Act of 2007 (U.S. Public Law 110-69), replacing the old metric system definition with the International System of Units (SI).

U.S. national prototype kilograms. The prototype meter was subsequently replaced by a *Mise en Pratique*, an internationally approved method to realize the unit, using stabilized lasers.⁵

From 1893 until 1959, the yard was defined as equal exactly to $^{3600}/_{3937}$ meter. In 1959, a small change was made in the definition of the yard to resolve discrepancies both in this country and abroad. Since 1959, the U.S. has defined the yard as equal exactly to 0.914 4 meter; the new yard is shorter than the old yard by exactly two parts in a million.⁶ At the same time, it was decided that any data expressed in feet derived from geodetic surveys within the United States would continue to bear the relationship as defined in 1893 (one foot equals $^{1200}/_{3937}$ meter) until the basic geodetic survey networks of the United States were readjusted. Based on this decision, the 1893 definition of the foot is called the U.S. survey foot, while the foot definition adopted in 1959 is called the international foot.

The intent of the 1959 action was that continued use of the U.S. survey foot would be temporary and that its use would be discontinued once the United States geodetic networks were readjusted. This was completed in 1986; however, use of the U.S. survey foot continued after 1986, creating a situation where it was used simultaneously with the international foot. This concurrent use of two nearly identical definitions of the foot caused confusion and errors. To remedy this situation, the National Oceanic and Atmospheric Administration (NOAA) and NIST took collaborative action to provide national uniformity in the measurement of length. In 2020, a Federal Register notice was published announcing the final decision to retire the U.S. survey foot with a deprecation date of December 31, 2022.⁷ Beginning on January 1, 2023, the U.S. survey foot should be avoided, except for historic and legacy applications, and will be superseded by the international foot definition (i.e., 1 foot = 0.304 8 meter exactly) in all applications. Prior to this date, except for the mile and square mile, the units cable’s length, chain, fathom, furlong, league, link, rod, pole, perch, acre, and acre-foot were previously only defined in terms of the U.S. survey foot. With this update, relationships are available in terms of the international foot, which can simply be referred to as the “foot.” Either the term “foot” or “international foot” may be used, as required for clarity in technical applications. This is particularly the case for surveying and mapping applications, although over time “foot” will become more prevalent. The preferred measurement unit of length in the United States is the meter (m) and surveyors, map makers, and engineers are encouraged to adopt the SI for their work.

Since 1970, actions have been taken to encourage the use of metric units of measurement in the United States. A brief summary of actions by Congress is provided below as reported in the Federal Register.⁸

Section 403 of Public Law 93-380, the Education Amendment of 1974, states that it is the policy of the United States to encourage educational agencies and institutions to prepare students to use the metric system of measurement as part of the regular education program.⁹ Under both this act and the Metric Conversion Act of 1975¹⁰, the “metric system of measurement” is defined as the International System of Units as established in 1960 by the General Conference on Weights and Measures and interpreted or modified for the United States by the Secretary of Commerce (Section 4(4)- Public Law 94-168; Section 403(a)(3)- Public Law 93-380). The Secretary has delegated authority under these subsections to the Director of the National Institute of Standards and Technology.

⁵ The *mise en pratique* for each SI base unit is prepared by the relevant Consultative Committee and published on the BIPM website, where they may be revised more frequently than the BIPM SI Brochure. Available at <https://www.bipm.org/en/publications/mises-en-pratique>.

⁶ *Federal Register*, July 1, 1959, Vol. 24, No. 128, p. 5348.

⁷ *Federal Register*, October 5, 2020, 85 FR 62698, p. 62698. Available at <https://www.govinfo.gov/content/pkg/FR-2020-10-05/pdf/2020-21902.pdf>.

⁸ *Federal Register*, July 28, 1998, Vol. 63, No. 144, p. 40334.

⁹ Section 403 of Public Law 93 380, the Education Amendment of 1974. Available at <https://www.govinfo.gov/content/pkg/STATUTE-88/pdf/STATUTE-88-Pg484.pdf>.

¹⁰ Metric Conversion Act of 1975 (15 U.S.C. 205a et seq.) amended by the Omnibus Trade and Competitiveness Act of 1988. Available at: <https://www.govinfo.gov/content/pkg/USCODE-2020-title15/pdf/USCODE-2020-title15-chap6-subchapII-sec205a.pdf>.

Section 5164 of Public Law 100-418, the Omnibus Trade and Competitiveness Act of 1988, amended Public Law 94-168, The Metric Conversion Act of 1975. In particular, Section 3, The Metric Conversion Act is amended to read as follows:

“Sec. 3. It is therefore the declared policy of the United States—

- (1) to designate the metric system of measurement as the preferred system of weights and measures for United States trade and commerce;
- (2) to require that each federal agency, by a date certain and to the extent economically feasible by the end of the fiscal year 1992, use the metric system of measurement in its procurements, grants, and other business-related activities, except to the extent that such use is impractical or is likely to cause significant inefficiencies or loss of markets to U.S. firms, such as when foreign competitors are producing competing products in non-metric units;
- (3) to seek ways to increase understanding of the metric system of measurement through educational information and guidance and in government publications; and
- (4) to permit the continued use of traditional systems of weights and measures in nonbusiness activities.”

The Code of Federal Regulations makes the use of metric units mandatory for agencies of the federal government.¹¹

2.3. British and United States Systems of Measurement. – In the past, the customary system of weights and measures in the British Commonwealth countries and that in the United States were very similar; however, the SI is now the official system of units in the United Kingdom, while both the SI and the U.S. customary units are used in the United States. It is incorrect to use the terms “Imperial” or “British” to describe the U.S. customary system because there are significant differences between many of these traditional measurement systems and the customary units in the U.S. NIST recommends use of the term “U.S. customary system of measurement” to describe the collection of non-SI measurement units currently used in the U.S.¹²

Because references to the units of the old British customary system are still found, the following discussion describes the differences between the U.S. and British customary systems of units.

After 1959, the U.S. and the British inches were defined identically for scientific work and were identical in commercial usage.¹³ A similar situation existed for the U.S. and the British pounds, and many relationships, such as 12 inches = 1 foot, 3 feet = 1 yard, and 1 760 yards = 1 international mile, were the same in both countries; but there were some very important differences.

In the first place, the U.S. customary bushel and the U.S. gallon, and their subdivisions differed from the corresponding British Imperial units. Also the British ton is 2 240 pounds, whereas the ton generally used in the United States is the short ton of 2 000 pounds. The American colonists adopted the English wine gallon of 231 cubic inches. The English of that period used this wine gallon and they also had another gallon, the ale gallon of 282 cubic inches. In 1824, the British abandoned these two gallons when they adopted the British Imperial gallon, which they defined as the volume of 10 pounds of water, at a temperature of 62 °F, which, by calculation, is equivalent to 277.42 cubic inches. At the same time, they redefined the bushel as 8 gallons.

In the customary British system, the units of dry measure are the same as those of liquid measure. In the United States these two are not the same; the gallon and its subdivisions are used in the measurement of liquids and the bushel, with its subdivisions, is used in the measurement of certain dry commodities. The U.S. gallon is divided into four liquid quarts and the U.S. bushel into 32 dry quarts. All the units of capacity or volume mentioned thus far are larger in the

¹¹ *Federal Register*, January 2, 1991, Vol. 56, No. 1, p. 160.

¹² *Federal Register*, October 5, 2020, 85 FR 62698, p. 62698.

¹³ *Federal Register*, July 1, 1959, Vol. 24, No. 128, p. 5348.

customary British system than in the U.S. system. But the British fluid ounce is smaller than the U.S. fluid ounce, because the British quart is divided into 40 fluid ounces whereas the U.S. quart is divided into 32 fluid ounces.

From this we see that in the customary British system an avoirdupois ounce of water at 62 °F has a volume of one fluid ounce, because 10 pounds is equivalent to 160 avoirdupois ounces, and 1 gallon is equivalent to 4 quarts, or 160 fluid ounces. This convenient relation does not exist in the U.S. system because a U.S. gallon of water at 62 °F weighs about $8\frac{1}{2}$ pounds, or $133\frac{1}{2}$ avoirdupois ounces, and the U.S. gallon is equivalent to 4×32 , or 128 fluid ounces.

1 U.S. fluid ounce	= 1.041 British fluid ounces
1 British fluid ounce	= 0.961 U.S. fluid ounce
1 U.S. gallon	= 0.833 British Imperial gallon
1 British Imperial gallon	= 1.201 U.S. gallons

Among other differences between the customary British and the United States measurement systems, we should note that the British government abolished the use of the troy pound on January 6, 1879, retaining only the troy ounce and its subdivisions. The troy pound is still legal in the United States, although it is infrequently used. Although the stone of 14 pounds is in common use for body weight in Britain, it is not used in the United States, although its influence was shown in the practice until World War II of selling flour by the barrel of 196 pounds (14 stone). In the apothecary system of liquid measure the British add a unit, the fluid scruple, equal to one third of a fluid drachm (spelled dram in the United States) between their minim and their fluid drachm. In the United States, the general practice now is to sell dry commodities, such as fruits and vegetables, by mass.

2.4. Subdivision of Units. – In general, units are subdivided by one of three methods: (a) decimal, into tenths; (b) duodecimal, into twelfths; or (c) binary, into halves (twos). Usually the subdivision is continued by using the same method. Each method has its advantages for certain purposes, and it cannot properly be said that any one method is “best” unless the use to which the unit and its subdivisions are to be put is known.

For example, if we are concerned only with measurements of length to moderate precision, it is convenient to measure and to express these lengths in feet, inches, and binary fractions of an inch, thus 9 feet, $4\frac{3}{8}$ inches. However, if these lengths are to be subsequently used to calculate area or volume, that method of subdivision at once becomes extremely inconvenient. For that reason, surveyors and civil engineers, who are concerned with areas of land, volumes of cuts, fills, excavations, etc., instead of dividing the foot into inches and binary subdivisions of the inch, divide it decimally; that is, into tenths, hundredths, and thousandths of a foot.

The method of subdivision of a unit is thus largely made based on convenience to the user. The fact that units have commonly been subdivided into certain subunits for centuries does not preclude also having another mode of subdivision in some frequently used cases where convenience indicates the value of such other method. Thus, while we usually subdivide the gallon into quarts and pints, most gasoline-measuring pumps, of the price-computing type, are graduated to show tenths, hundredths, or thousandths of a gallon.

Although the mile has for centuries been divided into rods, yards, feet, and inches, the odometer part of an automobile speedometer shows tenths of a mile. Although we divide our dollar into 100 parts, we habitually use and speak of halves and quarters. An illustration of rather complex subdividing is found on the scales used by draftsmen. These scales are of two types: (a) architects, which are commonly graduated with scales in which $\frac{3}{32}$, $\frac{3}{16}$, $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$, 1, $1\frac{1}{2}$, and 3 inches, respectively, represent 1 foot full scale, and also having a scale graduated in the usual manner to $\frac{1}{16}$ inch; and (b) engineers, which are commonly subdivided to 10, 20, 30, 40, 50, and 60 parts to the inch.

The dictum of convenience applies not only to subdivisions of a unit but also to multiples of a unit. Land elevations above sea level are given in feet although the height may be several miles; the height of aircraft above sea level as given by an altimeter is likewise given in feet, no matter how high it may be.

On the other hand, machinists, toolmakers, gauge makers, scientists, and others who are engaged in precision measurements of relatively small distances, even though concerned with measurements of length only, find it convenient to use the inch, instead of the tenth of a foot, but to divide the inch decimally to tenths, hundredths, thousandths, etc., even down to millionths of an inch. Verniers, micrometers, and other precision measuring

instruments are usually graduated in this manner. Machinist scales are commonly graduated decimally along one edge and are also graduated along another edge to binary fractions as small as $\frac{1}{64}$ inch. The scales with binary fractions are used only for relatively rough measurements.

It is seldom convenient or advisable to use binary subdivisions of the inch that are smaller than $\frac{1}{64}$. In fact, $\frac{1}{32}$ -, $\frac{1}{16}$ -, or $\frac{1}{8}$ -inch subdivisions are usually preferable for use on a scale to be read with the unaided eye.

2.5. Arithmetical Systems of Numbers. – The subdivision of units of measurement is closely associated with arithmetical systems of numbers. The systems of units used in this country for commercial and scientific work, having many origins as has already been shown, naturally show traces of the various number systems associated with their origins and developments. Thus, (a) the binary subdivision has come down to us from the Hindus, (b) the duodecimal system of fractions from the Romans, (c) the decimal system from the Chinese and Egyptians, some developments having been made by the Hindus, and (d) the sexagesimal system (division by 60) now illustrated in the subdivision of units of angle and of time, from the ancient Babylonians. The use of decimal numbers in measurements is becoming the standard practice.

3. Standards of Length, Mass, and Capacity or Volume

3.1. Standards of Length. – The meter, which is defined in terms of the speed of light in a vacuum, is the unit on which all length measurements are based.

The yard is defined¹⁴ as follows:

1 yard = 0.914 4 meter exactly, and

1 inch = 25.4 millimeters exactly.

3.1.1. Calibration of Length Standards. – NIST calibrates standards of length including gage blocks, line standards, metal tapes, step gages, and a variety of other special length standards. In general, NIST accepts for calibration only apparatus of such material, design, and construction as to ensure accuracy and permanence sufficient to justify calibration by the Institute. NIST performs dimensional calibrations that are described in the online catalog and Special Publication 250 Measurement Services series¹⁵

When carpenter rules, machinist scales, draftsman scales, and the like require calibration, they should be submitted to state or local weights and measures calibration laboratory officials.¹⁶

3.2. Standards of Mass. Mass measurements in the U.S. are traceable to the SI using Planck's constant through the U.S. national prototype kilograms.

In Colonial times, the British standards were considered the primary standards of the United States. Later, the U.S. avoirdupois pound was defined in terms of the Troy Pound of the Mint, which is a brass standard kept at the United States Mint in Philadelphia, Pennsylvania. In 1911, the Troy Pound of the Mint was superseded, for coinage purposes, by the Troy Pound of the Institute.

The avoirdupois pound is defined in terms of the kilogram by the relation:

¹⁴ *Federal Register*, July 1, 1959, Vol. 24, No. 128, p. 5348.

¹⁵ NIST Special Publication (SP) 250 Series on Measurement Services. Available at <https://shop.nist.gov/> and <https://www.nist.gov/calibrations/sp-250-publications>.

¹⁶ The current recognition status (NIST Handbook 143) and accreditation status (National Voluntary Laboratory Accreditation Program, NVLAP) of state and local calibration laboratories are available at <https://www.nist.gov/pml/owm/resources/state-laboratories> and measurement service scopes summarized at <https://www.nist.gov/pml/owm/state-calibration-scope>.

1 avoirdupois pound = 0.453 592 37 kilogram.¹⁷

These changes in definition have not made any appreciable change in the value of the pound.

The grain is $\frac{1}{7000}$ of the avoirdupois pound and is identical in the avoirdupois, troy, and apothecary systems. The troy ounce and the apothecary ounce differ from the avoirdupois ounce but are equal to each other, and equal to 480 grains. The avoirdupois ounce is equal to 437.5 grains.

3.2.1. Mass and Weight. – The mass of a body is a measure of its inertial property or how much matter it contains. The weight of a body is a measure of the force exerted on it by gravity or the force needed to support it. Gravity on earth gives a body a downward acceleration of about 9.8 m/s^2 . (In common parlance, weight is often used as a synonym for mass in weights and measures.) The incorrect use of weight in place of mass should be phased out, and the term mass used when mass is meant.

Standards of mass are ordinarily calibrated by comparison to a reference standard of mass. If two objects are compared on a balance and give the same balance indication, they have the same “mass” (excluding the effect of air buoyancy). The forces of gravity on the two objects are balanced. Even though the value of the acceleration of gravity, g , is different from location to location, because the two objects of equal mass in the same location (where both masses are acted upon by the same g) will be affected in the same manner and by the same amount by any change in the value of g , the two objects will balance each other under any value of g .

However, on a spring balance the mass of a body is not balanced against the mass of another body. Instead, the gravitational force on the body is balanced by the restoring force of a spring. Therefore, if a very sensitive spring balance is used, the indicated mass of the body would be found to change if the spring balance and the body were moved from one locality to another locality with a different acceleration of gravity. But a spring balance is usually used in one locality and is adjusted or calibrated to indicate mass at that locality.

3.2.2. Effect of Air Buoyancy. – Another point that must be taken into account in the calibration and use of standards of mass is the buoyancy or lifting effect of the air. A body immersed in any fluid is buoyed up by a force equal to the force of gravity on the displaced fluid. Two bodies of equal mass, if placed one on each pan of an equal-arm balance, will balance each other in a vacuum. A comparison in a vacuum against a known mass standard gives “true mass.” If compared in air, however, they will not balance each other unless they are of equal volume. If of unequal volume, the larger body will displace the greater volume of air and will be buoyed up by a greater force than will the smaller body, and the larger body will appear to be of less mass than the smaller body.

The greater the difference in volume, and the greater the density of the air in which we make the comparison weighing, the greater will be the apparent difference in mass. For that reason, in assigning a precise numerical value of mass to a standard, it is necessary to base this value on definite values for the air density and the density of the mass standard of reference.

The apparent mass of an object is equal to the mass of just enough reference material of a specified density (at 20°C) that will produce a balance reading equal to that produced by the object if the measurements are done in air with a density of 1.2 mg/cm^3 at 20°C . The original basis for reporting apparent mass is apparent mass versus brass. The apparent mass versus a density of 8.0 g/cm^3 is the more recent definition, and is used extensively throughout the world. The use of apparent mass versus 8.0 g/cm^3 is encouraged over apparent mass versus brass. The difference in these apparent mass systems is insignificant in most commercial weighing applications.

A full discussion of this topic is given in NIST Monograph 133.¹⁸

¹⁷ *Federal Register*, July 1, 1959, Vol. 24, No. 128, p. 5348.

¹⁸ Pontius, Paul E. (1974) Mass and Mass Values (National Institute of Standards and Technology, Gaithersburg, MD), NIST Monograph 133. Available at <https://nvlpubs.nist.gov/nistpubs/Legacy/MONO/nbsmonograph133.pdf>.

3.2.3. Calibrations of Mass Standards. – Many mass laboratory and field standards typically used in ordinary trade should be calibrated by state or local weights and measures officials.¹⁹ NIST typically calibrates primary mass standards, but it does not manufacture or sell them. NIST mass calibration services are described in the online catalog and NIST Special Publication 250 series.²⁰

3.3. Standards of Capacity. – Units of capacity or volume, being derived units, are defined in terms of linear units in the United States. Laboratory standards have been constructed and are maintained at NIST. These have validity only by calibration with reference either directly or indirectly to the linear standards. In the past, Congress authorized NIST to distribute capacity standards to the state laboratories. Other capacity standards have been purchased by organizations and verified by calibration for a variety of uses in science, technology, engineering, and commerce.

3.3.1. Calibrations of Capacity Standards. – NIST makes calibrations on capacity or volume standards that are in the customary units of trade; that is, the gallon, its multiples, and submultiples, or in metric units. Further, NIST calibrates precision-grade volumetric glassware which is normally in metric units. NIST makes calibrations in accordance with fee schedules, copies of which may be obtained from NIST.

3.4. Maintenance and Preservation of Fundamental Standard of Mass. – It is a statutory responsibility of NIST to maintain and preserve the national standard of mass and to realize all the other base units. The U.S. Prototype Kilogram maintained at NIST is fully protected by an alarm system. All measurements made with this standard are conducted in special air-conditioned laboratories to which the standard is taken a sufficiently long time before the observations to ensure that the standard will be in a state of equilibrium under standard conditions when the measurements or comparisons are made. Hence, it is not necessary to maintain the standard at standard conditions, but care is taken to prevent large changes of temperature. More important is the care to prevent any damage to the standard because of careless handling.

4. Specialized Use of the Terms “Ton” and “Tonnage”

As weighing and measuring are important factors in our everyday lives, it is quite natural that questions arise about the use of various units and terms and about the magnitude of quantities involved. For example, the words “ton” and “tonnage” are used in widely different senses, and a great deal of confusion has arisen regarding the application of these terms.

The ton is used as a unit of measure in two distinct senses: (1) as a unit of mass, and (2) as a unit of capacity or volume.

In the first sense, the term has the following meanings:

- (a) The short, or net ton of 2 000 pounds.
- (b) The long, gross, or shipper’s ton of 2 240 pounds.
- (c) The metric ton of 1 000 kilograms, or 2 204.6 pounds.

In the second sense (capacity), it is usually restricted to uses relating to ships and has the following meaning:

- (a) The register ton of 100 cubic feet.

¹⁹ The current recognition status (NIST Handbook 143) and accreditation status (National Voluntary Laboratory Accreditation Program, NVLAP) of state and local calibration laboratories are available at <https://www.nist.gov/pml/owm/resources/state-laboratories> and measurement service scopes summarized at <https://www.nist.gov/pml/owm/state-calibration-scope>.

²⁰ NIST Special Publication (SP) 250 Series on Measurement Services. Available at <https://shop.nist.gov/> and <https://www.nist.gov/calibrations/sp-250-publications>.

- (b) The measurement ton of 40 cubic feet.
- (c) The English water ton of 224 British Imperial gallons.

In the United States and Canada the ton (mass) most commonly used is the short ton. In Great Britain, it is the long ton, and in countries using the metric system, it is the metric ton. The register ton and the measurement ton are capacity or volume units used in expressing the tonnage of ships. The English water ton is used, chiefly in Great Britain, in statistics dealing with petroleum products.

There have been many other uses of the term ton such as the timber ton of 40 cubic feet and the wheat ton of 20 bushels, but their uses have been local and the meanings have not been consistent from one place to another.

Properly, the word “tonnage” is used as a noun only in respect to the capacity or volume and dimensions of ships, and to the amount of the ship’s cargo. There are two distinct kinds of tonnage; namely, vessel tonnage and cargo tonnage and each of these is used in various meanings. The several kinds of vessel tonnage are as follows:

Gross tonnage, or gross register tonnage, is the total cubical capacity or volume of a ship expressed in register tons of 100 cubic feet, or 2.83 cubic meters, less such space as hatchways, bakeries, galleys, etc., as are exempted from measurement by different governments. There is some lack of uniformity in the gross tonnages as given by different nations due to lack of agreement on the spaces that are to be exempted. Official merchant marine statistics of most countries are published in terms of the gross register tonnage. Press references to ship tonnage are usually to the gross tonnage.

The net tonnage, or net register tonnage, is the gross tonnage less the different spaces specified by maritime nations in their measurement rules and laws. The spaces deducted are those totally unavailable for carrying cargo, such as the engine room, coal bunkers, crew quarters, chart and instrument room, etc. The net tonnage is used in computing how much cargo that can be loaded on a ship. It is used as the basis for wharfage and other similar charges.

The register under-deck tonnage is the cubical capacity of a ship under her tonnage deck expressed in register tons. In a vessel having more than one deck, the tonnage deck is the second from the keel.

There are several variations of displacement tonnage.

The dead weight tonnage is the difference between the “loaded” and “light” displacement tonnages of a vessel. It is expressed in terms of the long ton of 2 240 pounds, or the metric ton of 2 204.6 pounds, and is the weight of fuel, passengers, and cargo that a vessel can carry when loaded to its maximum draft.

The second variety of tonnage, cargo tonnage, refers to the weight of the particular items making up the cargo. In overseas traffic it is usually expressed in long tons of 2 240 pounds or metric tons of 2 204.6 pounds. The short ton is only occasionally used. Therefore, the cargo tonnage is very distinct from vessel tonnage.

Table of Contents

Appendix C. General Tables of Units of Measurement	C-3
1. Tables of Metric Units of Measurement	C-3
Units of Length.....	C-4
Units of Area	C-4
Units of Volume	C-4
Units of Mass	C-4
2. Tables of U.S. Customary Units of Measurement	C-5
Units of Length	C-5
Gunter’s or Surveyors Chain Units of Measurement	C-5
Units of Area	C-6
Units of Volume	C-6
Units of Liquid Volume	C-6
Apothecaries Units of Liquid Volume	C-6
Units of Dry Volume	C-6
Avoirdupois Units of Mass	C-7
Troy Units of Mass	C-7
Apothecaries Units of Mass	C-8
3. Notes on British Units of Measurement	C-8
4. Tables of Units of Measurement	C-9
Units of Length	C-9
Units of Length – International Foot and Survey Equivalent Measurements	C-10
Units of Length – Survey Measure	C-10
Units of Length – Thickness Measurement	C-11
Units of Area	C-11
Units of Area – International Foot and Survey Equivalent Measurements	C-12
Units of Area – Survey Measure	C-12
Units of Volume	C-13
Units of Capacity or Volume – Dry Volume Measure	C-14
Units of Capacity or Volume – Liquid Volume Measure	C-15
Units of Volume – International Foot and Survey Equivalent Measurements	C-16
Units of Mass Not Less Than Avoirdupois Ounces	C-17
Units of Mass Not Greater Than Pounds and Kilograms	C-18
Units of Pressure	C-20
Conversion Equations for Units of Temperature	C-20
5. Tables of Equivalents	C-21
Units of Length	C-21
Units of Area	C-23
Units of Capacity or Volume	C-24
Units of Mass	C-27

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Appendix C. General Tables of Units of Measurement

These tables have been prepared for the benefit of those requiring tables of units for occasional ready reference. In Section 4 of this Appendix, the tables are carried out to a large number of decimal places and exact values are indicated by underlining. In most of the other tables, only a limited number of decimal places are given, therefore, making the tables better adapted to the average user.

1. Tables of Metric Units of Measurement

In the International System of Units (SI), commonly known as the metric system of measurement, designations of multiples and subdivisions of any unit may be arrived at by combining the unit symbol with the prefixes deka, hecto, and kilo meaning, respectively, ten (10), one hundred (100), and one thousand (1 000), and deci, centi, and milli, meaning, respectively, one-tenth (0.1), one-hundredth (0.01), and one-thousandth (0.001). In some of the following metric tables, some such multiples and subdivisions have not been included for the reason that these have limited usage.

In certain cases, particularly in scientific usage, it becomes convenient to provide for multiples larger than one thousand (1 000) and for subdivisions smaller than one-thousandth (0.001). The following prefixes are recognized for this purpose¹:

quetta,	(Q),	meaning 10^{30}	deci,	(d),	meaning 10^{-1}
ronna,	(R),	meaning 10^{27}	centi,	(c),	meaning 10^{-2}
yotta,	(Y),	meaning 10^{24}	milli,	(m),	meaning 10^{-3}
zetta,	(Z),	meaning 10^{21}	micro,	(μ),	meaning 10^{-6}
exa,	(E),	meaning 10^{18}	nano,	(n),	meaning 10^{-9}
peta,	(P),	meaning 10^{15}	pico,	(p),	meaning 10^{-12}
tera,	(T),	meaning 10^{12}	femto,	(f),	meaning 10^{-15}
giga,	(G),	meaning 10^9	atto,	(a),	meaning 10^{-18}
mega,	(M),	meaning 10^6	zepto,	(z),	meaning 10^{-21}
kilo,	(k),	meaning 10^3	yocto,	(y),	meaning 10^{-24}
hecto,	(h),	meaning 10^2	ronto,	(r),	meaning 10^{-27}
deka,	(da),	meaning 10^1	quecto,	(q),	meaning 10^{-30}

For example, a kilometer is 1 000 meters and a millimeter is 0.001 meter.

¹ By action of the 27th General Conference on Weights and Measures (2022), the number of International System of Units (SI) prefixes was expanded from 20 to 24 with the addition of ronna, ronto, quetta, and quecto. The International Bureau of Weights and Measures (BIPM) implemented the update in The International System of Units [Brochure], 9th Edition, version 2.01. For more information see <https://doi.org/10.59161/AUE>.

Units of Length

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

Units of Area

100 square millimeters (mm ²)	= 1 square centimeter (cm ²)
100 square centimeters	= 1 square decimeter (dm ²)
100 square decimeters	= 1 square meter (m ²)
100 square meters	= 1 square dekameter (dam ²) = 1 are
100 square dekameters	= 1 square hectometer (hm ²) = 1 hectare (ha)
100 square hectometers	= 1 square kilometer (km ²)

Units of Volume

10 milliliters (mL)	= 1 centiliter (cL)
10 centiliters	= 1 deciliter (dL) = 100 milliliters
10 deciliters	= 1 liter ² (L) = 1 000 milliliters
10 liters	= 1 dekaliter (daL)
10 dekaliters	= 1 hectoliter (hL) = 100 liters
10 hectoliters	= 1 kiloliter (kL) = 1 000 liters
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)
	= 1 000 000 cubic centimeters
	= 1 000 000 000 cubic millimeters

Units of Mass

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 megagram (Mg) or 1 metric ton (t)

² By action of the 12th General Conference on Weights and Measures (1964), the liter is a special name for the cubic decimeter (dm³).

2. Tables of U.S. Customary Units of Measurement^{3, 4}

Units of Length

12 inches (in)	= 1 foot (ft)
3 feet	= 1 yard (yd)
16½ feet	= 1 rod (rd), pole, or perch
40 rods	= 1 furlong (fur) = 660 feet
8 furlongs	= 1 mile (mi) ⁵ = 5 280 feet
1 852 meters (m)	= 6 076.115 49 feet (approximately)
	= 1 international nautical mile

Gunter's or Surveyors Chain Units of Measurement

1 link (li)	= 0.66 foot (ft) = 0.04 rod (rd) = 0.01 chain (ch)
1 fathom	= 6 feet
1 rod, perch, or pole	= 25 links = 16.5 feet = 0.25 chain
1 chain	= 66 feet = 4 rods = 100 links
1 furlong (fur)	= 660 feet = 10 chains = 40 rods
1 cable's length	= 720 feet = 120 fathoms
1 mile (mi)	= 5 280 feet = 8 furlongs = 80 chains = 320 rods
1 league	= 15 840 feet = 3 miles

³ This section lists units of measurement traditionally used in the United States. In keeping with the Metric Conversion Act of 1975 (15 U.S.C. 205a et seq.) as amended by Omnibus Trade and Competitiveness Act of 1988, the ultimate objective is to make the International System of Units (SI) the primary measurement system used in the United States.

⁴ *Federal Register*, July 1, 1959, Vol. 24, No. 128, p. 5348. NOTICE: In collaboration, National Oceanic and Atmospheric Administration (NOAA) and NIST have taken action to provide national uniformity in the measurement of length. The final decision to retire the U.S. survey foot was published in the *Federal Register*, announcing the deprecation date of December 31, 2022. Beginning on January 1, 2023, the U.S. survey foot should be avoided, except for historic and legacy applications and will be superseded by the international foot definition (i.e., 1 foot = 0.3048 meter exactly) in all applications. Prior to this date, except for the mile and square mile, the cable's length, chain, fathom, furlong, league, link, rod, pole, perch, acre, and acre-foot were previously only defined in terms of the U.S. survey foot. With this update, relationships are available in terms of the international foot, which can simply be referred as the "foot." Either the term "foot" or "international foot" may be used, as required for clarity in technical applications. This is particularly the case for surveying and mapping applications, although over time "foot" will become more prevalent. The preferred measurement unit of length in the United States is the meter (m) and surveyors, map makers, and engineers are encouraged to adopt the SI for their work. For more information see *Federal Register* (October 5, 2020, 85 FR 62698, p. 62698) available at <https://www.govinfo.gov/content/pkg/FR-2020-10-05/pdf/2020-21902.pdf>.

⁵ Originally referred to as the "statute mile," when Queen Elizabeth I changed the definition of the mile from the Roman mile of 5 000 feet to the statute mile of 5 280 feet. Although the U.S. statute mile was originally based on the U.S. survey foot (1 200/393 7 meter), its definition is now based the international foot (0.304 8 meter), per *Federal Register* (October 5, 2020, 85 FR 62698, p. 62698), which states that definitions based on the U.S. survey foot should be avoided after December 31, 2022, except for historic and legacy applications. The mile based on the international foot is about 3 millimeters shorter than the mile based on the U.S. survey foot, although both are defined as being equal to 5 280 feet.

Units of Area⁶

1 square foot (ft ²)	=144 square inches (in ²)
1 square yard (yd ²)	= 9 square feet = 1 296 square inches
1 square rod (rd ²), square pole, or square perch	= 272.25 square feet = 0.062 5 square chain (ch ²)
1 square chain	= 4 356 square feet = 16 square rods = 0.1 acre
1 acre (ac)	= 43 560 square feet = 160 square rods
	= 10 square chains
1 square mile (mi ²)	= 27 878 400 square feet = 640 acres
1 square mile (mi ²)	= 27 878 400 square feet = 640 acres

Units of Volume

1 728 cubic inches (in ³)	= 1 cubic foot (ft ³)
27 cubic feet	= 1 cubic yard (yd ³)

Units of Liquid Volume⁷

4 gills (gi)	= 1 pint (pt) = 28.875 cubic inches (in ³)
2 pints	= 1 quart (qt) = 57.75 cubic inches
4 quarts	= 1 gallon (gal) = 231 cubic inches
	= 8 pints = 32 gills

Apothecaries Units of Liquid Volume

60 minims	= 1 fluid dram (fl dr or <i>f</i> 3)
	= 0.225 6 cubic inch (in ³)
8 fluid drams	= 1 fluid ounce (fl oz or <i>f</i> ʒ)
	= 1.804 7 cubic inches
16 fluid ounces	= 1 pint (pt)
	= 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

Units of Dry Volume⁸

2 pints (pt)	= 1 quart (qt) = 67.200 6 cubic inches (in ³)
8 quarts	= 1 peck (pk) = 537.605 cubic inches
	= 16 pints
4 pecks	= 1 bushel (bu) = 2 150.42 cubic inches
	= 32 quarts

⁶ Squares and cubes of U.S. customary but not of SI units are sometimes expressed by the use of abbreviations rather than symbols. For example, sq ft is an abbreviation that represents square foot, and cu ft is an abbreviation that represents cubic foot.

⁷ When necessary to distinguish units of liquid measure such as the fluid ounce, liquid pint, or liquid quart from dry measures, the word “liquid” or “fluid,” or the abbreviations “liq” or “fl,” should be used in combination with the unit name or abbreviation.

⁸ When necessary to distinguish 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 dry unit.

Avoirdupois Units of Mass⁹

[The “grain” is an equivalent quantity in avoirdupois, troy, and apothecaries units of mass.]

1 µlb	= 0.000 001 pound (lb)
27 ¹¹ / ₃₂ grains (gr)	= 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) ¹⁰
20 hundredweights	= 1 ton (tn) ¹¹
	= 2 000 pounds ⁹

In “gross” or “long” measure, the following values are recognized:

112 pounds (lb)	= 1 gross (or long) hundredweight (cwt) ⁹
20 gross (or long) hundredweights	= 1 gross (or long) ton
	= 2 240 pounds ⁹

Troy Units of Mass

[The “grain” is an equivalent quantity in avoirdupois, troy, and apothecaries units of mass.]

24 grains (gr)	= 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

⁸ Use the measurement system name or the abbreviation 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. When necessary, the word “avoirdupois” or the abbreviation “avdp” should be used in combination with, following the name or abbreviation of the avoirdupois unit. However, if the term “avoirdupois” or “avdp” does not specifically appear in association with a measurement expressed in drams, ounces, or pounds, the value it is understood to represent the avoirdupois unit. The word “troy” or the abbreviation “t” should be used in combination with, following the name or abbreviation of the troy unit. The word “apothecaries” or the abbreviation “ap” should be used in combination with, following the name or abbreviation of the apothecaries unit. For example, “1 pound apothecaries (lb ap),” not “1 apothecaries pound (ap lb).”

¹⁰ When the terms “hundredweight” and “ton” are used unmodified, they are commonly understood to mean the 100-pound hundredweight and the 2000-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.

¹¹ As of January 1, 2014, “tn” is the required abbreviation for “short ton.” Devices manufactured between January 1, 2008, and December 31, 2013, may use an abbreviation other than “tn” to specify “short ton.”

(Added 2013)

Apothecaries Units of Mass

[The “grain” is an equivalent quantity in avoirdupois, troy, and apothecaries units of mass.]

20 grains (gr)	= 1 scruple (s ap or ʒ)
3 scruples	= 1 dram apothecaries (dr ap or ʒ)
	= 60 grains
8 drams apothecaries	= 1 ounce apothecaries (oz ap or ʒ)
	= 24 scruples = 480 grains
12 ounces apothecaries	= 1 pound apothecaries (lb ap)
	= 96 drams apothecaries
	= 288 scruples = 5 760 grains

3. Notes on British Units of Measurement

In Great Britain, the yard, the avoirdupois pound, the troy pound, and the apothecaries pound relationships are identical with the units of the same names used in the United States. The tables of British linear measure, troy mass, and apothecaries mass are the same as the corresponding United States tables, except for the British spelling “drachm” in the table of apothecaries mass. The table of British avoirdupois mass 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 % and 3 % 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 fluid 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)

4. Tables of Units of Measurement

Unit conversion is a multi-step process that involves multiplication or division by a numerical factor; selection of the correct number of significant digits; and rounding. Accurate unit conversions are obtained by selecting an appropriate conversion factor (a ratio which converts one unit of measure into another without changing the quantity), which are supplied in these tables.

Some unit conversions may be exact, without increasing or decreasing the precision of the original quantity. Exact unit conversion factors are underlined in these tables. It is good practice to keep all the digits, especially if other mathematical operations or conversions will follow. Rounding should be the last step of the conversion process and should be performed only once.

To convert a value from one unit of measurement to different unit of measurement follow the steps below.

- Find the table corresponding to the general category of measurement; for example, the table titled “Units of Volume” includes conversion factors for volume measurements.
- Locate the “starting unit” of measurement in the far, left column.
- Proceed horizontally to the right on the same row until you reach the column with the heading of the appropriate “ending unit” of measurement.
- The unit conversion factor is located at the intersection of the row and column.
- Multiply the quantity value of the starting unit of measurement by the conversion factor.
- The result is the equivalent quantity value in the ending unit of measurement.

Units of Length¹²
(All underlined figures are exact.)

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:					
	Inches	Feet	Yards	Miles	Centimeters	Meters
1 inch (in) =	<u>1</u>	0.083 333 33	0.027 777 78	0.000 015 782 83	<u>2.54</u>	<u>0.025 4</u>
1 foot (ft) =	<u>12</u>	<u>1</u>	0.333 333 3	0.000 189 393 9	<u>30.48</u>	<u>0.304 8</u>
1 yard (yd) =	<u>36</u>	<u>3</u>	<u>1</u>	0.000 568 181 8	<u>91.44</u>	<u>0.914 4</u>
1 mile (mi) =	<u>63 360</u>	<u>5 280</u>	<u>1 760</u>	<u>1</u>	<u>160 934.4</u>	<u>1 609.344</u>
1 centimeter (cm) =	0.393 700 8	0.032 808 40	0.010 936 13	0.000 006 213 712	<u>1</u>	<u>0.01</u>
1 meter (m) =	39.370 08	3.280 840	1.093 613	0.000 621 371 2	<u>100</u>	<u>1</u>
NOTE: Per Federal Register, July 1, 1959, Vol. 24, No. 128, p. 5348, the following are exact mathematical relationships: 1 U.S. survey foot = 1 200/393 7 meter (exactly) 1 international foot = 12 × 0.025 4 meter = 0.304 8 (exactly) 1 international foot = 0.999 998 survey foot (exactly) 1 international foot = 0.025 4 × 39.37 U.S. survey foot (exactly) 1 international mile = 0.999 998 survey mile (exactly)						

¹² See Footnote 3.

Units of Length – International Foot and Survey Equivalent Measurements¹³(All underlined figures are exact.)

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:	
	International foot metric equivalent	U.S. survey foot metric equivalent
	Meters	Meters
1 foot =	0.304 8	0.304 800 609 601
1 cable's length =	219.456	219.456 438 913
1 chain (ch) =	20.116 8	20.116 840 234
1 fathom =	1.828 8	1.828 803 658
1 furlong (fur) =	201.168	201.168 402 337
1 league =	4 828.032	4 828.041 656 083
1 link (li) =	0.201 168	0.201 168 402
1 mile =	1 609.344	1 609.347 218 694
1 rod (rd), perch, or pole =	5.029 2	5.029 210 058

Units of Length – Survey Measure(All underlined figures are exact; conversions to meters based on international foot.¹⁴)

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:					
	Links	Feet	Rods	Chains	Miles	Meters
1 link (li) =	1	0.66	0.04	0.01	0.000 125	0.201 168
1 foot (ft) =	1.515 151 5	1	0.060 606 06	0.015 151 5	0.000 189 393 9	0.304 8
1 rod (rd), pole, or perch =	25	16.5	1	0.25	0.003 125	5.029 2
1 chain (ch) =	100	66	4	1	0.0125	20.116 8
1 mile (mi) =	8 000	5 280	320	80	1	1 609.344
1 meter (m) =	4.970 970	3.280 840	0.198 838 8	0.049 709 70	0.000 621 371 2	1

¹³ *Federal Register* (October 5, 2020, 85 FR 62698, p. 62698). Units in this table were historically defined using the U.S. survey foot. They may now be defined using either the international definition of the foot or U.S. survey foot. Use of definitions based on the U.S. survey foot should be avoided after December 31, 2022, except for historic and legacy applications.

¹⁴ See Footnote 3.

Units of Length – Thickness Measurement

(All underlined figures are exact.)

Starting Unit ↓	Multiply by the Conversion Factor Below the Ending Unit:		
	Inches	Millimeters	Micrometers
1 mil =	0.001	0.025 4	25.4
NOTE: The unit “mil” is a unit traditionally used by some U.S. industry sectors for the measurement of thickness.			

Units of Area¹⁵

(All underlined figures are exact.)

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:		
	Square Inches	Square Feet	Square Yards
1 square inch (in ²) =	1	0.006 944 444	0.000 771 604 9
1 square foot (ft ²) =	144	1	0.111 111 1
1 square yard (yd ²) =	1 296	9	1
1 square mile (mi ²) =	4 014 489 600	27 878 400	3 097 600
1 square centimeter (cm ²) =	0.155 000 3	0.001 076 391	0.000 119 599 0
1 square meter (m ²) =	1 550.003	10.763 91	1.195 990

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:		
	Square Miles	Square Centimeters	Square Meters
1 square inch (in ²) =	0.000 000 000 249 097 7	<u>6.451 6</u>	<u>0.000 645 16</u>
1 square foot (ft ²) =	0.000 000 035 870 06	<u>929.030 4</u>	<u>0.092 903 04</u>
1 square yard (yd ²) =	0.000 000 322 830 6	<u>8 361.273 6</u>	<u>0.836 127 36</u>
1 square mile (mi ²) =	<u>1</u>	<u>25 899 881 103.36</u>	<u>2 589 988.110 336</u>
1 square centimeter (cm ²) =	0.000 000 000 038 610 22	<u>1</u>	<u>0.000 1</u>
1 square meter (m ²) =	0.000 000 386 102 2	<u>10 000</u>	<u>1</u>

¹⁵ Area measurements are applied to both regular (e.g., regular polygons such as the square, rectangle, or equilateral triangle, or circle, ellipse, etc.) and irregular geometric shapes. For example, an acre is not necessarily a regular shape, such as a square or rectangle. If an acre is a square, then the length of one side is approximately equal to $\sqrt{43560 \text{ ft}^2} = 208.710 \text{ ft}$.

Units of Area – International Foot and Survey Equivalent Measurements¹⁶(All underlined figures are exact.)

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:	
	International foot metric equivalent	U.S. survey foot metric equivalent
	Square Meters	Square Meters
1 square rod (rd ²), square pole, or square perch =	25.292 852 64	25.292 953 812
1 square chain (ch ²) =	404.685 642 24	404.687 260 987
1 acre (ac) =	4 046.856 422 4	4 046.872 609 874
1 square mile (mi ²) =	2 589 988.110 336	2 589 998.470 319 521

Units of Area – Survey Measure¹⁶(All underlined figures are exact; SI equivalents based on the international foot.)

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:			
	Square Feet	Square Rods	Square Chains	Acres
1 square foot (ft ²) =	1	0.003 673 095	0.000 229 568 4	0.000 022 956 84
1 square rod (rd ²), square pole, or square perch =	272.25	1	0.062 5	0.006 25
1 square chain (ch ²) =	4 356	16	1	0.1
1 acre (ac) =	43 560	160	10	1
1 square mile (mi ²) =	27 878 400	102 400	6 400	640
1 square meter (m ²) =	10.763 91	0.039 536 86	0.002 471 054	0.000 247 105 4
1 hectare (ha) =	107 639.1	395.368 6	24.710 54	2.471 054

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:		
	Square Miles	Square Meters	Hectares
1 square foot (ft ²) =	0.000 000 035 870 06	<u>0.092 903 04</u>	<u>0.000 009 290 304</u>
1 square rod (rd ²), square pole, square perch =	<u>0.000 009 765 625</u>	<u>25.292 852 64</u>	<u>0.002 529 285 264</u>
1 square chain (ch ²) =	<u>0.000 156 25</u>	<u>404.685 642 24</u>	<u>0.040 468 564 224</u>
1 acre (ac) =	<u>0.001 562 5</u>	<u>4 046.856 422 4</u>	<u>0.404 685 642 24</u>
1 square mile (mi ²) =	<u>1</u>	<u>2 589 988.110 336</u>	<u>258.998 811 033 6</u>
1 square meter (m ²) =	0.000 000 386 102 2	<u>1</u>	<u>0.000 1</u>
1 hectare (ha) =	0.003 861 022	<u>10 000</u>	<u>1</u>

¹⁶ *Federal Register* (October 5, 2020, 85 FR 62698, p. 62698). Use of definitions based on the U.S. survey foot should be avoided after December 31, 2022, except for historic and legacy applications.

Units of Volume¹⁷
(All underlined figures are exact.)

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:		
	Cubic Inches	Cubic Feet	Cubic Yards
1 cubic inch (in ³) =	1	0.000 578 703 7	0.000 021 433 47
1 cubic foot (ft ³) =	1 728	1	0.037 037 04
1 cubic yard (yd ³) =	46 656	27	1
1 cubic centimeter (cm ³) =	0.061 023 74	0.000 035 314 67	0.000 001 307 951
1 cubic decimeter (dm ³) =	61.023 74	0.035 314 67	0.001 307 951
1 cubic meter (m ³) =	61 023.74	35.314 67	1.307 951

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:		
	Milliliters (Cubic Centimeters)	Liters (Cubic Decimeters)	Cubic Meters
1 cubic inch (in ³) =	16.387 064	0.016 387 064	0.000 016 387 064
1 cubic foot (ft ³) =	28 316.846 592	28.316 846 592	0.028 316 846 592
1 cubic yard (yd ³) =	764 554.857 984	764.554 857 984	0.764 554 857 984
1 cubic centimeter (cm ³) =	1	0.001	0.000 001
1 cubic decimeter (dm ³) =	1 000	1	0.001
1 cubic meter (m ³) =	1 000 000	1 000	1

¹⁷ Volume or capacity measurement units are applied to both regular (e.g., cube, rectangular prism, cylinder, cone, pyramid, sphere, etc.) and irregular geometric objects.

Units of Capacity or Volume – Dry Volume Measure(All underlined figures are exact.)

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:			
	Dry Pints	Dry Quarts	Pecks	Bushels
1 dry pint (pt) =	1	0.5	0.062 5	0.015 625
1 dry quart (qt) =	2	1	0.125	0.031 25
1 peck (pk) =	16	8	1	0.25
1 bushel (bu) =	64	32	4	1
1 cubic inch (in ³) =	0.029 761 6	0.014 880 8	0.001 860 10	0.000 465 025
1 cubic foot (ft ³) =	51.428 09	25.714 05	3.214 256	0.803 563 95
1 liter (L) =	1.816 166	0.908 083 0	0.113 510 4	0.028 377 59
1 cubic meter (m ³) =	1 816.166	908.083 0	113.510 4	28.377 59

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:			
	Cubic Inches	Cubic Feet	Liters	Cubic Meters
1 dry pint (pt) =	33.600 312 5	0.019 444 63	0.550 610 5	0.000 550 610 5
1 dry quart (qt) =	67.200 625	0.038 889 25	1.101 221	0.001 101 221
1 peck (pk) =	537.605	0.311 114	8.809 768	0.008 809 768
1 bushel (bu) =	2 150.42	1.244 456	35.239 070 166 88	0.035 239 070 166 88
1 cubic inch (in ³) =	1	0.000 578 703 7	0.016 387 064	0.000 016 387 064
1 cubic foot (ft ³) =	1 728	1	28.316 846 592	0.028 316 846 592
1 liter (L) =	61.023 74	0.035 314 67	1	0.001
1 cubic meter (m ³) =	61 023.74	35.314 67	1 000	1

Units of Capacity or Volume – Liquid Volume Measure(All underlined figures are exact.)

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:			
	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 (fl dr) =	60	1	0.125	0.031 25
1 fluid ounce (fl oz) =	480	8	1	0.25
1 gill (gi) =	1 920	32	4	1
1 liquid pint (pt) =	7 680	128	16	4
1 liquid quart (qt) =	15 360	256	32	8
1 gallon (gal) =	61 440	1 024	128	32
1 cubic inch (in ³) =	265.974 0	4.432 900	0.554 112 6	0.138 528 1
1 cubic foot (ft ³) =	459 603.1	7 660.052	957.506 5	239.376 6
1 milliliter (mL) =	16.230 73	0.270 512 2	0.033 814 02	0.008 453 506
1 liter (L) =	16 230.73	270.512 2	33.814 02	8.453 506

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:			
	Liquid Pints	Liquid Quarts	Gallons	Cubic Inches
1 minim =	0.000 130 208 3	0.000 065 104 17	0.000 016 276 04	0.003 759 766
1 fluid dram (fl dr) =	0.007 812 5	0.003 906 25	0.000 976 562 5	0.225 585 94
1 fluid ounce (fl oz) =	0.062 5	0.031 25	0.007 812 5	1.804 687 5
1 gill (gi) =	0.25	0.125	0.031 25	7.218 75
1 liquid pint (pt) =	1	0.5	0.125	28.875
1 liquid quart (qt) =	2	1	0.25	57.75
1 gallon (gal) =	8	4	1	231
1 cubic inch (in ³) =	0.034 632 03	0.017 316 02	0.004 329 004	1
1 cubic foot (ft ³) =	59.844 16	29.922 08	7.480 519	1 728
1 milliliter (mL) =	0.002 113 376	0.001 056 688	0.000 264 172 1	0.061 023 74
1 liter (L) =	2.113 376	1.056 688	0.264 172 1	61.023 74

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:		
	Cubic Feet	Milliliters	Liters
1 minim =	0.000 002 175 790	0.061 611 52	0.000 061 611 52
1 fluid dram (fl dr) =	0.000 130 547 4	3.696 691	0.003 696 691
1 fluid ounce (fl oz) =	0.001 044 379	29.573 53	0.029 573 53
1 gill (gi) =	0.004 177 517	118.294 1	0.118 294 1
1 liquid pint (pt) =	0.016 710 07	473.176 5	0.473 176 5
1 liquid quart (qt) =	0.033 420 14	946.352 9	0.946 352 9
1 gallon (gal) =	0.133 680 6	3 785.411 784	3.785 411 784
1 cubic inch (in ³) =	0.000 578 703 7	16.387 06	0.016 387 06
1 cubic foot (ft ³) =	1	28 316.85	28.316 85
1 milliliter (mL) =	0.000 035 314 67	1	0.001
1 liter (L) =	0.035 314 67	1 000	1

Units of Volume – International Foot and Survey Equivalent Measurements¹⁸
 (All underlined> figures are exact.)

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:	
	International foot metric equivalent	U.S. survey foot metric equivalent
	Cubic Meters	Cubic Meters
acre-foot =	1 233.481 837 547 52	1 233.489 238 468 149

¹⁸ *Federal Register* (October 5, 2020, 85 FR 62698, p. 62698). Units in this table were historically defined using the U.S. survey foot. They may now be defined using either the international definition of the foot or U.S. survey foot. Use of definitions based on the U.S. survey foot should be avoided after December 31, 2022, except for historic and legacy applications.

Units of Mass Not Less Than Avoirdupois Ounces(All underlined figures are exact.)

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:			
	Avoirdupois Ounces	Avoirdupois Pounds	Short Hundredweights	Short Tons
1 avoirdupois ounce (oz) =	1	0.062 5	0.000 625	0.000 031 25
1 avoirdupois pound (lb) =	16	1	0.01	0.000 5
1 short hundredweight (ctw) =	1 600	100	1	0.05
1 short ton (tn) =	32 000	2 000	20	1
1 long ton =	35 840	2 240	22.4	1.12
1 kilogram (kg) =	35.273 96	2.204 623	0.022 046 23	0.001 102 311
1 metric ton (t) =	35 273.96	2 204.623	22.046 23	1.102 311

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:		
	Long Tons	Kilograms	Metric Tons
1 avoirdupois ounce (oz) =	0.000 027 901 79	<u>0.028 349 523 125</u>	<u>0.000 028 349 523 125</u>
1 avoirdupois pound (lb) =	0.000 446 428 6	<u>0.453 592 37</u>	<u>0.000 453 592 37</u>
1 short hundredweight (ctw) =	0.044 642 86	<u>45.359 237</u>	<u>0.045 359 237</u>
1 short ton (tn) =	0.892 857 1	<u>907.184 74</u>	<u>0.907 184 74</u>
1 long ton =	<u>1</u>	<u>1 016.046 908 8</u>	<u>1.016 046 908 8</u>
1 kilogram (kg) =	0.000 984 206 5	<u>1</u>	<u>0.001</u>
1 metric ton (t) =	0.984 206 5	<u>1 000</u>	<u>1</u>

Units of Mass Not Greater Than Pounds and Kilograms(All underlined figures are exact.)

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:			
	Grains	Apothecaries Scruples	Pennyweights	Avoirdupois Drams
1 grain (gr) =	1	0.05	0.041 666 67	0.036 571 43
1 apothecaries scruple (dr ap) =	20	1	0.833 333 3	0.731 428 6
1 pennyweight (dwt) =	24	1.2	1	0.877 714 3
1 avoirdupois dram (dr) =	27.343 75	1.367 187 5	1.139 323	1
1 apothecaries dram (dr ap) =	60	3	2.5	2.194 286
1 avoirdupois ounce (oz) =	437.5	21.875	18.229 17	16
1 apothecaries ounce (oz) =	480	24	20	17.554 29
1 troy ounce (oz t) =	480	24	20	17.554 29
1 apothecaries pound (lb ap) =	5 760	288	240	210.651 4
1 troy pound (lb t) =	5 760	288	240	210.651 4
1 avoirdupois pound (lb) =	7 000	350	291.666 7	256
1 milligram (mg) =	0.015 432 36	0.000 771 617 9	0.000 643 014 9	0.000 564 383 4
1 gram (g) =	15.432 36	0.771 617 9	0.643 014 9	0.564 383 4
1 kilogram (kg) =	15 432.36	771.617 9	643.014 9	564.383 4

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:			
	Apothecaries Drams	Avoirdupois Ounces	Apothecaries or Troy Ounces	Apothecaries or Troy Pounds
1 grain (gr) =	0.016 666 67	0.002 285 714	0.002 083 333	0.000 173 611 1
1 apothecaries scruple (s ap) =	0.333 333 3	0.045 714 29	0.041 666 67	0.003 472 222
1 pennyweight (dwt) =	0.4	0.054 857 14	0.05	0.004 166 667
1 avoirdupois dram (dr) =	0.455 729 2	0.062 5	0.569 661 5	0.004 747 179
1 apothecaries dram (dr ap) =	1	0.137 142 9	0.125	0.010 416 67
1 avoirdupois ounce (oz) =	7.291 667	1	0.911 458 3	0.075 954 86
1 apothecaries ounce (oz) =	8	1.097 143	1	0.083 333 333
1 troy ounce (oz t) =	8	1.097 143	1	0.083 333 333
1 apothecaries pound (lb) =	96	13.165 71	12	1
1 troy pound (lb t) =	96	13.165 71	12	1
1 avoirdupois pound (lb) =	116.666 7	16	14.583 33	1.215 278
1 milligram (mg) =	0.000 257 206 0	0.000 035 273 96	0.000 032 150 75	0.000 002 679 229
1 gram (g) =	0.257 206 0	0.035 273 96	0.032 150 75	0.002 679 229
1 kilogram (kg) =	257.206 0	35.273 96	32.150 75	2.679 229

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:			
	Avoirdupois Pounds	Milligrams	Grams	Kilograms
1 grain (gr) =	0.000 142 857 1	64.798 91	0.064 798 91	0.000 064 798 91
1 apothecaries scruple (s ap) =	0.002 857 143	1 295.978 2	1.295 978 2	0.001 295 978 2
1 pennyweight (dwt) =	0.003 428 571	1 555.173 84	1.555 173 84	0.001 555 173 84
1 avoirdupois dram (dr) =	0.003 906 25	1 771.845 195 312 5	1.771 845 195 312 5	0.001 771 845 195 312 5
1 apothecaries dram (dr ap) =	0.008 571 429	3 887.934 6	3.887 934 6	0.003 887 934 6
1 avoirdupois ounce (oz) =	0.062 5	28 349.523 125	28.349 523 125	0.028 349 523 125
1 apothecaries ounce (oz ap) =	0.068 571 43	31 103.476 8	31.103 476 8	0.031 103 476 8
1 troy ounce (oz t) =	0.068 571 43	31 103.476 8	31.103 476 8	0.031 103 476 8
1 apothecaries pound (lb ap) =	0.822 857 1	373 241.721 6	373.241 721 6	0.373 241 721 6
1 troy pound (lb t) =	0.822 857 1	373 241.721 6	373.241 721 6	0.373 241 721 6
1 avoirdupois pound (lb) =	1	453 592.37	453.592 37	0.453 592 37
1 milligram (mg) =	0.000 002 204 623	1	0.001	0.000 001
1 gram (g) =	0.002 204 623	1 000	1	0.001
1 kilogram (kg) =	2.204 623	1 000 000	1 000	1

Units of Pressure
(All underlined> figures are exact.)

Starting Unit ↓	Multiply by the Ending Unit Conversion Factor:					
	Pascal (Pa)	Kilopascal (kPa)	Megapascal (MPa)	Pound-force per square inch (psi) (lbf/in ²)	Millimeter of mercury (mm Hg [0 °C])	Inch of water (in H ₂ O [4 °C])
1 Pa =	1	0.001	0.000 001	0.000 145 037 74	0.007 500 615	0.004 014 742 13
1 kPa =	1 000.0	1	0.001	0.145 037 744	7.500 615 05	4.014 742 133
1 MPa =	1 000 000	1 000	1	145.037 744	7 500.615 05	4 014.742 13
1 psi (lbf/in ²) =	6 894.757	6.894 757	0.006 894 757	1	51.714 918 1	27.680 671 4
1 mmHg (0 °C) =	133.322 4	0.133 322 4	0.000 133 322 4	0.019 336 78	1	0.535 255 057
1 inH ₂ O (4 °C) =	249.082	0.249 082	0.000 249 082	0.036 126 291	1.868 268 198	1

Conversion Equations for Units of Temperature
(Exact)

Units	To Degree Fahrenheit (°F)	To Degree Celsius (°C)	To Kelvin (K)
Degree Fahrenheit (°F)	°F	$\frac{(°F - 32)}{1.8}$	$\frac{(°F - 32)}{1.8} + 273.15$
Degree Celsius (°C)	$(°C \times 1.8) + 32$	°C	$(°C) + 273.15$
Kelvin (K)	$(K - 273.15) \times 1.8 + 32$	$K - 273.15$	K

Instructions for the Conversion Equations for Temperature:

Start at the left column of the table until you reach the row labeled with the starting unit. Then proceed horizontally to the right along that row until you reach the column of the desired unit. The unit conversion factor is located at the intersection of the row and column.

5. Tables of Equivalents¹⁹

In these tables, all SI equivalents that use the foot (or other U.S. Customary units derived from the foot) are based on the international foot.

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. The equivalents of the imprecise units “tablespoon” and “teaspoon” are rounded to the nearest milliliter.

Units of Length (all SI equivalents that use the foot are based on the international foot definition, 1 foot = 0.3 048 m exactly) (All <u>underlined</u> figures are exact.)	
1 cable’s length	<u>120</u> fathoms <u>720</u> feet <u>219.456</u> meters
1 centimeter (cm)	<u>0.01</u> meter 0.393 7 inch
1 chain (ch) (Gunter’s or surveyor’s)	<u>66</u> feet <u>20.116 8</u> meters
1 decimeter (dm)	<u>0.1</u> meter (exactly) 3.937 inches
1 dekameter (dam)	<u>10</u> meters (exactly) 32.808 feet
1 fathom	<u>6 feet</u> (exactly) <u>1.828 8</u> meters (exactly)
1 foot (ft)	<u>12 inches</u> (exactly) <u>0.304 8 meter</u> (exactly)
1 furlong (fur)	<u>10 chains</u> (exactly) <u>660 feet</u> (exactly) <u>1/8</u> mile (exactly) <u>201.168</u> meters (exactly)
[1 hand]	<u>4</u> inches
1 inch (in)	<u>2.54</u> centimeters (exactly)
1 kilometer (km)	<u>1 000</u> meters (exactly) <u>0.621</u> mile
1 league (land)	<u>3</u> miles (exactly) <u>4.828 032</u> kilometers (exactly)

¹⁹ *Federal Register* (October 5, 2020, 85 FR 62698, p. 62698). Use of definitions based on the U.S. survey foot should be avoided after December 31, 2022, except for historic and legacy applications.

Units of Length (all SI equivalents that use the foot are based on the international foot definition, 1 foot = 0.3 048 m exactly) (All <u>underlined</u> figures are exact.)	
1 link (li) (Gunter’s or surveyor’s)	<u>0.66</u> foot (exactly) <u>0.201 168</u> meter (exactly)
1 meter (m)	<u>0.001</u> kilometer (exactly) 39.37 inches 1.094 yards
1 mil	<u>0.001</u> inch (exactly) <u>0.025 4</u> millimeter (exactly) <u>25.4</u> micrometer (exactly)
1 micrometer (μm) ²⁰	<u>0.001</u> millimeter (exactly) <u>0.000 001</u> meter (exactly) 0.000 039 37 inch
1 mile (mi)	<u>5 280</u> feet (exactly) <u>1.609 344</u> kilometers (exactly)
1 mile (mi) (international nautical) ²¹	<u>1 852</u> meters (exactly) <u>1.852</u> kilometers (exactly) 1.151 miles
1 millimeter (mm)	<u>0.001</u> meter (exactly) <u>0.039 370 1</u> inch (exactly)
1 nanometer (nm)	<u>0.000 000 001</u> meter (exactly) 0.000 000 039 37 inch
1 point	<u>0.013 837</u> inch (exactly) ¹ / ₇₂ inch (approximately) 0.351 millimeter (“point” is historically used in typography)
1 rod (rd), pole, or perch	<u>16½</u> feet (exactly) <u>5.029 2</u> meters (exactly)
1 yard (yd)	<u>3</u> feet (exactly) <u>0.914 4</u> meter (exactly)

²⁰ The SI symbol for the prefix micro is the Greek letter mu (μ).

²¹ **NIST SP 447**, *Weights and Measures Standards of the United States, A Brief History* (1975). The international nautical mile of 1 852 meters (6 076.115 49 feet) was adopted by the First International Extraordinary Hydrographic Conference, Monaco, 1929, under the name “International nautical mile.” It was later adopted for use in the United States (effective July 1, 1954) by identical directives of the U.S. Department of Commerce and Department of Defense. The value formerly used in the United States was 6 080.20 feet = 1 nautical (geographical or sea) mile.

Units of Area (All <u>underlined</u> figures are exact.)	
1 acre (ac)	$\underline{43\,560}$ square feet (exactly) $\underline{0.404\,685\,642\,24}$ hectare (exactly)
1 are (a)	$\underline{100}$ square meters (exactly) 119.599 square yards 0.025 acre
1 hectare (ha)	$\underline{10\,000}$ square meters (exactly) $\underline{0.01}$ square kilometer (exactly) 2.471 acres
[1 section (of land)]	[1 mile square] (approximate)
[1 square (building)]	100 square feet
1 square centimeter (cm ²)	$\underline{0.000\,1}$ square meter (exactly) 0.155 square inch
1 square decimeter (dm ²)	$\underline{0.01}$ square meter (exactly) 15.500 square inches
1 square foot (ft ²)	$\underline{144}$ square inches (exactly) $\underline{929.030\,4}$ square centimeters (exactly)
1 square inch (in ²)	0.006 944 444 square feet $\underline{6\,451\,6}$ square centimeters (exactly)
1 square kilometer (km ²)	$\underline{1\,000\,000}$ square meters (exactly) 247.104 acres 0.386 square mile
1 square meter (m ²)	$\underline{0.000\,001}$ square kilometer (exactly) $\underline{1\,000\,000}$ square millimeters (exactly) 1.196 square yards 10.764 square feet
1 square mile (mi ²)	2.589 99 square kilometers 258.999 hectares
1 square millimeter (mm ²)	$\underline{0.000\,001}$ square meter (exactly) 0.002 square inch
1 square rod (rd ²), square pole, or square perch	$\underline{25.292\,852\,64}$ square meters (exactly)
1 square yard (yd ²)	$\underline{0.836\,127\,36}$ square meter (exactly) $\underline{9}$ square feet (exactly) $\underline{1\,296}$ square inches (exactly)
[1 township]	[6 miles square] (approximate) [36 sections (of land)] 36 square miles (approximate)

Units of Capacity or Volume (All <u>underlined</u> figures are exact.)	
1 barrel (bbl), liquid	31 to 42 gallons ²²
1 barrel (bbl), standard for fruits, vegetables, and other dry commodities, except cranberries	7 056 cubic inches 105 dry quarts 3.281 bushels, struck measure
1 barrel (bbl), standard, cranberry	5 826 cubic inches 86 ⁴⁵ / ₆₄ dry quarts 2.709 bushels, struck measure
1 bushel (bu) (U.S.) struck measure	<u>2 150.42</u> cubic inches (exactly) 35.238 liters
[1 bushel, heaped (U.S.)]	2 747.715 cubic inches 1.278 bushels, struck measure ²³
[1 bushel (bu) (British Imperial) (struck measure)]	1.032 U.S. bushels, struck measure 2 219.36 cubic inches
1 cord (cd) (firewood)	<u>128</u> cubic feet (exactly)
1 cubic centimeter (cm ³)	<u>0.001</u> cubic decimeter (exactly) <u>0.001</u> liter (exactly) <u>1</u> milliliter (exactly) 0.061 cubic inch
1 cubic decimeter (dm ³)	<u>1 000</u> cubic centimeters (exactly) <u>1 000</u> milliliters (exactly) <u>1</u> liter (exactly) 61.024 cubic inches
1 cubic foot (ft ³)	7.481 gallons 28.316 cubic decimeters (liters)
1 cubic inch (in ³)	0.554 fluid ounce (fl oz) (or <i>f 5</i>) 4.433 fluid drams (fl dr) (or <i>f 3</i>) 16.387 cubic centimeters
1 cubic meter (m ³)	1 000 cubic decimeters 1 000 liters 1.308 cubic yards
1 cubic yard (yd ³)	0.765 cubic meter <u>27</u> cubic feet (exactly)

²² A variety of “barrels” are established by law or industry usage. Consult federal laws and regulations, state laws and regulations, and documentary standards for the industry application to ensure the use of the appropriate barrel definition. 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; a 36-gallon barrel has been used for cistern measurement; federal law recognizes a 40-gallon barrel for “proof spirits;” and by custom, 42 gallons comprise a barrel of crude oil or petroleum products for statistical purposes, and this equivalent is recognized “for liquids” by some states.

²³ Frequently recognized as 1¼ bushels, struck measure.

Units of Capacity or Volume (All <u>underlined</u> figures are exact.)	
1 cup, measuring	<u>8</u> fluid ounces (exactly) 237 milliliters $\frac{1}{2}$ liquid pint (exactly)
1 dekaliter (daL)	<u>10</u> liters (exactly) 2.642 gallons 1.135 pecks
1 dram, fluid (or liquid) (fl dr) (or <i>f 3</i>) (U.S.)	$\frac{1}{8}$ fluid ounce (exactly) 0.226 cubic inch 3.697 milliliters 1.041 British fluid drachms
[1 drachm, fluid (fl dr) (British)]	0.961 U.S. fluid dram 0.217 cubic inch 3.552 milliliters
1 gallon (gal) (U.S.)	<u>231</u> cubic inches (exactly) 3.785 liters 0.833 British gallon <u>128</u> U.S. fluid ounces (exactly)
[1 gallon (gal) (British Imperial)]	277.42 cubic inches 1.201 U.S. gallons 4.546 liters <u>160</u> British fluid ounces (exactly)
1 gill (gi)	7.219 cubic inches <u>4</u> fluid ounces (exactly) 0.118 liter
1 hectoliter (hL)	100 liters 26.418 gallons 2.838 bushels
1 liter (L)	<u>1</u> cubic decimeter (exactly) <u>1 000</u> milliliters (exactly) 1.057 liquid quarts 0.908 dry quart 61.024 cubic inches
1 milliliter (mL)	<u>0.001</u> cubic decimeter (exactly) <u>0.001</u> liter (exactly) 0.271 fluid dram 16.231 minims 0.061 cubic inch
1 ounce, fluid (or liquid) (fl oz) (or <i>f 3</i>) (U.S.)	1.805 cubic inches 29.573 milliliters 1.041 British fluid ounces

Units of Capacity or Volume (All <u>underlined</u> figures are exact.)	
[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	<u>28.875</u> cubic inches (exactly) 0.473 liter
1 quart (qt), dry (U.S.)	67.201 cubic inches 1.101 liters 0.969 British quart
1 quart (qt), liquid (U.S.)	<u>57.75</u> cubic inches (exactly) 0.946 liter 0.833 British quart
[1 quart (qt) (British)]	69.354 cubic inches 1.032 U.S. dry quarts 1.201 U.S. liquid quarts
1 tablespoon, measuring	<u>3</u> teaspoons (exactly) 15 milliliters 4 fluid drams <u>$\frac{1}{2}$</u> fluid ounce (exactly)
1 teaspoon, measuring	<u>$\frac{1}{3}$</u> tablespoon (exactly) 5 milliliters 1 $\frac{1}{3}$ fluid drams ²⁴
1 water ton (English)	270.91 U.S. gallons <u>224</u> British Imperial gallons (exactly)

²⁴ The equivalent “1 teaspoon = 1 $\frac{1}{3}$ fluid drams” has been found by NIST 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.

Units of Mass (All <u>underlined</u> figures are exact.)	
1 assay ton (AT) ²⁵	29.167 grams
1 carat (c) ²⁶	<u>200</u> milligrams (exactly) 3.086 grains
1 dram apothecaries (dr ap or ℥)	<u>60</u> grains (exactly) 3.888 grams
1 dram avoirdupois (dr)	27 ¹¹ / ₃₂ (= 27.344) grains 1.772 grams
1 gamma (γ)	<u>1</u> microgram (exactly)
1 grain (gr)	<u>64.798 91</u> milligrams (exactly)
1 gram (g)	<u>0.001</u> kilogram (exactly) 15.432 grains 0.035 ounce, avoirdupois
1 hundredweight, gross or long ²⁷ (gross cwt)	<u>112</u> pounds (exactly) 50.802 kilograms
1 hundredweight, gross or short (cwt or net cwt)	<u>100</u> pounds (exactly) 45.359 kilograms
1 kilogram (kg)	<u>1 000</u> grams (exactly) 2.205 pounds
1 microgram (μg) ²⁸	<u>0.000 001</u> gram (exactly)
1 milligram (mg)	<u>0.001</u> gram (exactly) 0.015 grain <u>0.005</u> carat (exactly)
1 ounce, avoirdupois (oz)	<u>437.5</u> grains (exactly) 0.911 troy or apothecaries ounce 28.350 grams
1 ounce, troy or apothecaries (oz t or oz ap or ℥)	<u>480</u> grains (exactly) 1.097 avoirdupois ounces 31.103 grams
1 ounce, troy (oz t)	<u>480</u> grains (exactly) 1.097 avoirdupois ounces 31.103 grams

²⁵ Used in assaying. The assay ton bears the same relation to the milligram that a ton of 2000 pounds avoirdupois bears to the troy ounce; hence the mass in milligrams of precious metal obtained from one assay ton of ore gives directly the number of troy ounces to the net ton.

²⁶ NIST Circular 43 (1913) The Metric Carat. As of July 1, 1913, the international metric carat was recognized as 200 milligrams for diamonds and other precious stones and expressed as decimal fractions. A carat is further divided where 1 carat equals 100 points. Available at <https://nvlpubs.nist.gov/nistpubs/Legacy/circ/nbscircular43.pdf>.

²⁷ 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. The units are the same as the British “ton” and the “hundredweights.”

²⁸ The SI symbol for the prefix micro is the Greek letter mu (μ).

Units of Mass (All <u>underlined</u> figures are exact.)	
1 ounce, apothecaries (oz ap or ℥)	<u>480</u> grains (exactly) 1.097 avoirdupois ounces 31.103 grams
1 pennyweight (dwt)	1.555 grams
1 point	<u>0.01</u> carat (exactly) <u>2</u> milligrams (exactly) (“point” is historically used in the jewelry industry to describe gemstones)
1 pound, avoirdupois (lb)	<u>7 000</u> grains (exactly) 1.215 troy or apothecaries pounds <u>453.592 37</u> grams (exactly)
1 micropound (μlb) ²⁹	<u>0.000 001</u> pound (exactly)
1 pound, troy (lb t)	<u>5 760</u> grains (exactly) 0.823 avoirdupois pound 373.242 grams
1 pound, apothecaries (lb ap)	<u>5 760</u> grains (exactly) 0.823 avoirdupois pound 373.242 grams
1 scruple (s ap or ℥)	<u>20</u> grains (exactly) 1.296 grams
1 ton, gross or long ²⁹	<u>2 240</u> pounds (exactly) <u>1.12</u> net tons (exactly) 1.016 metric tons
1 ton, metric (t)	2 204.623 pounds 0.984 gross ton 1.102 net tons
1 ton, net or short (tn) ³⁰	<u>2 000</u> pounds (exactly) 0.893 gross ton 0.907 metric ton

²⁹ The SI symbol for the prefix micro is the Greek letter mu (μ). This is an example where SI writing style is applied to a non-SI unit abbreviation. The Greek letter mu prefix is used in combination with the abbreviation for pound (lb).

³⁰ As of January 1, 2014, “tn” is the required abbreviation for “short ton.” Devices manufactured between January 1, 2008, and December 31, 2013, may use an abbreviation other than “tn” to specify “short ton.”

(Added 2013)

Table of Contents

Appendix D. Definitions D-7

A D-7

absolute value.	D-7
acceptance test.	D-7
accurate.	D-7
all-class.	D-7
alternating current (AC).	D-7
ampere.	D-7
analog or digital recorder.	D-7
analog type.	D-7
animal scale.	D-7
apparent mass versus 8.0 g/cm^3	D-7
approval seal.	D-7
assumed atmospheric pressure.	D-7
audit trail.	D-8
automatic bulk weighing system.	D-8
automatic checkweigher.	D-8
automatic gravimetric filling machine (instrument).	D-8
automatic-indicating scale.	D-8
automatic temperature or density compensation.	D-8
automatic weighing system (AWS).	D-8
automatic zero-setting mechanism (AZSM).	D-8
automatic zero-setting mechanism (belt- conveyor scale).	D-8
automatic zero-tracking (AZT) mechanism.	D-9
auxiliary indication.	D-9
auxiliary indicator.	D-9
axle-load scale.	D-9

B D-9

badge.	D-9
balance, zero-load.	D-9
balance indicator.	D-9
balancing mechanism.	D-9
base pressure.	D-9
basic distance rate.	D-9
basic time rate.	D-9
basic tolerances.	D-9
batching system.	D-9
batching meter.	D-9
beam.	D-9
beam scale.	D-9
bell prover.	D-10
belt-conveyor.	D-10
belt-conveyor scale.	D-10
belt-conveyor scale systems area.	D-10
belt load.	D-10
belt revolution.	D-10

billed weight.	D-10
binary submultiples.	D-10
built-for-purpose device.	D-10

C D-10

calibration parameter.	D-10
carbon dioxide liquid-measuring device.	D-10
car-wash timer.	D-10
center-reading tank.	D-10
cereal grain and oil seeds.	D-10
Certificate of Conformance (CC), Active.	D-11
Certificate of Conformance (CC), Inactive.	D-11
chart recorder.	D-11
check rate.	D-11
checkweighing scale.	D-11
class of grain.	D-11
clear interval between graduations.	D-11
cleared.	D-11
cold-tire pressure.	D-11
commercial equipment.	D-11
computing scale.	D-11
computing type or computing type device.	D-11
concave curve.	D-11
concentrated load capacity (CLC)	D-12
configuration parameter.	D-12
consecutive-car test train.	D-12
construction materials hopper scale.	D-12
contract sale.	D-12
conventional scale.	D-12
conversion table.	D-12
convex curve.	D-12
conveyor stringers.	D-12
correct.	D-12
correction table.	D-12
counterbalance weight(s).	D-12
counterpoise weight(s).	D-12
coupled-in-motion railroad weighing system.	D-13
crane scale.	D-13
creep.	D-13
cryogenic liquid-measuring device.	D-13
cryogenic liquids.	D-13
cubic foot, gas.	D-13
current.	D-13

D D-13

“d,” dimension division value.	D-13
d, value scale division.	D-13
$D_{\max}$ (maximum load of the measuring range).	D-13
$D_{\min}$ (minimum load of the measuring range).	D-13

data acquisition time (DAT).	D-13	gauge pressure.	D-18
dairy-product-test scale.	D-13	gauge rod.	D-18
decimal submultiples.	D-14	gauging.	D-18
decreasing-load test.	D-14	graduated interval.	D-18
deficiency.	D-14	graduation.	D-18
diesel gallon equivalent (DGE).	D-14	grain class.	D-18
digital type.	D-14	grain hopper scale.	D-18
dimensional offset.	D-14	grain moisture meter.	D-18
dimensional weight (or dim, weight).	D-14	grain sample.	D-18
direct current (DC).	D-14	grain-test scale.	D-18
direct sale.	D-14	grain type.	D-18
discharge hose.	D-14	gravity discharge.	D-18
discharge line.	D-14		
discrimination (of an automatic-indicating scale).	D-14	H D-18	
dispenser.	D-14	head pulley.	D-18
distributed-car test train.	D-14	hertz (Hz).	D-18
dry hose.	D-14	hexahedron.	D-18
dry-hose type.	D-15	hired.	D-18
dynamic monorail weighing system.	D-15	hopper scale.	D-19
E D-15			
e, value of verification scale division.	D-15	I D-19	
$E_{\max}$ (maximum capacity).	D-15	idlers or idler rollers.	D-19
$E_{\min}$ (minimum dead load).	D-15	idler space.	D-19
$e_{\min}$ (minimum verification scale division).	D-15	increasing-load test.	D-19
$e_{\min}$ (minimum verification scale interval).	D-15	increment.	D-19
electric vehicle, plug-in.	D-15	index of an indicator.	D-19
electric vehicle supply equipment (EVSE).	D-15	indicating element.	D-19
electricity as vehicle fuel.	D-15	indicator, balance.	D-19
electronic link.	D-16	initial distance or time interval.	D-19
element.	D-16	initial zero-setting mechanism.	D-19
energy.	D-16	in-service light indicator.	D-19
energy flow.	D-16	integrator.	D-19
equal-arm scale.	D-16	interval, clear, between graduations.	D-19
equipment, commercial.	D-16	interval, graduated.	D-19
event counter.	D-16	irregularly-shaped object.	D-19
event logger.	D-16		
EVSE field reference standard.	D-16	J D-19	
excess and deficiency.	D-16	jewelers' scale.	D-19
extended display mode.	D-17		
extras.	D-17	K D-20	
F D-17		kilowatt (kW).	D-20
face.	D-17	kilowatt-hour (kWh).	D-20
face.	D-17	kind of grain.	D-20
fare.	D-17		
farm milk tank.	D-17	L D-20	
feeding mechanism.	D-17	label.	D-20
ft^3/h .	D-17	large-delivery device.	D-20
fifth wheel.	D-17	laundry-drier timer.	D-20
fifth-wheel test.	D-17	liquefied petroleum gas.	D-20
flat rate.	D-17	liquefied petroleum gas liquid-measuring device.	D-20
fractional bar.	D-17	liquefied petroleum gas retail motor-fuel device.	D-20
G D-17		liquefied petroleum gas vapor-measuring device.	D-20
gasoline gallon equivalent (GGE).	D-17	liquid fuel.	D-20
		liquid-fuel device.	D-20

liquid-measuring device.	D-20	multi-revolution scale.	D-24
liquid volume correction factor.	D-20	multiple-tariff taximeter.	D-24
livestock scale.	D-21	N D-24	
load, full.	D-21	nationally recognized testing laboratory	
load, light.	D-21	(NRTL).	D-24
load cell.	D-21	National Type Evaluation Program	
load cell verification interval (v).	D-21	(NTEP).	D-24
loading point.	D-21	NBP.	D-25
load-receiving element.	D-21	NTP.	D-25
location services.	D-21	NTP density and volume correction factor.	D-25
low-flame test.	D-21	natural gas.	D-25
lubricant device.	D-21	negotiated rate.	D-25
M D-21		$n_{\max}$ (maximum number of scale divisions).	D-25
m^3/h	D-21	$n_{\max}$ (maximum number of verification	
main bar.	D-21	scale intervals).	D-25
main graduation.	D-21	no-load reference value.	D-25
main-weighbeam elements.	D-21	nominal.	D-25
manual zero-setting mechanism.	D-21	nominal capacity.	D-25
manufactured device.	D-22	nominal capacity, batching scale.	D-26
mass flow meter.	D-22	nominal capacity, hopper scale.	D-26
master meter, electric.	D-22	non-automatic checkweigher.	D-26
master meter test method.	D-22	non-automatic weighing instrument.	D-26
master weight totalizer.	D-22	non-resettable totalizer.	D-26
material test.	D-22	nonretroactive.	D-26
maximum capacity.	D-22	nose-iron.	D-26
maximum cargo load.	D-22	notes.	D-26
maximum current deliverable (MCD).	D-22	O D-27	
maximum deliverable amperage (MDA).	D-22	odometer.	D-27
measurement field.	D-22	official grain samples.	D-27
measuring element.	D-22	official with statutory authority.	D-27
meter, electricity.	D-22	ohm (Ω).	D-27
meter register.	D-23	(Added 2022).	D-27
metrological components.	D-23	operating tire pressure.	D-27
metrological integrity (of a device).	D-23	over-and-under indicator.	D-27
minimum capacity.	D-23	overregistration and underregistration.	D-27
minimum clear interval.	D-23	P D-27	
minimum delivery.	D-23	parallax.	D-27
minimum load cell verification interval.	D-23	parking meter.	D-27
– See $v_{\min}$	D-23	passenger vehicles.	D-27
minimum measured quantity (MMQ).	D-23	percent registration.	D-27
minimum tolerance.	D-23	performance requirements.	D-28
minimum totalized load.	D-23	point-based railroad weighing systems.	D-28
moisture content (wet basis).	D-23	point-of-sale system.	D-28
money drop.	D-23	poise.	D-28
money-operated type.	D-23	postal scale.	D-28
motor-fuel.	D-23	power factor (PF).	D-28
motor-fuel device or motor-fuel dispenser or		prepackaging scale.	D-28
retail motor-fuel device.	D-24	prescription scale.	D-28
multi-class.	D-24	pressure type (device).	D-28
multi-interval scale.	D-24	primary indicating or recording elements. ..	D-28
multi-jet water meter.	D-24	prover method.	D-29
multiple.	D-24	prover oil.	D-29
multiple cell application load cell.	D-24	proving indicator.	D-29
multiple range scale.	D-24		
multiple of a scale.	D-24		

R D-29

“r” factor.....	D-29
radio frequency interference (RFI).....	D-29
random error(s).....	D-29
ranges, weight.....	D-29
rated capacity.....	D-29
rated scale capacity.....	D-29
ratio test.....	D-29
reading face.....	D-29
reading-face capacity.....	D-29
recorded representation.....	D-30
recorded representation, EVSE.....	D-30
recording element.....	D-30
recording element, EVSE.....	D-30
recording scale.....	D-30
reference weight car.....	D-30
reference vehicle.....	D-30
remanufactured device.....	D-30
remanufactured element.....	D-30
remote configuration capability.....	D-30
repaired device.....	D-30
repaired element.....	D-31
retail device.....	D-31
retroactive.....	D-31
road test.....	D-31
rolling circumference.....	D-31

S D-31

scale.....	D-31
scale area, belt-conveyor.....	D-31
scale division, number of (n).....	D-31
scale division, value of (d).....	D-31
scale section.....	D-31
seal.....	D-31
section capacity.....	D-31
section test.....	D-31
security means.....	D-31
security seal.....	D-31
selector-type.....	D-32
semi-automatic zero-setting mechanism.....	D-32
sensitivity (of a nonautomatic-indicating scale).....	D-32
sensitivity requirement (SR).....	D-32
serving utility.....	D-32
shift test.....	D-32
side.....	D-32
simulated-road test.....	D-32
simulated test.....	D-32
single cell application load cell.....	D-32
single-tariff taximeter.....	D-32
skirting.....	D-32
slow-flow meter.....	D-32
small-delivery device.....	D-32
span (structural).....	D-32
specification.....	D-32
standard, field.....	D-32

standard, transfer, Type 1 and Type 2.....	D-33
starting load.....	D-33
static monorail weighing system.....	D-33
strain-load test.....	D-33
submeter.....	D-33
subordinate graduation.....	D-33
subsequent distance or time intervals.....	D-33
substitution test.....	D-33
substitution test load.....	D-33
surface gauge.....	D-33
systematic (average) error ($\bar{x}$).....	D-34

T D-34

tail pulley.....	D-34
take-up.....	D-34
tare mechanism.....	D-34
tare-weighbeam elements.....	D-34
taximeter.....	D-34
test accuracy – in-service.....	D-34
test amperes (TA).....	D-34
test chain.....	D-34
test liquid.....	D-34
test object.....	D-34
test puck.....	D-34
test train.....	D-35
test weight car.....	D-35
testing.....	D-35
thermal overload protector.....	D-35
time recorder.....	D-35
timing device.....	D-35
tolerance.....	D-35
training idlers.....	D-35
tripper.....	D-35

U D-35

uncoupled-in-motion railroad weighing system.....	D-35
underregistration.....	D-35
unit price.....	D-35
unit train.....	D-35
unit weight.....	D-35
user requirement.....	D-36
usual and customary.....	D-36
utility-type water meter.....	D-36

V D-36

value of minimum graduated interval.....	D-36
vapor equalization credit.....	D-36
vapor equalization line.....	D-36
vehicle connector.....	D-36
vehicle coupler.....	D-36
vehicle inlet.....	D-36
vehicle on-board weighing system.....	D-36
vehicle scale.....	D-36
verification scale interval, value of (e).....	D-36
verification scale interval, number of (n)....	D-37

visible type.....	D-37
$v_{\min}$ (minimum load cell verification interval).	D-37
volt.....	D-37

W D-37

watt (W).....	D-37
watthour (Wh).	D-37
weighbeam.....	D-37
weigh-belt system.	D-37
weighing element.....	D-37
weigh-in-motion (WIM) vehicle scale.....	D-37
weigh-labeler.	D-37
weigh module.	D-38
weightment.	D-38
weight, unit.	D-38
weight classifier.....	D-38
weight ranges.....	D-38
wet basis.	D-38
wet hose.....	D-38

wet-hose type.....	D-38
wheel-load weighers.	D-38
wholesale device.....	D-38
wing pulley.	D-38

Z D-38

zero-load balance.....	D-38
zero-load balance, automatic-indicating scale.	D-38
zero-load balance, nonautomatic-indicating scale.	D-38
zero-load balance for a recording scale.	D-38
zero-load reference (belt-conveyor scales).	D-39
zero-setting mechanism.	D-39
zero-setting mechanism (belt-conveyor scale).....	D-39
zero-tracking mechanism.....	D-39
zone of uncertainty.	D-39

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Appendix D. Definitions

The specific code to which the definition applies is shown in [brackets] at the end of the definition. Definitions for the General Code [1.10] apply to all codes in Handbook 44.

A

absolute value. – The absolute value of a number is the magnitude of that number without considering the positive or negative sign. [2.20]

acceptance test. – The first official test of a farm milk tank, at a particular location, in which the tank is accepted as correct. This test applies to newly constructed tanks, relocated used tanks, and recalibrated tanks. [4.42]

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.” (Also see “correct.”) [Appendix A]

all-class. – A description of a multi-class calibration that includes all the classes of a grain type. [5.56(a), 5.57]
(Added 2007)

alternating current (AC). – An electric current that reverses direction in a circuit at regular intervals. [3.40]
(Added 2022)

ampere. – The practical unit of electric current. It is the quantity of current caused to flow by a potential difference of one volt through a resistance of one ohm. One ampere (A) is equal to the flow of one coulomb of charge per second. One coulomb (C) is the unit of electric charge equal in magnitude to the charge of 6.24×10^{18} electrons. [3.40]
(Added 2022)

analog or digital recorder. – An element used with a belt-conveyor scale that continuously records the rate-of-flow of bulk material over the scale (formerly referred to as a chart recorder). [2.21]
(Amended 1989)

analog type. – 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. [1.10]

animal scale. – A scale designed for weighing single heads of livestock. [2.20]
(Amended 1987)

apparent mass versus 8.0 g/cm³. – The apparent mass of an object versus 8.0 g/cm³ is the mass of material of density 8.0 g/cm³ that produces exactly the same balance reading as the object when the comparison is made in air with a density of 1.2 mg/cm³ at 20 °C. [3.37]

approval seal. – A label, tag, stamped or etched impression, or the like, indicating official approval of a device. (Also see “security seal.”) [1.10]

assumed atmospheric pressure. – The average atmospheric pressure agreed to exist at the meter at various ranges of elevation, irrespective of variations in atmospheric pressure from time to time. [3.33]

audit trail. – An electronic count and/or information record of the changes to the values of the calibration or configuration parameters of a device. [1.10, 2.20, 2.21, 2.24, 3.30, 3.31, 3.32, 3.34, 3.35, 3.36, 3.37, 3.38, 3.39, 3.40, 5.54, 5.56(a), 5.58]

(Added 1993) (Amended 2019 and 2022)

automatic bulk weighing system. – A weighing system adapted to the automatic weighing of bulk commodities in successive drafts of predetermined amounts, automatically recording the no-load and loaded weight values and accumulating the net weight of each draft. [2.22]

automatic checkweigher. – An automatic weighing system that does not require the intervention of an operator during the weighing process and used to subdivide items of different weights into one or more subgroups, such as identifying packages that have acceptable or unacceptable fill levels according to the value of the difference between their weight and a pre-determined set point. These systems may be used to fill standard packages for compliance with net weight requirements. [2.24]

(Amended 2004)

automatic gravimetric filling machine (instrument). – A filling machine or instrument that fills containers or packages with predetermined and virtually constant mass of product from bulk by automatic weighing, and which comprises essentially an automatic feeding device or devices associated with one or more weighing unit and the appropriate discharge devices. [2.24]

(Added 2004)

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.) [2.20, 2.22]

automatic temperature or density compensation. – The use of integrated or ancillary equipment to obtain from the output of a volumetric meter an equivalent mass, or an equivalent liquid volume at the assigned reference temperature below and a pressure of 14.696 lb/in² absolute.

Cryogenic liquids	21 °C (70 °F) [3.34]
Hydrocarbon gas vapor	15 °C (60 °F) [3.33]
Hydrogen gas	21 °C (70 °F) [3.39]
Liquid carbon dioxide	21 °C (70 °F) [3.38]
Liquefied petroleum gas (LPG) and Anhydrous ammonia	15 °C (60 °F) [3.32]
Petroleum liquid fuels and lubricants	15 °C (60 °F) [3.30]

(Amended 2019)

automatic weighing system (AWS). – An automatic weighing system is a weighing device that, in combination with other hardware and/or software components, automatically weighs discrete items and that does not require the intervention of an operator during the weighing process. Examples include, but are not limited to, weigh-labelers and checkweighers. [2.24]

(Amended 2004)

automatic zero-setting mechanism (AZSM). – See “automatic zero-setting mechanism” under “zero-setting mechanism.” [2.22]

(Amended 2010)

automatic zero-setting mechanism (belt-conveyor scale). – A zero setting device that operates automatically without intervention of the operator after the belt has been running empty. [2.21]

(Added 2002)

automatic zero-tracking (AZT) mechanism. – Automatic means provided to maintain the zero-balance indication, within specified limits, without the intervention of an operator. [2.20, 2.22, 2.24]

(Amended 2010)

auxiliary indication. – a means to increase the displayed resolution of a weighing device, such as a rider or vernier on an analog device, or a differentiated least significant digit to the right of the decimal point on a digital device. [2.20]

(Added 2024)

auxiliary indicator. – Any indicator other than the master weight totalizer that indicates the weight of material determined by the scale. [2.21]

axle-load scale. – A scale permanently installed in a fixed location, having a load-receiving element specially adapted to determine the combined load of all wheels (1) on a single axle or (2) on a tandem axle of a highway vehicle. [2.20]

B

badge. – A metal plate affixed to the meter by the manufacturer showing the manufacturer’s name, serial number and model number of the meter, and its rated capacity. [3.33]

balance, zero-load. – See “zero-load balance.” [2.20]

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. [2.20]

balancing mechanism. – A mechanism (including a balance ball) that is designed for adjusting a scale to an accurate zero-load balance condition. [2.20]

base pressure. – The absolute pressure used in defining the gas measurement unit to be used, and is the gauge pressure at the meter plus an agreed atmospheric pressure. [3.33]

basic distance rate. – The charge for distance for all intervals except the initial interval. [5.54]

basic time rate. – The charge for time for all intervals except the initial interval. [5.54]

basic tolerances. – Tolerances on under-registration and on over-registration, 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. [2.20, 2.22., 3.34, 3.38, 4.42, 5.54]

batching system. – One in which raw materials are proportioned in pre-determined quantities by weight and/or liquid measure for inclusion in a finished product. [2.22, 3.36]

(Added 2018)

batching meter. – A device used for the purpose of measuring quantities of water to be used in a batching operation. [3.36]

beam. – See “weighbeam.” [2.20]

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. [2.20]

bell prover. – A calibrated cylindrical metal tank of the annular type with a scale thereon that, in the downward travel in a surrounding tank containing a sealing medium, displaces air through the meter being proved or calibrated. [3.33]

belt-conveyor. – An endless moving belt for transporting material from place to place. [2.21]

belt-conveyor scale. – A device that employs a weighing element in contact with a belt to sense the weight of the material being conveyed and the speed (travel) of the material, and integrates these values to produce total delivered weight. [2.21]

belt-conveyor scale systems area. – The scale system area refers to the scale suspension, weigh idlers attached to the scale suspension, 5 approach (–) idlers, and 5 retreat (+) idlers. [2.21]

(Added 2001)

belt load. – The weight of the material carried by the conveyor belt, expressed in terms of weight units per unit of length (e.g., pounds per foot, kilograms per meter). Also called “belt loading.” [2.21]

(Added 2013)

belt revolution. – The amount of conveyor belt movement or travel that is equivalent to the total length of the conveyor belt. Also referred to as “belt circuit.” [2.21]

(Added 2013)

billed weight. – The weight used in the computation of the freight, postal, or storage charge, whether actual weight or dimensional weight. [5.58]

binary submultiples. – Fractional parts obtained by successively dividing by the number two. Thus, one-half, one-fourth, one-eighth, one-sixteenth, and so on, are binary submultiples. [1.10]

built-for-purpose device. – Any main device or element which was manufactured with the intent that it be used as, or part of, a weighing or measuring device or system. [1.10]

(Added 2003)

C

calibration parameter. – Any adjustable parameter that can affect measurement or performance accuracy and, due to its nature, needs to be updated on an ongoing basis to maintain device accuracy (e.g., span adjustments, linearization factors, and coarse zero adjustments). [2.20, 2.21, 2.24, 3.30, 3.31, 3.32, 3.34, 3.35, 3.36, 3.37, 3.38, 3.39, 3.40, 5.54, 5.56(a), 5.58.]

(Added 1993) (Amended 2016, 2019, and 2022)

carbon dioxide liquid-measuring device. – A system including a mechanism or machine of (a) the meter or (b) a weighing type of device mounted on a vehicle designed to measure and deliver liquid carbon dioxide. Means may be provided to indicate automatically, for one of a series of unit prices, the total money value of the quantity measured. [3.38]

car-wash timer. – A timer used in conjunction with a coin-operated device to measure the time during which car-wash water, cleaning solutions, or waxing solutions are dispensed. [5.55]

center-reading tank. – One so designed that the gauge rod or surface gauge, when properly positioned for use, will be approximately in the vertical axis of the tank, centrally positioned with respect to the tank walls. [4.43]

cereal grain and oil seeds. – Agricultural commodities including, but not limited to, corn, wheat, oats, barley, flax, rice, sorghum, soybeans, peanuts, dry beans, safflower, sunflower, fescue seed, etc. [5.56(a), 5.56(b)]

Certificate of Conformance (CC), Active. – A document issued based on testing by a Participating Laboratory, which the certificate holder maintains in active status under the National Type Evaluation Program (NTEP). The document constitutes evidence of conformance of a type with the requirements of this document, NIST Handbook 44, “Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices,” and the test procedures contained in NCWM Publication 14. By maintaining the Certificate in active status, the Certificate holder declares the intent to continue to manufacture or remanufacture the device consistent with the type and in conformance with the applicable requirements. A device is traceable to an active CC if: (a) it is of the same type identified on the Certificate, and (b) it was manufactured during the period that the Certificate was maintained in active status. For manufacturers of grain moisture meters, maintenance of active status also involves annual participation in the NTEP Laboratory On-going Calibration Program, OCP (Phase II).
(Added 2024)

Certificate of Conformance (CC), Inactive. – A document issued based on testing by a Participating Laboratory, which was previously active, but the device, measurement system, instrument or element is no longer being manufactured for commercial applications. However, devices, measurement systems, instruments or elements already manufactured, installed or in inventory may be used, sold, repaired, and resold under inactive CCs.
(Added 2024)

chart recorder. – See analog or digital recorder.
(Amended 1989)

check rate. – A rate of flow usually 20 % of the capacity rate. [3.33]

checkweighing scale. – One used to verify predetermined weight within prescribed limits. [2.24]

class of grain. – Hard Red Winter Wheat as distinguished from Hard Red Spring Wheat as distinguished from Soft Red Winter Wheat, etc. [5.56(a), 5.56(b), 5.57]

clear interval between graduations. – The distance between adjacent edges of successive graduations in 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. (Also see “minimum clear interval.”) [1.10]

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. [5.54]

cold-tire pressure. – The pressure in a tire at ambient temperature. [5.53, 5.54]

commercial equipment. – See “equipment.”
(Added 2008)

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. [2.20]

computing type or computing type device. – 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. [1.10]

concave curve. – A change in the angle of inclination of a belt conveyor where the center of the curve is above the conveyor. [2.21]

concentrated load capacity (CLC) (also referred to as Dual Tandem Axle Capacity [DTAC]). – A capacity rating of a vehicle or axle-load scale, specified by the manufacturer, defining the maximum load applied by a group of two axles with a centerline spaced four feet apart and an axle width of eight feet for which the weighbridge is designed. The concentrated load capacity rating is for both test and use. [2.20]

(Added 1988) (Amended 1991, 1994, and 2003)

configuration parameter. – Any adjustable or selectable parameter for a device feature that can affect the accuracy of a transaction or can significantly increase the potential for fraudulent use of the device and, due to its nature, needs to be updated only during device installation or upon replacement of a component (e.g., division value (increment), sensor range, and units of measurement). [2.20, 2.21, 2.24, 3.30, 3.31, 3.32, 3.34, 3.35, 3.36, 3.37, 3.38, 3.39, 3.40, 5.54, 5.56(a), 5.58]

(Added 1993) (Amended 2019 and 2022)

consecutive-car test train. – A train consisting of cars weighed on a reference scale, then coupled consecutively and run over the coupled-in-motion railway track scale under test. [2.20]

(Added 1990)

construction materials hopper scale. – A scale adapted to weighing construction materials such as sand, gravel, cement, and hot oil. [2.20]

contract sale. – A sale where a written agreement exists, prior to the point of sale, in which both buyer and seller have accepted pricing conditions of the sale. Examples include, but are not limited to: e-commerce, club sales, or pre-purchase agreements. Any devices used in the determination of quantity must comply with NIST Handbook 44. [3.30, 3.32, 3.37]

(Added 1993) (Amended 2002)

conventional scale. – If the use of conversion tables is necessary to obtain a moisture content value, the moisture meter indicating scale is called “conventional scale.” The values indicated by the scale are dimensionless. [5.56(b)]

conversion table. – Any table, graph, slide rule, or other external device used to determine the moisture content from the value indicated by the moisture meter. [5.56(b)]

convex curve. – A change in the angle of inclination of a belt conveyor where the center of the curve is below the conveyor. [2.21]

conveyor stringers. – Support members for the conveyor on which the scale and idlers are mounted. [2.21]

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.” (Also see “accurate.”) [Appendix A]

correction table. – Any table, graph, slide rule, or other external device used to determine the moisture content from the value indicated by the moisture meter when the indicated value is altered by a parameter not automatically corrected for in the moisture meter (for example, temperature or test weight). [5.56(b)]

counterbalance weight(s). – One intended for application near the butt of a weighbeam for zero-load balancing purposes. [2.20]

counterpoise weight(s). – A slotted or “hanger” weight intended for application near the tip of the weighbeam of a scale having a multiple greater than one. [2.20]

coupled-in-motion railroad weighing system. – A device and related installation characteristics consisting of (1) the associated approach trackage, (2) the scale (i.e., the weighing element, the load-receiving element, and the indicating element with its software), and (3) the exit trackage, which permit the weighing of railroad cars coupled in motion. [2.20, 2.23]

(Added 1992)

crane scale. – One with a nominal capacity of 5 000 pounds or more designed to weigh loads while they are suspended freely from an overhead, track-mounted crane. [2.20]

creep. – A continuous apparent measurement of energy indicated by a system with operating voltage applied and no power consumed (load terminals open circuited). [3.40]

(Added 2022)

cryogenic liquid-measuring device. – A system including a liquid-measuring element designed to measure and deliver cryogenic liquids in the liquid state. [3.34]

(Amended 1986 and 2003)

cryogenic liquids. – Fluids whose normal boiling point is below 120 kelvin (-243°F). [3.34]

cubic foot, gas. – The amount of a cryogenic liquid in the gaseous state at a temperature of 70°F and under a pressure of 14.696 lb/in^2 absolute that occupies one cubic foot (1 ft^3). (See NTP.) [3.34]

current. – The rate of the flow of electrical charge past any one point in a circuit. The unit of measurement is amperes (A) or coulombs (C) per second. [3.40]

(Added 2022)

D

“d,” dimension division value. – The smallest increment that the device displays for any axis and length of object in that axis. [5.58]

d, value scale division. – See “scale division, value of (d).” [2.20, 2.22]

D_{max} (maximum load of the measuring range). – Largest value of a quantity (mass) which is applied to a load cell during test or use. This value shall not be greater than E_{max} . [2.20]

(Added 2005)

D_{min} (minimum load of the measuring range). – Smallest value of a quantity (mass) which is applied to a load cell during test or use. This value shall not be less than E_{min} . [2.20]

(Added 2006)

data acquisition time (DAT). – The total time an object is completely on a load-receiving element while it is being weighed in motion. An object is completely on a load-receiving element from the time the trailing edge of an object to be weighed first moves onto the load-receiving element up to the time the leading edge of the object first moves off the load-receiving element. This time duration is affected by the length of the load-receiving element, speed of the object to be weighed, and the length of the object to be weighed. [2.20]

(Added 2021)

dairy-product-test scale. – A scale used in determining the moisture content of butter and/or cheese or in determining the butterfat content of milk, cream, or butter. [2.20]

decimal submultiples. – Parts obtained by successively dividing by the number 10. Thus 0.1, 0.01, 0.001, and so on are decimal submultiples. [1.10]

decreasing-load test. – A test for automatic-indicating scales only, wherein the performance of the scale is tested as the load is reduced. [2.20, 2.22]
(Amended 1987)

deficiency. – See “excess and deficiency.” [1.10]

diesel gallon equivalent (DGE). – Diesel gallon equivalent (DGE) means 6.384 pounds of compressed natural gas or 6.059 pounds of liquefied natural gas. [3.37]
(Added 2016)

digital type. – 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. [1.10]

dimensional offset. – The effect of eliminating the conveyance material on a measurement made by a multiple dimension measuring device resulting in only the object intended to be measured being measured. [5.58.]
(Added 2021)

dimensional weight (or dim, weight). – A value computed by dividing the object’s volume by a conversion factor; it may be used for the calculation of charges when the value is greater than the actual weight. [5.58]
(Added 2004)

direct current (DC). – An electric current that flows in one direction. [3.40]
(Added 2022)

direct sale. – A sale in which both parties in the transaction are present when the quantity is being determined. An unattended automated or customer-operated weighing or measuring system is considered to represent the device/business owner in transactions involving an unattended device. [1.10]
(Amended 1993)

discharge hose. – A flexible hose connected to the discharge outlet of a measuring device or its discharge line. [3.30, 3.31, 3.32, 3.34, 3.37, 3.38, 3.39]
(Added 1987) (Amended 2019)

discharge line. – A rigid pipe connected to the outlet of a measuring device. [3.30, 3.31, 3.32, 3.34, 3.37, 3.39]
(Added 1987) (Amended 2019)

discrimination (of an automatic-indicating scale). – The value of the test load on the load-receiving element of the scale that will produce a specified minimum change of the indicated or recorded value on the scale. [2.20, 2.22]

dispenser. – See motor-fuel device. [3.30, 3.37]

distributed-car test train. – A train consisting of cars weighed first on a reference scale, cars coupled consecutively in groups at different locations within the train, then run over the coupled-in-motion railway track scale under test. The groups are typically placed at the front, middle, and rear of the train. [2.20]
(Added 1990)

dry hose. – A discharge hose intended to be completely drained at the end of each delivery of product. (Also see “dry-hose type.”) [3.30, 3.31]
(Amended 2002)

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. (Also see “dry hose.”) [3.30, 3.31, 3.34, 3.35]

dynamic monorail weighing system. – A weighing system which employs hardware or software to compensate for dynamic effects from the load or the system that do not exist in static weighing, in order to provide a stable indication. Dynamic factors may include shock or impact loading, system vibrations, oscillations, etc., and can occur even when the load is not moving across the load-receiving element. [2.20]

(Added 1999)

E

e, value of verification scale interval. – See “verification scale interval, value of (e).” [2.20]

E_{max} (maximum capacity). – Largest value of a quantity (mass) which may be applied to a load cell without exceeding the mpe. [2.20]

(Added 2005)

E_{min} (minimum dead load). – Smallest value of a quantity (mass) which may be applied to a load cell during test or use without exceeding the mpe. [2.20]

(Added 2006)

e_{min} (minimum verification scale division). – The smallest scale division for which a weighing element complies with the applicable requirements. [2.24]

(Added 1997) (Amended 2025)

e_{min} (minimum verification scale interval). – The smallest verification scale interval for which a weighing element complies with the applicable requirements. [2.20]

(Added 2025)

electric vehicle, plug-in. – A vehicle that employs electrical energy as a primary or secondary mode of propulsion. Plug-in electric vehicles may be all-electric vehicles (EVs) or plug-in hybrid electric vehicles (PHEVs). All-electric vehicles are powered by an electric motor and battery at all times. All-electric vehicles may also be called battery-electric vehicles (BEVs). Plug-in hybrid electric vehicles employ both an electric motor and an internal combustion engine that consumes either conventional or alternative fuel or a fuel cell. In a parallel type hybrid-electric vehicle, either the electric motor or the engine may propel the vehicle. In a series type hybrid-electric vehicle, the engine or fuel cell generates electricity that is then used by the electric motor to propel the vehicle. EVs, BEVs, and PHEVs are capable of receiving and storing electricity via connection to an external electrical supply. Not all hybrid-electric vehicles are of the plug-in type. Hybrid-electric vehicles that do not have the capability to receive electrical energy from an external supply (HEVs) generate electrical energy onboard with the internal combustion engine, regenerative braking, or both. [3.40]

(Added 2022)

electric vehicle supply equipment (EVSE). – A device or system designed and used specifically to transfer electrical energy to an electric vehicle, either as charge transferred via physical or wireless connection, by loading a fully charged battery, or by other means. [3.40]

(Added 2022)

electricity as vehicle fuel. – Electrical energy transferred to and/or stored onboard an electric vehicle primarily for the purpose of propulsion. [3.40]

(Added 2022)

electronic link. – An electronic connection between the weighing/load-receiving or other sensing element and indicating element where one recognizes the other and neither can be replaced without calibration. [2.20]

(Added 2001)

element. – A portion of a weighing or measuring device or system which performs a specific function and can be separated, evaluated separately, and is subject to specified full or partial error limits.

(Added 2002)

energy. – The integral of active power with respect to time. [3.40]

(Added 2022)

energy flow. – The flow of energy between line and load terminals (conductors) of an electricity system. Flow from the line to the load terminals is considered energy delivered. Energy flowing in the opposite direction (i.e., from the load to line terminals) is considered as energy received. [3.40]

(Added 2022)

equal-arm scale. – A scale having only a single lever with equal arms (that is, with a multiple of one), 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. [2.20]

equipment, commercial. – Weights, measures, and weighing and measuring devices, instruments, elements, and systems or portion thereof, used or employed in establishing the measurement or in computing any basic charge or payment for services rendered on the basis of weight or measure. As used in this definition, measurement includes the determination of size, quantity, value, extent, area, composition (limited to meat and poultry), constituent value (for grain), or measurement of quantities, things, produce, or articles for distribution or consumption, purchased, offered, or submitted for sale, hire, or award. [1.10, 2.20, 2.21, 2.22, 2.24, 3.30, 3.31, 3.32, 3.33, 3.34, 3.35, 3.36, 3.37, 3.38, 3.39, 3.40, 4.40, 5.51, 5.56.(a), 5.56.(b), 5.57, 5.58, 5.59]

(Added 2008) (Amended 2019 and 2022)

event counter. – A non-resettable counter that increments once each time the mode that permits changes to sealable parameters is entered and one or more changes are made to sealable calibration or configuration parameters of a device. [2.20, 2.21, 2.24, 3.30, 3.31, 3.32, 3.34, 3.35, 3.36, 3.37, 3.38, 3.39, 3.40, 5.54, 5.56(a), 5.56(b), 5.57, 5.58]

(Added 1993) (Amended 2019 and 2022)

event logger. – A form of audit trail containing a series of records where each record contains the number from the event counter corresponding to the change to a sealable parameter, the identification of the parameter that was changed, the time and date when the parameter was changed, and the new value of the parameter. [2.20, 2.21, 2.24, 3.30, 3.31, 3.32, 3.34, 3.35, 3.36, 3.37, 3.38, 3.39, 3.40, 5.54, 5.56(a), 5.56(b), 5.57, 5.58]

(Added 1993) (Amended 2019 and 2022)

EVSE field reference standard. – A portable apparatus that is traceable to NIST and is used as a standard to test EVSEs in commercial applications. This instrument is also known as a portable standard or working standard. [3.40]

(Added 2022)

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. (Also see “nominal.”) 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.” [1.10]

extended display mode. – A means to temporarily change the scale division (d) to a value less than the verification scale interval (e), following a manual command. [2.20]

(Added 2024)

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. [5.54]

F

face. – That side of a taximeter on which passenger charges are indicated. [5.54]

face. – That portion of a computing-type pump or dispenser which displays the actual computation of price per unit, delivered quantity, and total sale price. In the case of some electronic displays, this may not be an integral part of the pump or dispenser. [3.30, 3.32, 3.37, 3.39, and 3.40]

(Added 1987) (Amended 2022)

fare. – That portion of the charge for the hire of a vehicle that is automatically calculated by a taximeter through the operation of the distance and/or time mechanism. [5.54]

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 gauge rod or a surface gauge, and (3) a chart for converting level-of-liquid readings to volume; or such a unit in which readings are made on a gauge rod or surface gauge directly in terms of volume. Each compartment of a subdivided tank shall, for purposes of this code, be construed to be a “farm milk tank.” [4.43]

feeding mechanism. – The means for depositing material to be weighed on the belt conveyor. [2.21]

ft³/h. – Cubic feet per hour. [3.33]

fifth wheel. – A commercially-available distance-measuring device which, after calibration, is recommended for use as a field transfer standard for testing the accuracy of taximeters and odometers on rented vehicles. [5.53, 5.54]

fifth-wheel test. – A distance 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. [5.53, 5.54]

flat rate. – A rate selection that when applied results in the indication of a fixed (non-incrementing) amount for passenger charges. This rate shall be included on the statement of established rates that is required to be posted in the vehicle. [5.54.]

(Added 2016)

fractional bar. – A weighbeam bar of relatively small capacity for obtaining indications intermediate between notches or graduations on a main or tare bar. [2.20]

G

gasoline gallon equivalent (GGE). – Gasoline gallon equivalent (GGE) means 5.660 pounds of compressed natural gas. [3.37]

(Added 1994) (Amended 2016)

gauge pressure. – The difference between the pressure at the meter and the atmospheric pressure (psi). [3.33]

gauge 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. [4.42]

gauging. – The process of determining and assigning volumetric values to specific graduations on the gauge or gauge rod that serve as the basis for the tank volume chart. [4.42]

graduated interval. – The distance from the center of one graduation to the center of the next graduation in a series of graduations. (Also see “value of minimum graduated interval.”) [1.10]

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. (Also see “main graduation” and “subordinate graduation.”) [1.10]

grain class. – Different grains within the same grain type. For example, there are six classes for the grain type “wheat:” Durum Wheat, Hard Red Spring Wheat, Hard Red Winter Wheat, Soft Red Winter Wheat, Hard White Wheat, and Soft White Wheat. [5.56(a), 5.57]

(Added 2007)

grain hopper scale. – One adapted to the weighing of individual loads of varying amounts of grain. [2.20]

grain moisture meter. – Any device indicating either directly or through conversion tables and/or correction tables the moisture content of cereal grains and oil seeds. Also termed “moisture meter.” [5.56(a), 5.56(b)]

grain sample. – That portion of grain or seed taken from a bulk quantity of grain or seed to be bought or sold and used to determine the moisture content of the bulk. [5.56(a), 5.56(b)]

grain-test scale. – A scale adapted to weighing grain samples used in determining moisture content, dockage, weight per unit volume, etc. [2.20]

grain type. – See “kind of grain.” [5.56(a), 5.57]

(Added 2007)

gravity discharge. – A type of device designed for discharge by gravity. [3.30, 3.31]

H

head pulley. – The pulley at the discharge end of the belt conveyor. The power drive to drive the belt is generally applied to the head pulley. [2.21]

hertz (Hz). – Frequency or cycles per second. One cycle of an alternating current or voltage is one complete set of positive and negative values of the current or voltage. [3.40]

(Added 2022)

hexahedron. – A geometric solid (i.e., box) with six rectangular or square plane surfaces. [5.58]

(Added 2008)

hired. – A taximeter is “hired” when it is operative with respect to all applicable indications of fare or extras. The indications of fare include time and distance where applicable unless qualified by another indication of “Time Not Recording” or an equivalent expression. [5.54]

hopper scale. – A scale designed for weighing bulk commodities whose load-receiving element is a tank, box, or hopper mounted on a weighing element. (Also see “automatic hopper scale,” “grain hopper scale,” and “construction materials hopper scale.”) [2.20]

I

idlers or idler rollers. – Freely turning cylinders mounted on a frame to support the conveyor belt. For a flat belt, the idlers consist of one or more horizontal cylinders transverse to the direction of belt travel. For a troughed belt, the idlers consist of one or more horizontal cylinders and one or more cylinders at an angle to the horizontal to lift the sides of the belt to form a trough. [2.21]

idler space. – The center-to-center distance between idler rollers measured parallel to the belt. [2.21]

increasing-load test. – The normal basic performance test for a scale in which observations are made as increments of test load are successively added to the load-receiving element of the scale. [2.20, 2.22]

increment. – The value of the smallest change in value that can be indicated or recorded by a digital device in normal operation. [1.10]

index of an indicator. – The particular portion of an indicator that is directly utilized in making a reading. [1.10]

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. (Also see “primary indicating or recording element.”) [1.10]

indicator, balance. – See “balance indicator.” [2.20]

initial distance or time interval. – The interval corresponding to the initial money drop. [5.54]

initial zero-setting mechanism. – See “initial zero-setting mechanism” under “zero-setting mechanism.” [2.20]
(Added 1990)

in-service light indicator. – A light used to indicate that a timing device is in operation. [5.55]

integrator. – A device used with a belt-conveyor scale that combines conveyor belt load (e.g., lb/ft) and belt travel (e.g., feet) to produce a total weight of material passing over the belt-conveyor scale. An integrator may be a separate, detached mechanism or may be a component within a totalizing device. (Also see “master weight totalizer.”) [2.21]
(Added 2013)

interval, clear, between graduations. – See “clear interval between graduations.” [1.10]

interval, graduated. – See “graduated interval.” [1.10]

irregularly-shaped object. – Any object that is not a hexahedron shape. [5.58]
(Added 2008)

J

jewelers’ scale. – One adapted to weighing gems and precious metals. [2.20]

K

kilowatt (kW). – A unit of power equal to 1 000 watts (W). [3.40]

(Added 2022)

kilowatt-hour (kWh). – A unit of energy equal to 1 000 watthours (Wh). [3.40]

(Added 2022)

kind of grain. – Corn as distinguished from soybeans as distinguished from wheat, etc. [5.56(a), 5.56(b)]

L

label. – A printed ticket, to be attached to a package, produced by a printer that is a part of a prepackaging scale or that is an auxiliary device. [2.20]

large-delivery device. – Devices used primarily for single deliveries greater than 200 gallons, 2 000 liters, 20 000 cubic feet, 2 000 kilograms, or 2 000 pounds. [3.34, 3.38]

laundry-drier timer. – A timer used in conjunction with a coin-operated device to measure the period of time that a laundry drier is in operation. [5.55]

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. [3.31, 3.32, 3.33, 3.34, 3.37]

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 a definite quantity, 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. [3.32]

(Amended 1987)

liquefied petroleum gas retail motor-fuel device. – A device designed for the measurement and delivery of liquefied petroleum gas used as a fuel for internal combustion engines in vehicles bearing a state or federal license plate for use on public roads. The term means the same as “retail motor-fuel dispenser” and “retail motor-fuel device” as it appears in section 3.32 LPG and Anhydrous Ammonia Liquid-Measuring Devices. [3.32]

(Added 2022)

liquefied petroleum gas vapor-measuring device. – A system including a mechanism or device of the meter type, equipped with a totalizing index, designed to measure and deliver liquefied petroleum gas in the vapor state by definite volumes, and generally installed in a permanent location. The meters are similar in construction and operation to the conventional natural- and manufactured-gas meters. [3.33]

liquid fuel. – Any liquid used for fuel purposes, that is, as a fuel, including motor-fuel. [3.30, 3.31]

liquid-fuel device. – A device designed for the measurement and delivery of liquid fuels. [3.30]

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. [3.30]

liquid volume correction factor. – A correction factor used to adjust the liquid volume of a cryogenic product at the time of measurement to the liquid volume at NBP. [3.34]

livestock scale. – A scale equipped with stock racks and gates and adapted to weighing livestock standing on the scale platform. [2.20]

(Amended 1989)

load, full. – A test condition with rated voltage, current at 100 % of test amps level, and power factor of 1.0. [3.40]

(Added 2022)

load, light. – A test condition with rated voltage, current at 10 % of test amps level, and power factor of 1.0. [3.40]

(Added 2022)

load cell. – A device, whether electric, hydraulic, or pneumatic, that produces a signal (change in output) proportional to the load applied. [2.20, 2.21, 2.23]

load cell verification interval (v). – The load cell interval, expressed in units of mass, used in the test of the load cell for accuracy classification. [2.20, 2.21]

(Added 1996)

loading point. – A location on a conveyor where the material is received by the belt. The location of the discharge from a hopper, chute, or pre-feed device used to supply material to a conveyor. [2.21]

(Amended 2013)

load-receiving element. – That element of a scale that is designed to receive the load to be weighed; for example, platform, deck, rail, hopper, platter, plate, scoop. [2.20, 2.21, 2.23]

location services. – Any of the various technologies used to determine the geographical location of a receiving unit in or physically attached to a vehicle. These technologies may include but are not limited to: global positioning services; cellular networks; or wi-fi networks. [5.54]

(Added 2017)

low-flame test. – A test simulating extremely low-flow rates such as caused by pilot lights. [3.33]

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). [3.30]

M

m³/h. – Cubic meters per hour. [3.33]

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.”) [2.20]

main graduation. – A graduation defining the primary or principal subdivisions of a graduated series. (Also see “graduation.”) [1.10]

main-weighbeam elements. – The combination of a main bar and its fractional bar, or a main bar alone if no fractional bar is associated with it. [2.20]

manual zero-setting mechanism. – See “manual zero-setting mechanism” under “zero-setting mechanism.” [2.20]

manufactured device. – Any commercial weighing or measuring device shipped as new from the original equipment manufacturer. [1.10]

(Amended 2001)

mass flow meter. – A device that measures the mass of a product flowing through the system. The mass measurement may be determined directly from the effects of mass on the sensing unit or may be inferred by measuring the properties of the product, such as the volume, density, temperature, or pressure, and displaying the quantity in mass units. [3.37]

master meter, electric. – An electric watthour meter owned, maintained, and used for commercial billing purposes by the serving utility. All the electric energy served to a submetered service system is recorded by the master meter. [3.40]

(Added 2022)

master meter test method. – A method of testing milk tanks that utilizes an approved master meter system for measuring test liquid removed from or introduced into the tank. [4.42]

master weight totalizer. – A primary indicating element used with a belt-conveyor scale that incorporates the function of an integrator to indicate the totalized weight of material passed over the scale. (Also see “integrator.”) [2.21]

(Amended 2013)

material test. – The test of a belt-conveyor scale using material (preferably that for which the device is normally used) that has been weighed to an accuracy of 0.1 %. [2.21]

(Amended 1989)

maximum capacity. – The largest load that may be accurately weighed. [2.20, 2.24]

(Added 1999)

maximum cargo load. – The maximum cargo load for trucks is the difference between the manufacturer’s rated gross vehicle weight and the actual weight of the vehicle having no cargo load. [5.53]

maximum current deliverable (MCD). – The maximum current that the EVSE can deliver as installed under optimum conditions. [3.40]

(Added 2024)

maximum deliverable amperage (MDA). – The maximum current available from the EVSE at the time of the test as determined by the Control Pilot Pulse Width Modulation signal or via digital communication between the EVSE and EV or test equipment. [3.40]

(Added 2024)

measurement field. – A region of space or the measurement pattern produced by the measuring instrument in which objects are placed or passed through, either singly or in groups, when being measured by a single device. [5.58]

measuring element. – That portion of a complete multiple dimension measuring device that does not include the indicating element. [5.58]

meter, electricity. – An electric watthour meter. [3.40]

(Added 2022)

meter register. – An observation index for the cumulative reading of the gas flow through the meter. In addition, there are one or two proving circles in which one revolution of the test hand represents $\frac{1}{2}$, 1, 2, 5, or 10 cubic feet, or 0.025, 0.05, 0.1, 0.2, or 0.25 cubic meter, depending on meter size. If two proving circles are present, the circle representing the smallest volume per revolution is referred to as the “leak-test circle.” [3.33]

metrological components. – Elements or features of a measurement device or system that perform the measurement process or that may affect the final quantity determination or resulting price determinations. This includes accessories that can affect the validity of transactions based upon the measurement process. The measurement process includes determination of quantities; the transmission, processing, storage, or other corrections or adjustments of measurement data or values; and the indication or recording of measurement values or other derived values such as price or worth or charges. [3.40]

(Added 2022)

metrological integrity (of a device). – The design, features, operation, installation, or use of a device that facilitates (1) the accuracy and validity of a measurement or transaction, (2) compliance of the device with weights and measures requirements, or (3) the suitability of the device for a given application. [1.10, 2.20]

(Added 1993)

minimum capacity. – The smallest load that may be accurately weighed. The weighing results may be subject to excessive error if used below this value. [2.20, 2.24]

(Added 1999)

minimum clear interval. – The shortest distance between adjacent graduations when the graduations are not parallel. (Also see “clear interval.”) [3.30, 3.31, 3.32, 3.33, 3.34, 3.35, 3.36, 3.38, 5.50, 5.51, 5.56(b)]

minimum delivery. – The least amount of weight that is to be delivered as a single weight by a belt-conveyor scale system in normal use. [2.21]

minimum load cell verification interval. – See $v_{\min}$

minimum measured quantity (MMQ). – The smallest quantity delivered for which the measurement is to within the applicable tolerances for that system. [3.37, 3.39, 3.40]

(Added 2019) (Amended 2022)

minimum tolerance. – Minimum tolerances are the smallest tolerance values that can be applied to a scale. Minimum tolerances are determined on the basis of the value of the minimum graduated interval or the nominal or reading face capacity of the scale. (Also see definition for basic tolerances.) [2.20, 2.22, 2.24]

minimum totaled load. – The least amount of weight for which the scale is considered to be performing accurately. [2.21]

moisture content (wet basis). – The mass of water in a grain or seed sample (determined by the reference method) divided by the mass of the grain or seed sample expressed as a percentage (%). [5.56(a), 5.56(b)]

money drop. – An increment of fare indication. The “initial money drop” is the first increment of fare indication following activation of the taximeter. [5.54]

money-operated type. – A device designed to be released for service by the insertion of money, or to be actuated by the insertion of money to make deliveries of product. [1.10]

motor-fuel. – Liquid used as fuel for internal-combustion engines. [3.30]

motor-fuel device or motor-fuel dispenser or retail motor-fuel device. – A device designed for the measurement and delivery of liquids used as fuel for internal-combustion engines. The term “motor-fuel dispenser” means the same as “motor-fuel device;” the term “retail motor-fuel device” applies to a unique category of device. (Also see definitions of “retail device” and “liquefied petroleum gas retail motor-fuel device.”) [3.30 and 3.37]

(Amended 2022)

multi-class. – A description of a grouping of grain classes, from the same grain type, in one calibration. A multi-class grain calibration may include (1) all the classes of a grain type (all-class calibration), or (2) some of the classes of a grain type within the calibration. [5.56(a), 5.57.]

(Added 2007)

multi-interval scale. – A scale having one weighing range which is divided into partial weighing ranges (segments), each with different scale intervals, with each partial weighing range (segment) determined automatically according to the load applied, both on increasing and decreasing loads. [2.20]

(Added 1995)

multi-jet water meter. – A water meter in which the moving element takes the form of a multiblade rotor mounted on a vertical spindle within a cylindrical measuring chamber. The liquid enters the measuring chamber through several tangential orifices around the circumference and leaves the measuring chamber through another set of tangential orifices placed at a different level in the measuring chamber. These meters register by recording the revolutions of a rotor set in motion by the force of flowing water striking the blades. [3.36]

(Added 2003)

multiple. – An integral multiple; that is, a result obtained by multiplying by a whole number. (Also see “multiple of a scale.”) [1.10]

multiple cell application load cell. – A load cell intended for use in a weighing system which incorporates more than one load cell. A multiple cell application load cell is designated with the letter “M” or the term “Multiple.” (Also see “single cell application load cell.”) [2.20]

(Added 1999)

multiple range scale. – A scale having two or more weighing ranges with different maximum capacities and different scale intervals for the same load receptor, each range extending from zero to its maximum capacity. [2.20]

(Added 1995)

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 one pound applied to the tip pivot of the weighbeam.) [2.20]

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. [2.20]

multiple-tariff taximeter. – One that may be set to calculate fares at any one of two or more rates. [5.54]

N

nationally recognized testing laboratory (NRTL). – A laboratory that conducts testing and certification that is recognized by the Occupational Safety and Health Administration (OSHA). [3.40]

(Added 2022)

National Type Evaluation Program (NTEP). – A program administered by NCWM. It is a program of cooperation between the NCWM, NIST, other federal agencies, the states, and the private sector for determining, on a uniform

basis, conformance of a type with the relevant provisions of NIST Handbook 44 “Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices,” and NCWM, Publication 14, “National Type Evaluation Program, Technical Policy, Checklists, and Test Procedures.”

(Added 2024)

NBP. – Normal Boiling Point of a cryogenic liquid at 14.696 lb/in² absolute. [3.34]

NTP. – Normal Temperature and Pressure of a cryogen at a temperature of 21 °C (70 °F) and a pressure of 101.325 kPa (14.696 lb/in² absolute). [3.34]

NTP density and volume correction factor. – A correction factor used to adjust the liquid volume of a cryogenic product at the time of measurement to the gas equivalent at NTP. [3.34]

natural gas. – A gaseous fuel, composed primarily of methane, that is suitable for compression and dispensing into a fuel storage container(s) for use as an engine fuel. [3.37]

(Added 1994)

negotiated rate. – A rate selection that, when applied, results in a fixed (non-incrementing) amount for passenger charges and is based on a value that has been agreed upon by the operator and passenger. [5.54]

(Added 2016)

n_{max} (maximum number of scale divisions). – The maximum number of scale divisions for which a main element or load cell complies with the applicable requirements. The maximum number of scale divisions permitted for an installation is limited to the lowest n_{max} marked on the scale indicating element, weighing element, or load cell. [2.21, 2.24]

(Added 1997) (Amended 2024)

n_{max} (maximum number of verification scale intervals). – The maximum number of verification scale intervals for which a main element or load cell complies with the applicable requirements. The maximum number of verification scale intervals permitted for an installation is limited to the lowest n_{max} marked on the scale indicating element, weighing element, or load cell. [2.20]

(Added 2024)

no-load reference value. – A positive weight value indication with no load in the load-receiving element (hopper) of the scale. (Used with automatic bulk-weighing systems and certain single-draft, manually-operated receiving hopper scales installed below grade and used to receive grain.) [2.20]

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 be greater or lesser. (Also see nominal capacity of a scale.) [1.10]

nominal capacity. – The nominal capacity of a scale is (a) 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, and excluding any fractional bar with a capacity less than 2½ % of the sum of the capacities of the remaining reading elements, or (b) the capacity marked on the scale by the manufacturer, whichever is less. (Also see “nominal capacity, batching scale”; “nominal capacity, hopper scale.”) [2.20]

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. [2.20]

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. [2.20]

non-automatic checkweigher. – A weighing instrument that requires the intervention of an operator during the weighing process, used to subdivide items of different weights into one or more subgroups, such as identifying packages that have acceptable or unacceptable fill levels according to the value of the difference between their weight and a pre-determined set point. [2.24]

Notes: Determining the weighing result includes any intelligent action of the operator that affects the result, such as deciding and taking an action when an indication is stable or adjusting the weight of the weighed load.

Deciding the weighing result is acceptable means making a decision regarding the acceptance of each weighing result on observing the indication or releasing a print-out. The weighing process allows the operator to take an action which influences the weighing result in the case where the weighing result is not acceptable.

(Added 2004)

non-automatic weighing instrument. – A weighing instrument or system that requires the intervention of an operator during the weighing process to determine the weighing result or to decide that it is acceptable. [2.20, 2.24]

Notes: Determining the weighing result includes any intelligent action of the operator that affects the result, such as deciding and taking an action when an indication is stable or adjusting the weight of the weighed load.

Deciding the weighing result is acceptable means making a decision regarding the acceptance of each weighing result on observing the indication or releasing a print-out. The weighing process allows the operator to take an action which influences the weighing result in the case where the weighing result is not acceptable.

(Added 2004) (Amended 2005)

non-resettable totalizer. – An element interfaced with the measuring or weighing element that indicates the cumulative registration of the measured quantity with no means to return to zero. [3.30, 3.37, 3.39, 3.40]

(Added 2019) (Amended 2022)

nonretroactive. – “Nonretroactive” requirements are enforceable after the effective date for:

1. D-devices manufactured within a state after the effective date;
2. D-both new and used devices brought into a state after the effective date; and
3. D-devices used in noncommercial applications which are placed into commercial use after the effective 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 in italic type.*) [1.10]

(Amended 1989)

nose-iron. – A slide-mounted, manually-adjustable pivot assembly for changing the multiple of a lever. [2.20]

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.

O

odometer. – A device that automatically indicates the total distance traveled by a vehicle. For the purpose of this code, this definition includes hub odometers, cable-driven odometers, and the distance-indicating or odometer portions of “speedometer” assemblies for automotive vehicles. [5.53]

official grain samples. – Grain or seed used by the official as the official transfer standard from the reference standard method to test the accuracy and precision of grain moisture meters. [5.56(a), 5.56(b)]

official with statutory authority. – The representative of the jurisdiction(s) responsible for certifying the accuracy of the device. [2.20, 2.21, 2.22]

(Added 1991)

ohm (Ω). – The practical unit of electric resistance that allows one ampere of current to flow when the impressed potential is one volt. [3.40]

(Added 2022)

operating tire pressure. – The pressure in a tire immediately after a vehicle has been driven for at least 5 miles or 8 kilometers. [5.53, 5.54]

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.) [2.20]

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 weight of the applied load. [1.10]

P

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. [1.10]

parking meter. – A coin-operated device for measuring parking time for vehicles. [5.55]

passenger vehicles. – Vehicles such as automobiles, recreational vehicles, limousines, ambulances, and hearses. [5.53]

percent registration. – Percent registration is calculated as follows:

$$\text{Percent Registration} = \frac{\text{Wh measured by EVSE}}{\text{Wh measured by STANDARD}} \times 100$$

[3.40]

(Added 2022)

performance requirements. – Performance requirements include all tolerance requirements and, in the case of nonautomatic-indicating scales, sensitivity requirements (SR). (Also see definitions for “tolerance” and “sensitivity requirement.”) [1.10]

point-based railroad weighing systems. – An in-motion-railroad weighing system designed to weigh wheel(s) of a railway car when centered on the load sensor within a weighing zone typically of 2 inches or less. The weight of the wheels are added to obtain the total weight of the cars and train which are used for any transaction. [2.20]

(Added 2021)

point-of-sale system. – An assembly of elements including a weighing or measuring element, an indicating element, and a recording element (and may also be equipped with a “scanner”) used to complete a direct sales transaction. The system components, when operated together, must be capable of the following:

1. determining the weight or measure of a product or service offered;
2. calculating a charge for the product or service based on the weight or measure and an established price/rate structure;
3. determining a total cost that includes all associated charges involved with the transaction; and
4. providing a sales receipt.

[2.20, 3.30, 3.32, 3.37, 3.39]

(Added 1986) (Amended 1997, 2015, and 2019)

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.”) [2.20]

postal scale. – A scale (usually a computing scale) designed for use to determine shipping weight or delivery charges for letters or parcels delivered by the U.S. Postal Service or private shipping companies. A weight classifier may be used as a postal scale. [2.20]

(Added 1987)

power factor (PF). – The ratio of “active power” to “apparent power” in an AC circuit. It describes the efficient use of available power. [3.40]

(Added 2022)

prepackaging scale. – A computing scale specially designed for putting up packages of random weights in advance of sale. [2.20]

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. [2.20]

pressure type (device). – A type of device designed for operation with the liquid under artificially produced pressure. [3.30, 3.31]

primary indicating or recording elements. – The term “primary” is applied to those principal indicating (visual) elements 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. (Also see “indicating element” and “recording element.”) [1.10, 3.40]

(Amended 2022)

prover method. – A method of testing milk tanks that utilizes approved volumetric prover(s) for measuring the test liquid removed from or introduced into the tank. [4.42]

prover oil. – A light oil of low vapor pressure used as a sealing medium in bell provers, cubic-foot bottles, and portable cubic-foot standards. [3.33]

proving indicator. – The test hand or pointer of the proving or leak-test circle on the meter register or index. [3.33, 3.36.]

R

“r” factor. – A computation for determining the suitability of a vehicle scale for weighing vehicles with varying axle configurations. The factor was derived by dividing the weights in FHWA Federal Highway Bridge Gross Weight Table B by 34 000 lbs. (The resultant factors are contained in Table UR.3.2.1.) [2.20]

radio frequency interference (RFI). – Radio frequency interference is a type of electrical disturbance that, when introduced into electronic and electrical circuits, may cause deviations from the normally expected performance. [1.10]

random error(s). – The sample standard deviation of the error (indicated values) for a number of consecutive automatic weighings of a load, or loads, passed over the load receptor, shall be expressed mathematically as:

$$s = \sqrt{\frac{1}{n-1} \sum (x_i - \bar{x})^2} \quad \text{or} \quad s = \sqrt{\frac{1}{n-1} \left(\sum x_i^2 - \frac{(\sum x_i)^2}{n} \right)}$$

where: x = error of a load indication
 n = the number of loads

[2.24]

ranges, weight. – See “weight ranges.” [2.20]

rated capacity. – The rate of flow in cubic meters per hour of a hydrocarbon gas vapor-measuring device as recommended by the manufacturer. This rate of flow should cause a pressure drop across the meter not exceeding ½-inch water column. [3.33]

rated scale capacity. – That value representing the weight that can be delivered by the device in one hour. [2.21]

ratio test. – A test to determine the accuracy with which the actual multiple of a scale agrees with its designed multiple. This test is used for 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 use this test for some scales not employing counterpoise weights.) [2.20]

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 also provide money-value indications. [1.10, 2.20]

(Amended 2005)

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. [1.10]

recorded representation. – The printed, embossed, electronic, or other representation that is recorded as a quantity, unit price, total price, product identify, or other information required by a weighing or measuring device. [1.10, 2.20, 2.21, 2.22, 2.24, 2.25, 3.30, 3.31, 3.32, 3.33, 3.34, 3.35, 3.36, 3.37, 3.38, 3.39, 5.54, 5.55, 5.56(a), 5.56(b), 5.57, 5.58, 5.60]

(Amended 2023)

recorded representation, EVSE. – The printed, electronically recorded, or other representation that retains a copy of the quantity and any other required information generated by a weighing or measuring device. [3.40]

(Added 2022) (Amended 2023)

recording element. – An element incorporated in a weighing or measuring device by means of which the device's 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 or recorded electronically in instances where that option is permitted by specific code. [1.10, 2.20, 2.21, 2.22, 2.24, 2.25, 3.30, 3.31, 3.32, 3.33, 3.34, 3.35, 3.36, 3.37, 3.38, 3.39, 5.54, 5.55, 5.56(a), 5.56(b), 5.57, 5.58, 5.60]

(Amended 2023)

recording element, EVSE. – An element incorporated, connected to, or associated with a weighing or measuring device by means of which its performance relative to quantity or money value is permanently recorded in a printed or electronic form. [3.40]

(Added 2022) (Amended 2023)

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. [2.20]

reference weight car. – A railcar that has been statically weighed for temporary use as a mass standard over a short period of time, typically the time required to test one scale.

Note: A test weight car that is representative of the types of cars typically weighed on the scale under test may be used wherever reference weight cars are specified. [2.20]

(Added 1991) (Amended 2012)

reference vehicle. – A vehicle with an associated load, including the driver, that has been statically weighed for temporary use as a field standard, typically the time required to test on weigh-in-motion vehicle scale. [2.20]

(Added 2021)

remanufactured device. – A device that is disassembled, checked for wear, parts replaced or fixed, reassembled and made to operate like a new device of the same type. [1.10]

(Added 2001)

remanufactured element. – An element that is disassembled, checked for wear, parts replaced or fixed, reassembled and made to operate like a new element of the same type. [1.10]

(Added 2001)

remote configuration capability. – The ability to adjust a weighing or measuring device or change its sealable parameters from or through some other device that is not itself necessary to the operation of the weighing or measuring device or is not a permanent part of that device. [2.20, 2.21, 2.24, 3.30, 3.31, 3.32, 3.34, 3.35, 3.36, 3.37, 3.38, 3.39, 3.40, 5.54, 5.56(a), 5.58]

(Added 1993) (Amended 2019 and 2022)

repaired device. – A device to which work is performed that brings the device back into proper operating condition. [1.10]

(Added 2001)

repaired element. – An element to which work is performed that brings the element back into proper operating condition. [1.10]

(Added 2001)

retail device. – A measuring device primarily used to measure product for the purpose of sale to the end user. [3.30, 3.32, 3.37, 3.39, 3.40]

(Amended 1987, 2004, 2019, and 2022)

retroactive. – “Retroactive” requirements are enforceable with respect to all equipment. Retroactive requirements are printed herein in upright roman type. (Also see “nonretroactive.”) [1.10]

road test. – A distance 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. [5.53, 5.54]

rolling circumference. – The rolling circumference is the straight-line distance traveled per revolution of the wheel (or wheels) that actuates the taximeter or odometer. If more than one wheel actuates the taximeter or odometer, the rolling circumference is the average distance traveled per revolution of the actuating wheels. [5.53, 5.54]

S

scale. – See specific type of scale. [2.20]

scale area, belt-conveyor. – See belt-conveyor scale systems area. [2.21]

(Added 2001)

scale division, number of (n). – See “verification scale interval, number of (n).” [2.20]

(Amended 2024)

scale division, value of (d). – The value of the scale division, expressed in units of mass, is the smallest subdivision of the scale for analog indication or the difference between two consecutively indicated or printed values for digital indication or printing. (Also see “verification scale division.”) [2.20, 2.22]

scale section. – A part of a vehicle, axle-load, livestock, or railway track scale consisting of two main load supports, usually transverse to the direction in which the load is applied. [2.20]

seal. – See “approval seal,” “security seal.” [1.10]

section capacity. – The section capacity of a scale is the maximum live load that may be divided equally on the load pivots or load cells of a section. [2.20]

(Added 2001)

section test. – A shift test in which the test load is applied over individual sections of the scale. This test is conducted to disclose the weighing performance of individual sections, since scale capacity test loads are not always available and loads weighed are not always distributed evenly over all main load supports. [2.20]

security means. – A method used to prevent access by other than qualified personnel, or to indicate that access has been made to certain parts of a scale that affect the performance of the device. [2.21]

security seal. – A uniquely identifiable physical seal, such as a lead-and-wire seal or other type of locking seal, a pressure-sensitive seal sufficiently permanent to reveal its removal, or similar apparatus attached to a weighing or measuring device for protection against or indication of access to adjustment. (Also see “approval seal.”) [1.10]

(Amended 1994)

selector-type. – 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. [1.10]

semi-automatic zero-setting mechanism. – See “semi-automatic zero-setting mechanism” under “zero-setting mechanism.” [2.20]

sensitivity (of a nonautomatic-indicating scale). – The value of the test load on the load-receiving element of the scale that will produce a specified minimum change in the position of rest of the indicating element or elements of the scale. [2.20]

sensitivity requirement (SR). – A performance requirement for a non automatic-indicating scale; specifically, the minimum change in the position of rest of the indicating element or elements of the scale in response to the increase or decrease, by a specified amount, of the test load on the load-receiving element of the scale. [2.20]

serving utility. – The utility distribution company that owns the master meter and sells electric energy to the owner of a submeter system. [3.40]

(Added 2022)

shift test. – A test intended to disclose the weighing performance of a scale under off-center loading. [2.20]

side. – That portion of a pump or dispenser which faces the consumer during the normal delivery of product. [3.30]

(Added 1987)

simulated-road test. – A distance test during which the taximeter or odometer may be actuated by some means other than road travel. The distance traveled is either measured by a properly calibrated roller device or computed from rolling circumference and wheel-turn data. [5.53, 5.54]

simulated test. – A test using artificial means of loading the scale to determine the performance of a belt-conveyor scale. [2.21]

single cell application load cell. – A load cell intended for use in a weighing system which incorporates one or more load cells. A single cell application load cell is designated with the letter “S” or the term “Single.” (Also see “multiple cell application load cell.”) [2.20]

(Added 1999)

single-tariff taximeter. – One that calculates fares at a single rate only. [5.54]

skirting. – Stationary side boards or sections of belt conveyor attached to the conveyor support frame or other stationary support to prevent the bulk material from falling off the side of the belt. [2.21]

slow-flow meter. – A retail device designed for the measurement, at very slow rates (less than 40 L (10 gal) per hour), of liquid fuels at individual domestic installations. [3.30]

small-delivery device. – Any device other than a large-delivery device. [3.34, 3.38]

span (structural). – The distance between adjoining sections of a scale. [2.20]

(Added 1988)

specification. – A requirement usually dealing with the design, construction, or marking of a weighing or measuring device. Specifications are directed primarily to the manufacturers of devices. [1.10]

standard, field. – A physical artifact, static or dynamic measurement devices, such as scales, meters, etc., or a reference material that (a) meets the requirements of the Fundamental Considerations, Section 3.2., (b) is stable (accurate and repeatable) over a designated period of time of use (as determined by the Director), (c) is valid (with

corrections that may be applied) over the range of environmental and operational parameters in which the commercial measuring devices to be tested can be reasonably anticipated to be used, and (d) is traceable to the reference or working standards through comparisons, using acceptable laboratory procedures. [1.10]

(Added 2023)

standard, transfer, Type 1 and Type 2. – A physical artifact, static or dynamic measurement devices, such as scales, meters, etc., or a reference material that is demonstrated to be stable (accurate and repeatable) under the limited environmental and operational conditions and time during which the transfer standard is used. A Type 1 transfer standard is a transfer standard that meets the one-third accuracy requirement over a limited range of environmental conditions and/or a limited range of operating conditions and time in which it is used. A Type 2 transfer standard is one that does not meet the one-third requirement and may not be stable or valid over an extended time period or over wide ranges of environmental or operating conditions. [1.10]

(Added 2023)

starting load. – The minimum load above which the device will indicate energy flow continuously. [3.40]

(Added 2022)

static monorail weighing system. – A weighing system in which the load being applied is stationary during the weighing operation. [2.20]

(Added 1999)

strain-load test. – The test of a scale beginning with the scale under load and applying known test weights to determine accuracy over a portion of the weighing range. The scale errors for a strain-load test are the errors observed for the known test loads only. The tolerances to be applied are based on the known test load used for each error that is determined. [2.20, 2.22]

submeter. – A meter or meter system downstream of the electric master meter. [3.40]

(Added 2022)

subordinate graduation. – Any graduation other than a main graduation. (Also see “graduation.”) [1.10]

subsequent distance or time intervals. – The intervals corresponding to money drops following the initial money drop. [5.54]

substitution test. – A scale testing process used to quantify the weight of material or objects for use as a known test load. [2.20]

(Added 2003)

substitution test load. – The sum of the combination of field standard test weights and any other applied load used in the conduct of a test using substitution test methods. [2.20]

(Added 2003)

surface gauge. – 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. [4.42]

systematic (average) error ($\bar{x}$). – The mean value of the error (of indication) for a number of consecutive automatic weighings of a load, or loads, passed over the load-receiving element (e.g., weigh-table), shall be expressed mathematically as:

$$\bar{x} = \frac{\sum x}{n}$$

where: x = error of a load indication
 n = the number of loads

[2.24]

T

tail pulley. – The pulley at the opposite end of the conveyor from the head pulley. [2.21]

take-up. – A device to provide sufficient tension in a conveyor belt so that the belt will be positively driven by the drive pulley. – A counter-weighted take-up consists of a pulley free to move in either the vertical or horizontal direction with dead weights applied to the pulley shaft to provide the tension required. [2.21]

tare mechanism. – A mechanism (including a tare bar) designed for determining or balancing out the weight of packaging material, containers, vehicles, or other materials that are not intended to be included in net weight determinations. [2.20]

tare-weighbeam elements. – The combination of a tare bar and its fractional bar, or a tare bar alone if no fractional bar is associated with it. [2.20]

taximeter. – A device that automatically calculates, at a predetermined rate or rates, and indicates the charge for hire of a vehicle. [5.54]

test accuracy – in-service. – The device accuracy determined by a test made during the period that the system is in service. It may be made on the customer's premises without removing the system from its mounting or by removing the EVSE for testing either on the premises or in a laboratory or shop. [3.40]

(Added 2022)

test amperes (TA). – The full load current (amperage) specified by the EVSE manufacturer for testing and calibration adjustment. (Example: TA 30). [3.40]

(Added 2022)

test chain. – A device used for simulated tests consisting of a series of rollers or wheels linked together in such a manner as to assure uniformity of weight and freedom of motion to reduce wear, with consequent loss of weight, to a minimum. [2.21]

test liquid. – The liquid used during the test of a device. [3.30, 3.31, 3.34, 3.35, 3.36, 3.37, 3.38]

test object. – An object whose dimensions are verified by appropriate reference standards and intended to verify compliance of the device under test with certain metrological requirements. [5.58]

test puck. – A metal, plastic, or other suitable object that remains stable for the duration of the test, used as a test load to simulate a package. Pucks can be made in a variety of dimensions and have different weights to represent a wide range of package sizes. Metal versions may be covered with rubber cushions to eliminate the possibility of damage to weighing and handling equipment. The puck mass is adjusted to an accuracy specified in N.1.2. Accuracy of Test Pucks or Packages. [2.24]

(Amended 2004)

test train. – A train consisting of or including reference weight cars and used to test coupled-in-motion railway track scales. The reference weight cars may be placed consecutively or distributed in different places within a train. [2.25]
(Added 1990) (Amended 1991)

test weight car. – A railroad car designed to be a stable mass standard to test railway track scales. The test weight car may be one of the following types: a self-contained composite car, a self-propelled car, or a standard rail car. [2.20]
(Added 1991)

testing. – An operation consisting of a series of volumetric determinations made to verify the accuracy of the volume chart that was developed by gauging. [4.42]

thermal overload protector. – A circuit breaker or fuse that automatically limits the maximum current in a circuit. [3.40]
(Added 2022)

time recorder. – A clock-operated mechanism designed to record the time of day. Examples of time recorders are those used in parking garages to record the “in” and “out” time of day for parked vehicles. [5.55]

timing device. – A device used to measure the time during which a particular paid-for service is dispensed. Examples of timing devices are laundry driers, car-wash timers, parking meters, and parking-garage clocks and recorders. [5.55]

tolerance. – A value fixing the limit of allowable error or departure from true performance or value. (Also see “basic tolerances.”) [1.10]

training idlers. – Idlers of special design or mounting intended to shift the belt sideways on the conveyor to assure the belt is centered on the conveying idlers. [2.21]

tripper. – A device for unloading a belt conveyor at a point between the loading point and the head pulley. [2.21]

U

uncoupled-in-motion railroad weighing system. – A device and related installation characteristics consisting of (1) the associated approach trackage, (2) the scale (i.e., the weighing element, the load-receiving element, and the indicating element with its software), and (3) the exit trackage, which permit the weighing of railroad cars uncoupled in motion. [2.20]
(Added 1993)

underregistration. – See “overregistration” and “underregistration.” [1.10]

unit price. – The price at which the product is being sold and expressed in whole units of measurement. [1.10, 2.20, 3.30, 3.31, 3.32, 3.37, 3.39, 3.40]
(Added 1992) (Amended 2019 and 2022)

unit train. – A unit train is defined as a number of contiguous cars carrying a single commodity from one consignor to one consignee. The number of cars is determined by agreement among the consignor, consignee, and the operating railroad. [2.20]

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. [2.20]

user requirement. – A requirement dealing with the selection, installation, use, or maintenance of a weighing or measuring device. User requirements are directed primarily to the users of devices. (Also see Introduction, Section D.) [1.10]

usual and customary. – Commonly or ordinarily found in practice or in the normal course of events and in accordance with established practices. [1.10]

utility-type water meter. – A device used for the measurement of water, generally applicable to meters installed in residences or business establishments, excluding batching meters. [3.36]

(Added 2011)

V

value of minimum graduated interval. – (1) The value represented by the interval from the center of one graduation to the center of the succeeding graduation. (2) The increment between successive recorded values. (Also see “graduated interval.”) [1.10]

vapor equalization credit. – The quantity deducted from the metered quantity of liquid carbon dioxide when a vapor equalizing line is used to facilitate the transfer of liquid during a metered delivery. [3.38]

vapor equalization line. – A hose or pipe connected from the vapor space of the seller’s tank to the vapor space of the buyer’s tank that is used to equalize the pressure during a delivery. [3.38]

vehicle connector. – A device that by insertion into a vehicle inlet, establishes an electrical connection to the electric vehicle for the purpose of providing power and information exchange, with means for attachment of an electric vehicle cable. This device is a part of the vehicle coupler. [3.40]

(Added 2022)

vehicle coupler. – A means enabling the connection, at will, of an electric vehicle cable to the equipment. It consists of a vehicle connector and a vehicle inlet. [3.40]

(Added 2022)

vehicle inlet. – The part incorporated in, or fixed to the vehicle, which receives power from a vehicle connector. [3.40]

(Added 2022)

vehicle on-board weighing system. – A weighing system designed as an integral part of or attached to the frame, chassis, lifting mechanism, or bed of a vehicle, trailer, industrial truck, industrial tractor, or forklift truck. [2.20]

(Amended 1993)

vehicle scale. – A scale (including weigh-in-motion vehicle scales) adapted to weighing highway, farm, or other large industrial vehicles (except railroad freight cars), loaded or unloaded. [2.20]

(Amended 2021)

verification scale interval, value of (e). – A value, expressed in units of weight (mass) and specified by the manufacturer of a device, by which the tolerance values and the accuracy class applicable to the device are determined. The verification scale interval is applied to all scales, in particular to ungraduated devices since they have no graduations. [2.20]

(Amended 2024)

verification scale interval, number of (n). – The capacity divided by the value of the verification scale interval. [2.20]

$$n = \frac{\text{Capacity}}{e}$$

(Added 2024)

visible type. – A type of device in which the measurement takes place in a see-through glass measuring chamber. [3.30]

v_{min} (minimum load cell verification interval). – The smallest load cell verification interval, *expressed in units of mass** into which the load cell measuring range can be divided. [2.20, 2.24]

[*Nonretroactive as of January 1, 2001]

(Added 1996) (Amended 1999)

volt. – The practical unit of electromotive force. One volt will cause one ampere to flow when impressed across a resistance of one ohm. [3.40]

(Added 2022)

W

watt (W). – The practical unit of electric power. In an alternating-current (AC) circuit, the power in watts is volts times amperes multiplied by the circuit power factor. [3.40]

(Added 2022)

watthour (Wh). – The practical unit of electric energy that is expended in one hour when the average power consumed during the hour is one watt. [3.40]

(Added 2022)

weighbeam. – An element comprising one or more bars, equipped with movable poises or means for applying counterpoise weights or both. [2.20]

weigh-belt system. – A type of belt-conveyor scale system designed by the manufacturer as a self-contained conveyor system and that is installed as a unit. A unit is comprised of integral components and, at minimum, includes a: conveyor belt; belt drive; conveyor frame; and weighing system. A weigh-belt system may operate at single or multiple flow rates and may use variable-speed belt drives. [2.21]

(Added 2015)

weighing element. – That portion of a scale that supports the load-receiving element and transmits to the indicating element a signal or force resulting from the load applied to the load-receiving element. [2.20, 2.21, 2.22]

(Added 1988)

weigh-in-motion (WIM) vehicle scale. – A vehicle scale adapted to weighing vehicles as they travel across the scale without stopping. [2.20]

(Added 2021)

weigh-labeler. – An automatic weighing system that determines the weight of a package and prints a label or other document bearing a weight declaration for each discrete item (usually a label also includes unit and total price declarations). Weigh-labelers are sometimes used to weigh and label standard and random packages (also called “Prepackaging Scales”). [2.24]

(Amended 2004)

weigh module. – The portion of a load-receiving element supported by two sections. The length of a module is the distance to which load can be applied. [2.20]

(Added 2013)

weighment. – A single complete weighing operation. [2.20, 2.21]

(Added 1986)

weight, unit. – See “unit weight.” [2.20]

weight classifier. – A digital scale that rounds weight values up to the next verification scale interval (e). [2.20]

(Added 1987) (Amended 2024 and 2025)

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. [2.20]

wet basis. – See “moisture content (wet basis).” [5.56(a), 5.56(b)]

wet hose. – A discharge hose intended to be full of product at all times. (Also see “wet-hose type.”) [3.30, 3.31, 3.38, 3.39]

(Amended 2002 and 2019)

wet-hose type. – A type of device designed to be operated with the discharge hose full of product at all times. (Also see “wet hose.”) [3.30, 3.32, 3.34, 3.37, 3.38, 3.39]

(Amended 2002 and 2019)

wheel-load weighers. – Compact, self-contained, portable weighing elements specially adapted to determining the wheel loads or axle loads of vehicles on highways for the enforcement of highway weight laws only. [2.20]

wholesale device. – Any device other than a retail device. (Also see “retail device.”) [3.30, 3.32]

wing pulley. – A pulley made of widely spaced metal bars in order to set up a vibration to shake loose material off the underside (return side) of the belt. [2.21]

Z

zero-load balance. – A correct weight indication or representation of zero when there is no load on the load-receiving element. (Also see “zero-load balance for an automatic-indicating scale,” “zero-load balance for a nonautomatic-indicating scale,” “zero-load balance for a recording scale.”) [2.20]

zero-load balance, 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. [2.20]

zero-load balance, 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. [2.20]

zero-load balance for a recording scale. – A condition in which the scale will record a representation of zero load. [2.20]

zero-load reference (belt-conveyor scales). – A zero-load reference value represents no load on a moving conveyor belt. This value can be either; a number representing the electronic load cell output, a percentage of full scale capacity, or other reference value that accurately represents the no load condition of a moving conveyor belt. The no load reference value can only be updated after the completion of a zero load test.[2.21]

(Added 2002)

zero-setting mechanism. – Means provided to attain a zero balance indication with no load on the load-receiving element. The types of zero-setting mechanisms are: [2.20, 2.22, 2.24]

automatic zero-setting mechanism (AZSM). – Automatic means provided to set the zero-balance indication without the intervention of an operator. [2.22]

(Added 2010)

automatic zero-tracking (AZT) mechanism. – See “automatic zero-tracking (AZT) mechanism.” (NOTE: AZT maintains zero with specified limits. “Zero-setting sets/establishes zero with limits based on scale capacity.) [2.20, 2.22, 2.24]

initial zero-setting mechanism. – Automatic means provided to set the indication to zero at the time the instrument is switched on and before it is ready for use. [2.20]

(Added 1990)

manual zero-setting mechanism. – Nonautomatic means provided to attain a zero balance indication by the direct operation of a control. [2.20]

semiautomatic zero-setting mechanism. – Automatic means provided to attain a direct zero balance indication requiring a single initiation by an operator. [2.20]

(Amended 2010)

zero-setting mechanism (belt-conveyor scale). – A mechanism enabling zero totalization to be obtained over a whole number of belt revolutions. [2.21, 2.23]

(Added 2002)

zero-tracking mechanism. – See “automatic zero-tracking mechanism” under “zero-setting mechanism.” [2.20, 2.22, 2.24]

zone of uncertainty. – The zone between adjacent increments on a digital device in which the value of either of the adjacent increments may be displayed. [2.20]

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NIST Technical Publications

Periodical

Journal of Research of the National Institute of Standards and Technology—Reports NIST research and development in metrology and related fields of physical science, engineering, applied mathematics, statistics, biotechnology, and information technology. Papers cover a broad range of subjects, with major emphasis on measurement methodology and the basic technology underlying standardization. Also included from time to time are survey articles on topics closely related to the Institute's technical and scientific programs. Issued six times a year.

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E15 Fuel Registration

FFARs guidelines

[<https://epa.gov/fuels-registration-reporting-and-compliance-help/registration-guidelines-fuels-and-fuel-additives>](https://epa.gov/fuels-registration-reporting-and-compliance-help/registration-guidelines-fuels-and-fuel-additives)

E15 fuel registration

[<https://epa.gov/fuels-registration-reporting-and-compliance-help/e15-fuel-registration>](https://epa.gov/fuels-registration-reporting-and-compliance-help/e15-fuel-registration)

On this page:

- About E15 fuel
- Registering E15 fuel
 - Misfueling Mitigation Plans
 - Compliance Survey Plans
 - Fuel product registration under Part 79

About E15 fuel

E15 is a fuel blend of 15% ethanol and 85% gasoline. It can be used in:

- Flexible-fuel vehicles (FFVs);
- Model year 2001 and newer cars;
- Model year 2001 and newer light-duty trucks; and
- Model year 2001 and newer medium-duty passenger vehicles (SUVs).

It cannot be used in:

- On-highway and nonroad motorcycles;
- Vehicles with heavy-duty engines, such as school buses, transit buses, and delivery trucks;
- Nonroad vehicles, such as boats and snowmobiles;
- Engines in nonroad equipment, such as lawnmowers and chain saws; or

- Model year 2000 and older cars, light-duty trucks, and medium-duty passenger vehicles.

Learn more:

- Regulation History of the E15 Partial Waivers Under the Clean Air Act (pdf) (135 KB, September 2015, EPA-420-F-15-044)
- E15 Standards & Regulations <<https://epa.gov/gasoline-standards/final-rule-regulation-mitigate-misfueling-vehicles-and-engines-gasoline>>

Registering E15 fuel

Fuel producers must meet the following EPA requirements for E15 fuel.

1. Misfueling mitigation plans
2. Compliance survey plans
3. Fuel product registration under 40 CFR Part 79

Misfueling Mitigation Plans

The Misfueling Mitigation Rule requires companies to submit a Misfueling Mitigation Plan to EPA for approval prior to selling E15. These plans must include measures that the fuel producer will take to reduce the potential of misfueling vehicles that cannot use E15.

Companies can submit their own MMPs or request EPA approval to use the Model Misfueling Mitigation Plan. Companies cannot introduce E15 into commerce until EPA has approved the request and the plan has been implemented.

Follow these three (3) steps to submit the request:

1. Compose a letter on company letterhead that includes the following:
 - a. A request to use the Model Misfueling Mitigation Plan
 - b. The company's planned E15-related business (e.g., refiner, ethanol producer, oxygenate blender, retailer).

2. Have a company official sign the letter
3. Mail the letter to the appropriate address: EPA's Fuel Programs Mailing Addresses
<<https://epa.gov/fuels-registration-reporting-and-compliance-help/epas-fuel-programs-mailing-addresses>>

After receiving the letter, EPA may seek additional information and/or require additional misfueling mitigation measures, as appropriate, considering the company's specific circumstances.

- Documents related to E15 Misfueling Mitigation Plans

The following documents are related to E15 Misfueling Mitigation Plans. The E15 partial waivers to the Clean Air Act include conditions requiring each fuel and fuel additive manufacturer subject to the waivers to submit a misfueling mitigation plan for EPA's approval and to fully implement the EPA-approved MMP prior to introduction of the fuel or fuel additive into commerce as appropriate.

Download documents:

- Fact Sheet: Regulation history of E15 Misfueling Mitigation Plans (pdf) (139 KB, September 2015, EPA-420-F-15-042)
 - Fact Sheet: Approval of E15 Misfueling Mitigation Plans (pdf) (155 KB, June 2012, EPA-420-F-12-030)
 -  Companies with EPA-Approved E15 Misfueling Mitigation Plans (pdf) <<https://www.epa.gov/system/files/documents/2026-04/420b26014.pdf>> (146.85 KB, updated: March 24, 2026, EPA-420-B-26-014)
 -  Sample Letter from EPA Approving Misfueling Mitigation Plan Submission (pdf) <<https://www.epa.gov/sites/default/files/2015-09/documents/e15-mmp-approval-letter-sample.pdf>> (82.76 KB, May 2012)
 -  Renewable Fuels Association Model E15 Misfueling Mitigation Plan Submission (pdf) <<https://www.epa.gov/sites/default/files/2015-09/documents/rfa-model-e15-misfueling-mitigation-plan.pdf>> (95.47 KB, March 2012)
 -  Renewable Fuels Association E15 Retailer Handbook (pdf) <<https://www.epa.gov/sites/default/files/2016-06/documents/rfa-e15-retailer-handbook.pdf>> (3.94 MB, February 6, 2013)
 -  Letter from EPA to RFA about Model E15 Misfueling Mitigation Plan Submission (pdf) <<https://www.epa.gov/sites/default/files/2015-09/documents/rfa-model-e15-mmp-letter.pdf>> (829.66 KB, March 2012)
 - Frequent questions related to motorcycle fueling <<https://epa.gov/fuels-registration-reporting-and-compliance-help/frequent-questions-related-motorcycle-fueling>>
-

Compliance Survey Plans

Companies that use the Model Misfueling Mitigation Plan must submit a survey plan for EPA approval and cannot introduce E15 into commerce until EPA has approved the survey plan and the plan has been implemented.

Companies may choose to submit their own survey plans or use an approved survey plan.

The RFG Survey Association has submitted survey plans for every year that the E15 waiver has been in place. Companies that enroll in the RFGSA survey plan meet the waiver condition for a survey plan. Companies that wish to enroll in the RFGSA's E15 Compliance Survey program should contact RFGSA.

- Contact the RFGSA [🔗](https://www.rfgsa.org/) <https://www.rfgsa.org/>

Companies may submit their own survey plans by mailing a paper copy to the appropriate address: EPA's Fuels Programs Mailing Addresses <<https://epa.gov/fuels-registration-reporting-and-compliance-help/epas-fuel-programs-mailing-addresses>>

- Documents related to E15 Compliance Survey Plans

The following documents are related to the emissions and health effects testing of E15 fuel (a fuel blend of 15% ethanol and 85% gasoline).

The Clean Air Act and EPA regulations require that manufacturers of gasoline and diesel fuels and fuel additives produced and commercially distributed for use in highway motor vehicles must register their gasoline and diesel fuels and fuel additives with EPA. In addition to providing basic information such as product and manufacturer identification, manufacturers are required to analyze the emissions generated by the fuel and fuel additive products, survey existing scientific information for each product, and where adequate information is not available, conduct specified tests to screen for the potential adverse health effects of these emissions. The primary purpose of the registration program is to provide information for identifying and evaluating the potential adverse effects of fuels and fuel additives emissions to help inform any future regulatory decision-making.

-  RFG Survey Association E15 Compliance Survey Plan – 2016 Submission (pdf)
<<https://www.epa.gov/sites/default/files/2016-10/documents/epa-to-rfgsa-e15-compliance-survey-plan-2016-ltr-approval.pdf>> (43.39 KB, November 2015)
-  Regulation history of E15 Compliance Survey Plans (pdf)
<<https://www.epa.gov/sites/default/files/2015-09/documents/420f15043.pdf>> (151.84 KB, September 2015)
-  RFG Survey Association E15 Compliance Survey Plan – 2015 Submission (pdf)
<<https://www.epa.gov/sites/default/files/2015-09/documents/rfgsa-e15-compliance-survey-plan-2015-ltr.pdf>> (896.33 KB, October 2014)
-  Letter from EPA to RFGSA about E15 Compliance Survey – 2015 Submission (pdf) <<https://www.epa.gov/sites/default/files/2015-09/documents/epa-to-rfgsa-e15-compliance-survey-plan-2015-ltr-approval.pdf>> (185.64 KB, November 2014)
-  RFG Survey Association E15 Compliance Survey Plan – 2014 Submission (pdf)
<<https://www.epa.gov/sites/default/files/2015-09/documents/cy2014-e15-survey-plan.pdf>> (1.67 MB, November 2013)
-  Letter from EPA to RFGSA about E15 Compliance Survey – 2014 (pdf)
<<https://www.epa.gov/sites/default/files/2015-09/documents/cy2014-e15-survey-plan-approval-letter.pdf>> (52.11 KB, December 2013)

-  RFG Survey Association E15 Compliance Survey Plan – 2013 Submission (pdf) <<https://www.epa.gov/sites/default/files/2015-09/documents/cy2013-e15-survey-plan.pdf>> (824.71 KB, November 2012)
 -  Letter from EPA to RFGSA about E15 Compliance Survey – 2013 Submission (pdf) <<https://www.epa.gov/sites/default/files/2015-09/documents/cy2013-e15-survey-plan-approval-letter.pdf>> (49.87 KB, December 2012)
 -  RFG Survey Association E15 Compliance Survey Plan – 2012 Submission (pdf) <<https://www.epa.gov/sites/default/files/2015-09/documents/letter-pro-rfgsa-to-epa-05-04-12.pdf>> (1.54 MB, May 2012)
 -  Letter from EPA to RFGSA about E15 Compliance Survey – 2012 Submission (pdf) <<https://www.epa.gov/sites/default/files/2015-09/documents/letter-epa-to-rfgsa-e15survey-approval-05-24-12.pdf>> (947.57 KB, May 2012)
-

Fuel product registration under 40 CFR Part 79

All individual fuel and fuel additive manufacturers involved in manufacturing E15 must register with EPA. Manufacturers are required to:

- Analyze the combustion and evaporative emissions generated by their fuel and fuel additive products
- Survey existing scientific information for each product

- Conduct tests to screen for potential adverse health effects of these emissions, where adequate information is not available.
 - Documents related to the emissions and health effects testing of E15 fuel

The following documents are related to the emissions and health effects testing of E15 fuel (a fuel blend of 15% ethanol and 85% gasoline).

The Clean Air Act and EPA regulations require that manufacturers of gasoline and diesel fuels and fuel additives produced and commercially distributed for use in highway motor vehicles must register their gasoline and diesel fuels and fuel additives with EPA. In addition to providing basic information such as product and manufacturer identification, manufacturers are required to analyze the emissions generated by the fuel and fuel additive products, survey existing scientific information for each product, and where adequate information is not available, conduct specified tests to screen for the potential adverse health effects of these emissions. The primary purpose of the registration program is to provide information for identifying and evaluating the potential adverse effects of fuels and fuel additives emissions to help inform any future regulatory decision-making.

-  E15 Emissions Testing and Health Effects Submission by the Renewable Fuels Association and Growth Energy (pdf)
<<https://www.epa.gov/sites/default/files/2015-09/documents/e15-health-impact-data-package.pdf>> (8.25 MB, February 2012)
-  EPA Evaluation of RFA/GrE Submission in Partial Fulfillment of 40 CFR 79 Tier 1 and Tier 2 E15 Registration Requirements (pdf)
<<https://www.epa.gov/sites/default/files/2015-09/documents/420r12010.pdf>> (660.15 KB, February 2012)
-  Evaluation of E15 Health and Emissions Information (pdf)
<<https://www.epa.gov/sites/default/files/2015-09/documents/420f12013.pdf>> (542.29 KB, February 2012)
-  Letter from EPA to RFA and GE about E15 Health Effects Submission (pdf)
<<https://www.epa.gov/sites/default/files/2015-09/documents/e15-letter.pdf>> (85.1 KB, February 2012)

Instructions for registering a fuel product:

- Register or update a fuel or fuel additive under 40 CFR Part 79 <<https://epa.gov/fuels-registration-reporting-and-compliance-help/register-or-update-fuel-or-fuel-additive-request>>

Last updated on April 7, 2026

**California Multimedia Evaluation of Gasoline
Containing up to 15 percent Ethanol (E15)
Staff Written Summary**

December 2025

Table of Contents

1. Staff Written Summary.....	1
A. INTRODUCTION.....	1
1. Multimedia Evaluation	1
2. E15 Fuel Information	4
B. MMWG E15 MULTIMEDIA EVALUATION SUMMARIES	6
1. California Air Resources Board Evaluation	6
2. State Water Resources Control Board Evaluation	9
3. Office of Environmental Health Hazard Assessment Evaluation.....	10
4. Department of Toxic Substances Control Evaluation	12
C. Conclusions.....	14
1. Conclusions on Air Emissions Impact.....	14
2. Conclusions on Water Impact.....	14
3. Conclusions on Public Health Impact.....	15
4. Conclusions on Soil and Hazardous Waste Impact	15
D. Recommendations	16

LIST OF APPENDICES

- Appendix A. California Multimedia Evaluation of E11 - E15 Gasoline-Ethanol Blends Tier III Report
- Appendix B. MMWG Agency Evaluations
- California Air Resources Board: Impact Assessment of E15 on Exhaust and Evaporative Emissions From Light-Duty Vehicles
- State Water Resources Control Board: E15 Multimedia Evaluation
- Office of Environmental Health Hazard Assessment: The Potential for Toxicity of E15 versus E10 Exhausts
- Department of Toxic Substances Control: Recommendation on E15 Multimedia Evaluation
- Appendix C. Peer Review Reports and MMWG Response to Peer Review Comments

List of Acronyms and Abbreviations

ATDS	Automotive Testing and Development Services, Inc.
BTEX	Benzene, Toluene, Ethylbenzene, m/p Xylenes, o-Xylenes
CalEPA	California Environmental Protection Agency
CARB	California Air Resources Board
CARBOB	California Reformulated Gasoline Blendstock for Oxygenate Blending
CaRFG	California Phase 3 Reformulated Gasoline
CCR	California Code of Regulations
CEPC	California Environmental Policy Council
CE-CERT	University of California Bourns College of Engineering - Center for Environmental Research and Technology
CH ₄	Methane
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
DPR	Department of Pesticide Regulation
DTSC	Departement of Toxic Substance Control
E0	Gasoline without Ethanol
E10	Gasoline-Ethanol Fuel Blend of 10 Percent by Volume Ethanol
E15	Gasoline-Ethanol Fuel Blend of 15 Percent by Volume Ethanol
EPA	U.S. Environmental Protection Agency
GDI	Gasoline Direct Injection
GHG	Greenhouse Gas
HSC	Health and Safety Code
MMWG	Multimedia Working Group
MMP	Misfueling Mitigation Plan
MY	Model Year
N ₂ O	Nitrous Oxide
NH ₃	Ammonia
NMHC	Non-Methane Hydrocarbons
NO _x	Oxides of Nitrogen
OEHHA	Office of Environmental Health Hazard Assessment
PAH	Polycyclic Aromatic Hydrocarbon
PFI	Port Fuel Injection
PM	Particulate Matter
THC	Total Hydrocarbons
UST	Underground Storage Tanks
VOC	Volatile Organic Compounds

1. Staff Written Summary

A. INTRODUCTION

CARB is authorized to adopt standards, rules and regulations to achieve the maximum degree of emission reduction possible from vehicular and other mobile sources in order to accomplish California's attainment of the state and federal ambient air quality standards at the earliest practicable date. Before regulations establishing new fuel specifications can be adopted, California Health and Safety Code (HSC) section 43830.8 requires a multimedia evaluation to be conducted and reviewed by the California Environmental Policy Council (CEPC).¹ The purpose of the multimedia evaluation is to develop information on the potential impacts of new fuels on environmental and human health.

Growth Energy and the Renewable Fuels Association (RFA) prepared a multimedia evaluation of gasoline-ethanol blends based on the addition of 10.5 to 15 percent by volume denatured fuel ethanol with California Reformulated Gasoline Blendstock for Oxygenate Blending (CARBOB) approved for use under the California Reformulated Gasoline Regulations (CaRFG), referred to as E15. The Multimedia Working Group (MMWG), an interagency staff team described below, was established to oversee the multimedia evaluation process and make recommendations to the CEPC regarding the acceptability of new fuel specifications proposed for use in the State.

This Staff Written Summary was developed by the MMWG and includes: an assessment of the E15 multimedia evaluation prepared by Growth Energy and the Renewable Fuels Association. The Written Summary includes an analysis of potential significant adverse impacts on public health and the environment and the conclusions and recommendations of the MMWG for consideration by the CEPC. A draft version of the Staff Written Summary was provided to Scientific Peer Reviewers as described in section A.1.c. below. This final version incorporates comments from the Peer Reviewers, where appropriate, and the introductory sections and format were edited from the draft version for clarity and concision and to ensure the format supports distribution.

1. Multimedia Evaluation

HSC section 43830.8 defines "multimedia evaluation" as the identification and evaluation of any significant adverse impact on public health or the environment, including air, water, or soil, that may result from the production, use, or disposal of the motor vehicle fuel that may be used to meet the state board's motor vehicle fuel specifications.²

¹ Health & Saf. Code, § 43830.8.

² Health & Saf. Code, § 43830.8(b).

The multimedia evaluation must address:

- Emissions of air pollutants, including ozone forming compounds, particulate matter, toxic air contaminants, and greenhouse gases.
- Contamination of surface water, groundwater, and soil.
- Disposal or use of the byproducts and waste materials from the production of the fuel.

a. Overview of the Multimedia Evaluation Process

A multimedia evaluation consists of three tiers conducted by the fuel applicants seeking approval of the proposed fuel and overseen by the MMWG with CARB leading coordination between parties. In Tier I, a report is developed summarizing what is known about the fuel and identifying the information needed for the impact and risk assessment, currently available information and key knowledge gaps, if any exist. The Tier I report also establishes a scope and plan for additional evaluation and experiments needed to address any identified knowledge gaps. Tier II includes the development and review of analyses and experiments to address any knowledge gaps identified during Tier I and culminates in a Tier II experimental report. The MMWG reviews the Tier II report and all experiments and analyses conducted. The next step in the multimedia evaluation is the completion and review of the Tier III Multimedia Risk Assessment according to the agreed upon protocol developed through Tiers I and II. A final Tier III report, which incorporates the Tier I and Tier II reports, is produced and used as the basis for MMWG review and development of recommendations by the MMWG to the CEPC. At this point, the MMWG prepares a draft Staff Written Summary with recommendations to the CEPC. The draft Staff Written Summary Tier III report and Tier reports with all supporting documentation undergo independent peer review. Following the peer review, the MMWG reviews and prepares responses to all peer reviewer comments and develops a Final Staff Written Summary, incorporating peer review comments where appropriate.

Figure 1 below provides a graphical overview of the MME process. The process is described in its entirety in the 2016 MME guidance document³ on CARB's website.

³ https://ww2.arb.ca.gov/sites/default/files/2019-11/fuels_multimedia_guidance_mar2016.pdf

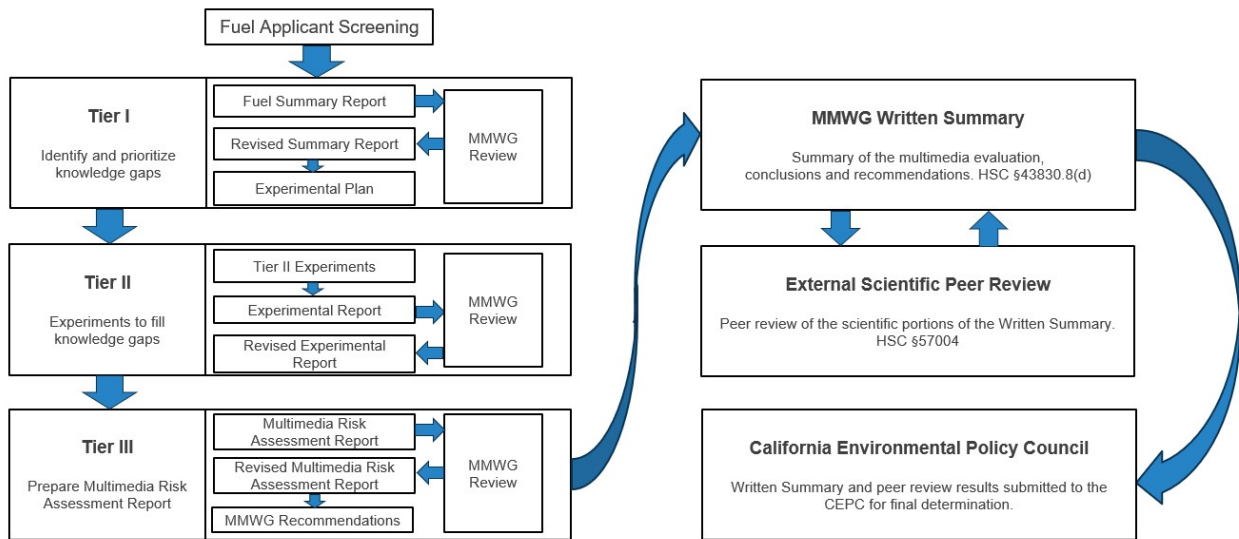


Figure 1. Multimedia Evaluation Process

For the E15 multimedia evaluation, the Tier I and Tier II Reports are available as individual reports, however, the Tier III Report incorporates the Tier I and Tier II Reports as appendices and therefore the Tier III Report provides all multimedia evaluation materials. The Tier III Report, including the Tier I and Tier II reports, is included as Appendix A to this document. All reports are also available on [CARB's Fuels Multimedia Evaluation of E15 webpage](#).

b. Multimedia Working Group

The California Environmental Protection Agency (CalEPA) formed the interagency MMWG to oversee the multimedia evaluation process and make recommendations to the CEPC. The MMWG is composed of representatives from CalEPA boards department and offices, including CARB, the State Water Resources Control Board (State Water Board), the Office of Environmental Health Hazard Assessment (OEHHA), the Department of Toxic Substances Control (DTSC), and the Department of Pesticide Regulation (DPR). The MMWG also consults with other agencies, such as the State Fire Marshal, as needed.

For the MMWG analysis of the E15 multimedia evaluation, CARB staff was responsible for the air quality impact assessment and overall coordination of the multimedia evaluation process. OEHHA staff was responsible for evaluating potential public health impacts, State Water Board staff was responsible for evaluating potential surface water and groundwater quality impacts, and DTSC staff was responsible for evaluating potential hazardous waste and soil impacts.

c. External Scientific Peer Review

HSC section 43830.8(d) requires an external scientific peer review of the multimedia evaluation be conducted pursuant to HSC section 57004. The purpose of the peer

review is to determine whether the scientific portions of the MMWG Written Summary are based upon "sound scientific knowledge, methods, and practices."⁴ The CalEPA External Scientific Peer Review Program manages the processes CalEPA boards, departments and offices use to comply with HSC section 57004 when a formal external scientific peer review is required.⁵

For the E15 multimedia evaluation, CARB coordinated with the CalEPA External Scientific Peer Review Program to complete the scientific peer review and the materials from that review including individual peer reviewer reports and agency responses to comments are included in Appendix C.

d. California Environmental Policy Council

Pursuant to Public Resources Code section 71017(b), the CEPC is comprised of the Secretary for Environmental Protection; the Chairpersons of CARB and the State Water Board; and the Directors of OEHH, DTSC, DPR, and the Department of Resources Recycling and Recovery. As noted above, HSC section 43830.8 requires that CARB may not adopt any regulation that establishes a specification for motor vehicle fuel unless that regulation, and a multimedia evaluation is reviewed by the CEPC.

If the CEPC determines that the use of fuels according to the proposed regulation will cause a significant adverse impact on public health or the environment, or that alternatives exist that would be less adverse, the CEPC shall recommend alternative measures that CARB or other state agencies may take to reduce the adverse impact on public health or the environment. According to HSC section 43830.8(e), the CEPC is required to complete its review of the multimedia evaluation and proposed regulation within 90 calendar days following CARB providing a draft proposed regulation and notice of intent to adopt the regulation.

In the case of the E15 multimedia evaluation, CARB has not yet developed proposed regulatory language. When completed, the proposed regulations will be provided to the CEPC to support their final review of all materials.

2. E15 Fuel Information

Title 40, Code of Federal Regulations, section 1090.80 defines E15 as gasoline that contains more than 10 and no more than 15 volume percent ethanol. The CaRFG Regulations currently permit the sale of gasoline with up to 10 percent ethanol by volume (E10). As noted in the introduction, the E15 test fuels evaluated under this multimedia evaluation were composed of fuel grade denatured ethanol, pursuant to

⁴ Health & Safety Code, §57004(d)(2).

⁵ State Water Resources Control Board. *External Scientific Peer Review* website.
https://www.waterboards.ca.gov/resources/peer_review/#stay-informed.

ASTM D4806⁶ and California Reformulated Gasoline Blendstock for Oxygenate Blending (CARBOB).⁷

a. Federal Considerations

In 2011, the U.S. Environmental Protection Agency (EPA) granted partial waivers that allow E15 use for light-duty conventional vehicles of model year (MY) 2001 and newer, subject to certain conditions.⁸ These waivers do not apply in California. EPA placed two types of conditions on the waivers for E15 use in other states:

1) Fuel quality conditions:

- Ethanol used for E15 must meet ASTM International D4806-10.
- Reid Vapor Pressure is limited to 9.0 pound per square inch during the summertime.

2) Misfuelling mitigation conditions:

Fuel and fuel additive manufacturers subject to the waivers must submit to EPA a misfuelling mitigation plan (MMP), for EPA's approval, and must fully implement the EPA-approved MMP prior to introduction of E15. Reasonable precautions in an MMP must include, but are not limited to, the following conditions:

- Labels must be placed on E15 retail dispensers indicating that E15 use is only for MY 2001 and new motor vehicles.
- Product Transfer Documents must accompany all transfers of fuels for E15 use.
- Parties involved in the manufacture of E15 must participate in a survey of compliance at fuel retail dispensing facilities.
- Any other reasonable measures EPA determines are appropriate.⁹

⁶ ASTM International. *ASTM D4806. Standard Specification for Denatured Fuel Ethanol Blending with Gasoline for Use as an Automotive Spark-Ignition Engine Fuel*. Oct 19, 2021.

⁷ , Cal. Code of Regs., tit. 17 § 2250-2273.5.

⁸ U.S. Environmental Protection Agency. *Final Rule: Regulation to Mitigate the Misfueling of Vehicles and Engines with Gasoline Containing Greater than Ten Volume Percent Ethanol*. <https://www.epa.gov/gasoline-standards/final-rule-regulation-mitigate-misfueling-vehicles-and-engines-gasoline>.

⁹ U.S. Environmental Protection Agency. *Regulation History of the E15 Partial Waivers Under the Clean Air Act*. EPA-420-F-15-044. <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100QJTU.pdf>. September 2015.

Nationwide, outside of California, over 3,000 gasoline stations sell E15, accounting for about 2% of all gasoline stations across the country.^{10,11} Currently, those retail stations offering E15 outside of California utilize a separate underground storage tank (UST) to accommodate E15.

B. MMWG E15 MULTIMEDIA EVALUATION SUMMARIES

This section provides summaries of the evaluations and analyses prepared by CARB, the State Water Board, OEHHA and DTSC. The evaluations are based on the relative differences between E10 that meets CaRFG Regulations and E15 as described above. The complete evaluations and supporting documentation are provided as appendices of this report.

1. California Air Resources Board Evaluation

CARB staff completed an air quality assessment of E15. The evaluation includes a description of the E15 emissions test programs and impact analyses on air emissions, including regulated emission, toxic air contaminants and evaporative emissions. The complete report is provided in Appendix B. Staff's assessment is based on the data and information provided for the E15 multimedia evaluation, including the fuel applicants' multimedia reports (Final Tier I, Tier II, and Tier III Reports); and the studies in the Tier II report including the "*Comparison of Exhaust Emissions Between E10 CaRFG and Splash Blended E15*" (Exhaust Emissions Study)¹² by the University of California Bourns College of Engineering - Center for Environmental Research and Technology (CE-CERT); and the "*Comparison of Evaporative Emissions Between E10 CaRFG and Splash Blended E15*" (Evaporative Emissions Study)¹³ by Automotive Testing and Development Services, Inc. (ATDS).

Exhaust and evaporative emissions testing were conducted to determine the emissions impacts of E15 compared to E10 gasoline meeting CaRFG Regulations. The baseline E10 fuel used for testing was a summer-grade CaRFG sourced from four different refineries. The E10 fuels were blended in four equal parts to create the final E10 fuel. The E15 test fuel was created by splash blending denatured ASTM D4806 fuel grade ethanol with the final E10 fuel. CE-CERT supplied the same E10 and E15

¹⁰ U.S. Department of Energy. Alternative Fuels Data Center. E15. <https://afdc.energy.gov/fuels/ethanol-e15>.

¹¹ API. America's Service Station FAQs. <https://www.api.org/oil-and-natural-gas/consumer-information/consumer-resources/service-station-faqs.aspx>.

¹² Karavalakis, G., Durbin T.D., & Tang, T. *Comparison of Exhaust Emissions Between E10 CaRFG and Splash Blended E15*. June 2022. https://ww2.arb.ca.gov/sites/default/files/2022-07/E15_Final_Report_7-14-22_0.pdf.

¹³ Automotive Testing and Development Services, Inc. *Comparison of Evaporative Emissions Between E10 CaRFG and Splash Blended E15*. January 2022.

fuels that were used in the Exhaust Emissions Study to ATDS for the Evaporative Emissions Study.^{14,15}

Exhaust emissions testing was performed on twenty light-duty vehicles that were selected to provide a wide range of makes, models, technology standards, and sizes. The test matrix included eleven vehicles with gasoline direct injection (GDI), six vehicles with port fuel injection (PFI) and two PFI+GDI fuel systems that are representative of the current California gasoline fleet. One hybrid electric vehicle equipped with a PFI engine was also used. All vehicles were equipped with three-way catalysts.¹⁶ Evaporative emissions testing was conducted on a subset of the vehicles tested in the Exhaust Emissions Study, including a 2016 Nissan Rogue, 2020 Jeep Cherokee, 2020 Jeep Compass, 2019 RAV4, and a 2021 Hyundai Accent.¹⁷

a. Health-Relevant Air Emissions

Emissions testing conducted as part of the Exhaust Emissions Study focused primarily on regulated emissions, including nitrogen oxides (NO_x), carbon monoxide (CO), total hydrocarbons (THC), nonmethane hydrocarbons, carbon dioxide (CO₂), methane (CH₄), and particulate matter (PM). More extensive testing, including toxics analyses, was completed as part of the study.¹⁸

Results generally found that most regulated emissions from E15 are reduced compared to E10, including PM, CO and THC. Weighted PM, CO and THC emissions showed a statistically significant reduction of 18%, 17% and 5%, respectively, for E15 compared to E10 across the entire fleet of 20 vehicles. NO_x did not show any statistically significant difference between the fuels.¹⁹ Results are considered "statistically significant" if the associated p-values are less than 0.05, which represent a 95 percent confidence level. Results are considered "marginally statistically significant" if the associated p-values are greater than or equal to 0.05 and less than 0.1.

¹⁴ Karavalakis, G., Durbin T.D., & Tang, T. *Comparison of Exhaust Emissions Between E10 CaRFG and Splash Blended E15*. June 2022. https://ww2.arb.ca.gov/sites/default/files/2022-07/E15_Final_Report_7-14-22_0.pdf.

¹⁵ Automotive Testing and Development Services, Inc. *Comparison of Evaporative Emissions Between E10 CaRFG and Splash Blended E15*. January 2022.

¹⁶ Karavalakis, G., Durbin T.D., & Tang, T. *Comparison of Exhaust Emissions Between E10 CaRFG and Splash Blended E15*. June 2022. https://ww2.arb.ca.gov/sites/default/files/2022-07/E15_Final_Report_7-14-22_0.pdf.

¹⁷ Automotive Testing and Development Services, Inc. *Comparison of Evaporative Emissions Between E10 CaRFG and Splash Blended E15*. January 2022.

¹⁸ Karavalakis, G., Durbin T.D., & Tang, T. *Comparison of Exhaust Emissions Between E10 CaRFG and Splash Blended E15*. June 2022. https://ww2.arb.ca.gov/sites/default/files/2022-07/E15_Final_Report_7-14-22_0.pdf.

¹⁹ Karavalakis, G., Durbin T.D., & Tang, T. *Comparison of Exhaust Emissions Between E10 CaRFG and Splash Blended E15*. June 2022. https://ww2.arb.ca.gov/sites/default/files/2022-07/E15_Final_Report_7-14-22_0.pdf, page vi.

Toxics emissions tests were conducted for various carbonyl compounds and hydrocarbon species, including benzene, toluene, ethylbenzene, m/p-xylenes, o-xylenes (BTEX), 1,3-butadiene, formaldehyde, acetaldehyde and ethanol emissions. Toxics results show statistically significant reductions in ethylbenzene (11%) and increases in acetaldehyde (32%) and ethanol (77%). As expected, acetaldehyde and ethanol emissions were consistently higher for E15 compared to E10 as acetaldehyde emissions are a function of ethanol content. Cumulative BTEX emissions results for benzene and toluene did not show any statistically significant differences between E10 and E15. For m/p-xylenes and o-xylene emissions, E15 showed marginally statistically significant reductions of 10% and 9%, respectively. 1,3-butadiene and formaldehyde emissions results did not show any statistically significant difference between E10 and E15.²⁰

b. Climate-Relevant Air Emissions

Gases that trap heat in the atmosphere are called greenhouse gases (GHGs). GHG emissions are primarily CO₂, CH₄, nitrous oxide (N₂O), and hydrofluorocarbons.²¹ Each of these gases can remain in the atmosphere for different amounts of time, ranging from a few years to thousands of years.²² GHG emissions from the use of fuels are primarily CO₂.²³

Weighted CO₂ emission results from the study did not show any statistically significant differences between E10 and E15. In general, any increase in CO₂ emissions would not necessarily suggest that the fuel leads to an overall increase in carbon emissions. Most THC and CO convert to CO₂ in the atmosphere, so total CO₂ produced by the combustion process is determined by direct CO₂ emissions, as well as THC and CO. As previously stated, weighted CO and THC emissions showed a statistically significant reduction of 17% and 5%, respectively, for E15 compared to E10 across the entire fleet of 20 vehicles.²⁴

²⁰ Karavalakis, G., Durbin T.D., & Tang, T. *Comparison of Exhaust Emissions Between E10 CaRFG and Splash Blended E15*. June 2022. https://ww2.arb.ca.gov/sites/default/files/2022-07/E15_Final_Report_7-14-22_0.pdf. Page 44.

²¹ California Air Resources Board. *Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Public Hearing to Consider Adoption of Regulations to Control Greenhouse Gas Emissions from Motor Vehicles*. August 6, 2004. Page i.

²² United States Environmental Protection Agency. *Overview of Greenhouse Gases* website. <https://www.epa.gov/ghgemissions/overview-greenhouse-gases>. Accessed November 20, 2024.

²³ California Air Resources Board. *Proposed Re-Adoption of the Low Carbon Fuel Standard. Staff Report: Initial Statement of Reasons*. December 2014, ES-2. <https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2015/lcfs2015/lcfs15isor.pdf>.

²⁴ Karavalakis, G., Durbin T.D., & Tang, T. *Comparison of Exhaust Emissions Between E10 CaRFG and Splash Blended E15*. June 2022. https://ww2.arb.ca.gov/sites/default/files/2022-07/E15_Final_Report_7-14-22_0.pdf. Page 54.

c. Secondary Air Pollutants

Secondary pollutants form in the atmosphere through chemical and photochemical reactions from other primary pollutants. An example includes ozone, which is formed when hydrocarbons and NO_x combine in the presence of light. Its precursor components are primarily the result of road traffic. Unlike many of the other GHGs, ozone is a short-lived gas that is found in regionally varying concentrations.

Both THC and NO_x emissions determine ozone concentrations. As previously stated, THC emissions showed statistically significant reductions. NO_x did not show any statistically significant difference between E10 and E15.

2. State Water Resources Control Board Evaluation

State Water Board staff have completed the evaluation of potential surface water and groundwater impacts from E15 fuel. Staff based their assessment on the information provided in the multimedia evaluation reports (Final Tier I, Tier II and Tier III Reports). The multimedia evaluation and State Water Board assessment of environmental impacts is specific to the difference between E15 and E10. The complete evaluation is provided in Appendix B.

a. Water Impacts

State Water Board staff reviewed the exposure data comparing the effects of E15 and E10. Human and ecological risks associated with E15 blends would not be significantly different than those present from the widespread use of E10.

b. Underground Storage Tank Material Compatibility and Leak Detection

California statutes require underground storage tank systems to be compatible with the substance stored, and the leak detection equipment to be able to function appropriately with the substance stored. Incompatibility increases the risk of unauthorized releases.

UST regulations require the storage of substances not certified as compatible by an independent testing organization, typically Underwriters Laboratories (UL), if the manufacturer of the components provides affirmative statements of compatibility. Fiberglass USTs manufactured before April 1, 1990 (Xerxes) and July 1, 1990 (Owens Corning) cannot be certified by UL and both manufacturers only will certify compatibility with fuel blends containing 10 percent ethanol or methanol.

California maintains approximately 35,000 secondarily contained USTs, of which 5,100 USTs and (estimated) 2,000 additional piping systems are not compatible with E15. Additionally, UST system upgrades require local agency permitting and review, and typically also require additional property improvements associated with local planning and fire code.

c. Biodegradability and Fate and Transport

Researchers provided data on the impacts of fate and transport properties of E15 compared to E10. Fate and transport, as well as biodegradability, are not expected to be significantly different given the similar chemical composition of E15 and E10.

d. Waste Discharge from Manufacturing

Chemicals used in, and byproducts created by, the production of the fuel are required to comply with hazardous waste laws and regulations. No significant areas of concern have been identified by staff when comparing the waste streams of E15 to E10.

3. Office of Environmental Health Hazard Assessment Evaluation

OEHHA staff evaluated potential public health impacts from the use of E15 based on review of the Tier Reports and focused on the comparison of toxicity between E15 and E10. The evaluation includes a brief description of OEHHA's previous assessment on health risks of ethanol in fuel, a summary of findings on comparative toxicity from the Tier I Report, and a summary of findings on comparative exposure from the Tier I and II Reports. The complete evaluation is provided in Appendix B.

a. OEHHA's previous assessment on the health risks of ethanol in gasoline

OEHHA previously assessed the potential health risks of ethanol in fuel, as an alternative oxygenate to methyl tertiary-butyl ether. In general, the addition of ethanol to fuel did not present significant risks to public health. The health risks associated with fuel stemmed primarily from the hydrocarbon portion of the fuel, including BTEX, its combustion byproducts (e.g., acetaldehyde, formaldehyde, and 1,3-butadiene), and secondary transformation products that may form in the atmosphere.

These compounds remain a concern with E15 fuels; although, the increase in the percent volume of ethanol from 10% to 15% leads to a percent volume decrease of some of the other constituents of the fuel.

b. Summary of findings on comparative toxicity

The Tier I Report summarized the results of a literature review of studies comparing the toxicity of ethanol blended fuels, including gasoline without ethanol (E0) and blends up to E85. The Tier I Report included studies published through early 2018. OEHHA reviewed the summaries of these studies in the Tier I Report, as well as several additional toxicological/mechanistic studies published since 2018. While most of the available studies did not compare E15 and E10 fuels directly, the inclusion of fuels with a wide range of ethanol concentrations in the studies as a whole allowed for quantitative comparisons that enabled the estimation of the toxicity of any blend.

Based on sub-acute studies in experimental animals, E15 does not appear to be more toxic than E10 in relation to maternal, behavioral, immunological, physiological, or cognitive outcomes. Subchronic studies with inhalation exposure to E0 or gasoline

combined with ethanol suggest that evaporative emissions of E15 may not increase health hazard compared to E10, but more comprehensive evaluations are warranted. *In vitro* experiments in human cell lines suggest E15 would not be more potent than E10 in inducing cytotoxic, pro-inflammatory, oxidative stress, mutagenic, or DNA-damage effects. While outside the scope of this study, future studies that are focused on low-dose toxicity assessments and mechanistic toxicity evaluations may be helpful to better understand the potential health risks of E15 versus E10.

Overall, the Tier I Report concludes that the use of gasoline-ethanol blends in the E11 - E15 range would not result in any human public health impacts different from those that already occur with existing E10 fuels. The additional studies do not change the conclusion from the Tier I Report regarding public health impact of E15 compared to E10.

c. Summary of findings on comparative exposure

Exposure scenarios for E15 are expected to be similar to those for E10, and include inhalation, oral ingestion, and dermal contact routes. Inhalation exposure can result from tailpipe emissions and evaporative emissions from vehicles, evaporation of volatile compounds during fuel handling, and vapors from contaminated soil and soil vapor. Dermal exposure can occur during fuel handling and from contact with contaminated soil. Oral exposures can occur through contamination of drinking water supplies. The increased ethanol content in E15 results in a proportional decrease in the hydrocarbon portion of the fuel, resulting in a slight decrease in exposure to key chemicals of concern.

E15 significantly reduces tailpipe emissions of, thereby reducing inhalation exposure to PM, CO, THC, non-methane hydrocarbons (NMHC), and some volatile organic compounds (VOCs), with no increase in NO_x or carbon dioxide emissions. There are no statistically significant differences in emissions of several toxic air contaminants compared to E10. While E15 reduces exposure to many pollutants, emissions of ethanol and acetaldehyde were increased compared to E10. However, the increased ethanol concentrations are expected to have no impact on health due to ethanol's low anticipated health risk relative to other fuel-related chemicals of concern and low amount anticipated to be inhaled given the likely outdoor exposure.

Besides tailpipe emissions, inhalation exposure resulting from the evaporation of volatile compounds can occur with vehicle refueling, fuel spills, and fuel transport. Evaporative emissions resulting from the volatilization of compounds from within the fuel system are not expected to differ since E15 and E10 have similar vapor pressures, as described in the Tier I Report. Evaporative emissions testing, detailed in the Tier II Report, found no statistically significant difference between E15 and E10. Exposure can also occur with vapor intrusion from contaminated soil and soil vapor into the indoor air of a building. According to the Tier I Report, the benzene component of E11-15 ethanol-gasoline blends is the primary risk driver for long-term vapor intrusion due to potential preferential degradation of ethanol over BTEX constituents. However,

the report did not specify the duration of “long-term”, which may be on the order of years, depending on environmental conditions and the amount of fuel released. The applicability of currently accepted vapor intrusion vertical screening distances to E15 releases is unknown and requires validation, as the distances are based on risk data from E0-E10 fuels.

Oral and dermal exposures are unlikely to differ significantly between E15 and E10. While there is an increase in ethanol content, it is highly volatile and unlikely to contribute additional risk via these exposure routes. The risks associated with exposures to the other constituents of the fuel do not change appreciably and remain similar to the risk associated with E10.

Overall, the Tier I Report concludes that the use of gasoline-ethanol blends in the E11 – E15 range would not result in any release scenarios or environmental impacts different from those that already occur with existing fuels.

4. Department of Toxic Substances Control Evaluation

DTSC staff assessed potential impacts to human health and the environment from the production and use of E15. Staff’s evaluation focused on: (1) hazardous waste generation during production, use, and storage of E15 in California, and (2) cleanup of contaminated sites in cases of spills of E15. Please refer to Appendix B for DTSC’s complete evaluation.

Today, virtually all gasoline sold in California is E10. E15 has been approved at the federal level. Allowing E15 to replace E10 is one way in which California can make progress towards achieving its goals regarding greenhouse gas emissions. Other potential benefits include, but are not limited to, reduced dependence on petroleum and reductions in several air pollutants.

Production of the increased ethanol that would be necessary to produce E15 is centered around fermentation of renewable organic feedstocks (e.g., sugar crops, corn, sorghum, and grasses) along with certain sugar-containing waste streams such as brewery and dairy wastes. Most ethanol currently consumed in California is derived from corn starch, with smaller amounts from sorghum. The primary co-product of the fermentation process is carbon dioxide. It can be expected that, in order to generate the increased amount of ethanol needed to produce E15, more carbon dioxide will be produced and potentially released. Regulated hazardous wastes are not a byproduct of ethanol production.

Transportation of ethanol used to create E15 blends would be conducted by the existing system of trucks, railcars, or waterborne vessels (e.g., ethanol from Brazil). Ethanol is then stored in dedicated tanks to be blended with petroleum and produced as a finished product for delivery to retail stations. Storage of E15 blends can be conducted in pre-existing approved infrastructure, such as tanks. Storage tanks may be above ground or below ground, with provisions for tank maintenance and monitoring, along with secondary containment, pursuant to 40 Code of Federal

Regulations sections 112 and 280. State regulations for underground storage tanks are also overseen by the SWRCB, see California Code of Regulations, title 23, chapter 16. Tanker truck roadway accidents, which may lead to fuel tank punctures must also be considered, although the likelihood of these accidents is not greater than existing probabilities for E10. As such, the transportation and storage of E15 do not represent an increased risk of hazardous waste generation compared to E10.

The most significant pollutants in surface or subsurface releases of gasoline-ethanol blends are BTEX. Because BTEX pollutants come from the petroleum fraction of E15, a higher concentration of ethanol would reduce the amounts of BTEX potentially being released. Ethanol increases the solubility of BTEX in water. However, via ethanol competition for electron acceptors, the increased ethanol concentration will reduce the rate of biodegradation of BTEX in the environment upon release.²⁵

In the event of a release of E15 into soil, modeling efforts suggest that increased ethanol content leads to a significant elongation effect on benzene plume lengths, with this effect most pronounced for E10-E20 blends. However, similar modeling indicates that the difference between baseline E10 plumes compared to potential E15 plumes is a fraction of a percent. Furthermore, the plume degradation time is inversely correlated with ethanol content in fuel blends. As such, the natural attenuation time for an E15 release is expected to be less than for a similar volume release of E10. A 2009 underground storage tank leak in Minnesota which had been used to store E85 detected the following:

- Consistent detection of benzene in onsite and offsite wells, with offsite migration of the benzene plume past 2015; and
- Rapidly dropping ethanol concentrations in onsite monitoring wells, with final detection in 2012.²⁶

Ethanol release and subsequent degradation is also associated with increased microbial activity, leading to the production of methane. Higher concentrations of ethanol, if released, have the potential to generate significant quantities of methane; studies of historical groundwater impacts after sudden (neat) ethanol releases demonstrate that methane can be expected to develop and persist in groundwater.²⁷ In general, the time to ethanol cleanup varied, with cleanups occurring between 27-60 months, when documented. Increased monitoring for methane in soil and

²⁵ National Response Team (NRT), NRT Quick Reference Guide: Fuel Grade Ethanol Spills (including E85). 2010.

²⁶ Pinnacle Engineering, Inc (Pinnacle), *Minnesota Pollution Control Agency Annual Monitoring Report, Miller & Holmes, Inc. Convenience Store, 1402 Vermillion Street, Hastings, Minnesota, Leak 17529*. (2015).

²⁷ Spalding, R. F., Toso, M. A., Exner Spalding, M., Hattan, G., Higgins, T.M., Sekely, A.C., et al., *Long-Term Groundwater Monitoring Results at Large, Sudden Denatured Ethanol Releases*. (2011). <https://doi.org/10.1111/j.1745-6592.2011.01336.x>.

groundwater in areas where there is potential for E15 spills may be needed due to the potential for explosions in the case of advective methane flow.

Finally, E15 has the same potential as E10 to be released into the environment, potentially affecting soil, surface water, and groundwater. Typically, the half-life of ethanol in the environment is 0.5-5 days (quicker in soil, longer in sewers), with possibly faster degradation in surface waters, due to the presence of aerobic microorganisms in the environment.²⁸ However, sensitive and other receptors may still be impacted through exposure via routes such as inhalation, ingestion, and dermal exposure. The primary human carcinogen found in fuel, benzene, would be expected to decrease in concentration as the proportion of ethanol increases. The human and ecological risks associated with E15 are largely similar to those associated with the current widespread use of E10.

C. Conclusions

This section provides the conclusions of each of the evaluations conducted by CARB, the State Water Board, OEHHA and DTSC. The conclusions on the impacts of E15 on public health and the environment are summarized below:

1. Conclusions on Air Emissions Impact

Based on the relative comparison between E10 and E15, CARB staff concludes that with fuel requirements, E15, as evaluated in this multimedia evaluation, does not pose a significant adverse impact on public health or the environment from potential air quality impacts.

Staff also makes the following general conclusions:

- E15 reduces PM, THC and CO exhaust emissions.
- No statistically significant difference in NO_x emissions compared to E10.
- E15 increases acetaldehyde and ethanol exhaust emissions.

2. Conclusions on Water Impact

State Water Board staff conclude that given the current information and the similarities between E15 and E10, there are minimal additional risks to the beneficial uses of California waters posed by E15 as compared to current fuel blend of E10. The State Water Board supports the multimedia evaluation of E15 which meets the ASTM fuel specifications and the finding of no significant adverse impacts on public health or the environment.

²⁸ Pinnacle Engineering, Inc (Pinnacle), *Minnesota Pollution Control Agency Annual Monitoring Report, Miller & Holmes, Inc. Convenience Store, 1402 Vermillion Street, Hastings, Minnesota, Leak 17529.* (2015).

3. Conclusions on Public Health Impact

As stated in the Tier Reports, there are risks to human health and the environment inherent in the use of gasoline-ethanol blends that are related primarily to the complex mixture of volatile hydrocarbons that make up the gasoline blendstock. The public health impacts resulting from E15 are not expected to differ from those of E10. As with E10, there is the potential for release of E15 into the environment, resulting in potential exposures to humans through inhalation, oral ingestion, and dermal contact. However, release and exposure scenarios for E15 are similar to those of E10 and are not expected to present an increased risk to human health.

Based on the information presented in the E15 multimedia evaluation, the substitution of E15 for E10 shows a general decrease in levels of ozone-forming compounds, particulate matter, some VOCs, and other contaminants of concern to human health. However, E15 use may increase tailpipe emissions of a few VOCs, such as ethanol and acetaldehyde.

Toxicological studies of gasoline blended with various levels of ethanol in laboratory animals do not indicate potential for different health hazards regarding maternal, behavioral, immunological, physiological, or cognitive outcomes. Studies using cultured human cells suggest that E15 will not be more potent than E10 in terms of its cytotoxic, pro-inflammatory, oxidative stress, mutagenic, or DNA-damage effects.

Overall, OEHHA did not find evidence of significant adverse impacts on human health from the use of E15 compared to E10. The Tier Reports support the approval of E15, based on significant environmental benefits, reduced greenhouse gas emissions, and no expected significant new public health risks compared to E10.

4. Conclusions on Soil and Hazardous Waste Impact

Based on available data, DTSC staff concludes that E15, if improperly released, may lead to an elongated subsurface benzene plume. However, this subsurface plume would overall also biodegrade more quickly due to the higher ethanol content compared to E10. BTEX contaminants from petroleum may also biodegrade less quickly in the event of an E15 release into the environment. Improper release of E15 may also result in increased generation and release of methane.

D. Recommendations

Based on the E15 multimedia evaluation and the information provided in the Final Tier I, Tier II and Tier III reports, the MMWG determined that the use of E15, as evaluated in this multimedia evaluation, does not pose a significant adverse impact on public health or the environment compared to E10.

The Multimedia Working Group recommends that the CEPC:

1. Find the use of E15 fuel in California, as evaluated in this multimedia evaluation, does not pose a significant adverse impact on public health or the environment compared to E10.
2. Condition the finding on the following:
 - a. Any hazardous substances and hazardous waste used in production, storage and transportation of E15 will be handled in compliance with applicable California and federal laws and regulations.
 - b. Fuel formulations not included within the scope of this multimedia evaluation must be reviewed by the MMWG for consideration of appropriate action.
 - c. Through existing programs CARB staff will continue to monitor acetaldehyde and ethanol emissions. In the event that emissions data indicates the potential for significant risks to public health CARB will take appropriate action under its authority.
 - d. In the event that any relevant available information indicates the potential for significant risks to public health or the environment, the specific use of E15 will be reviewed by the MMWG for appropriate action.

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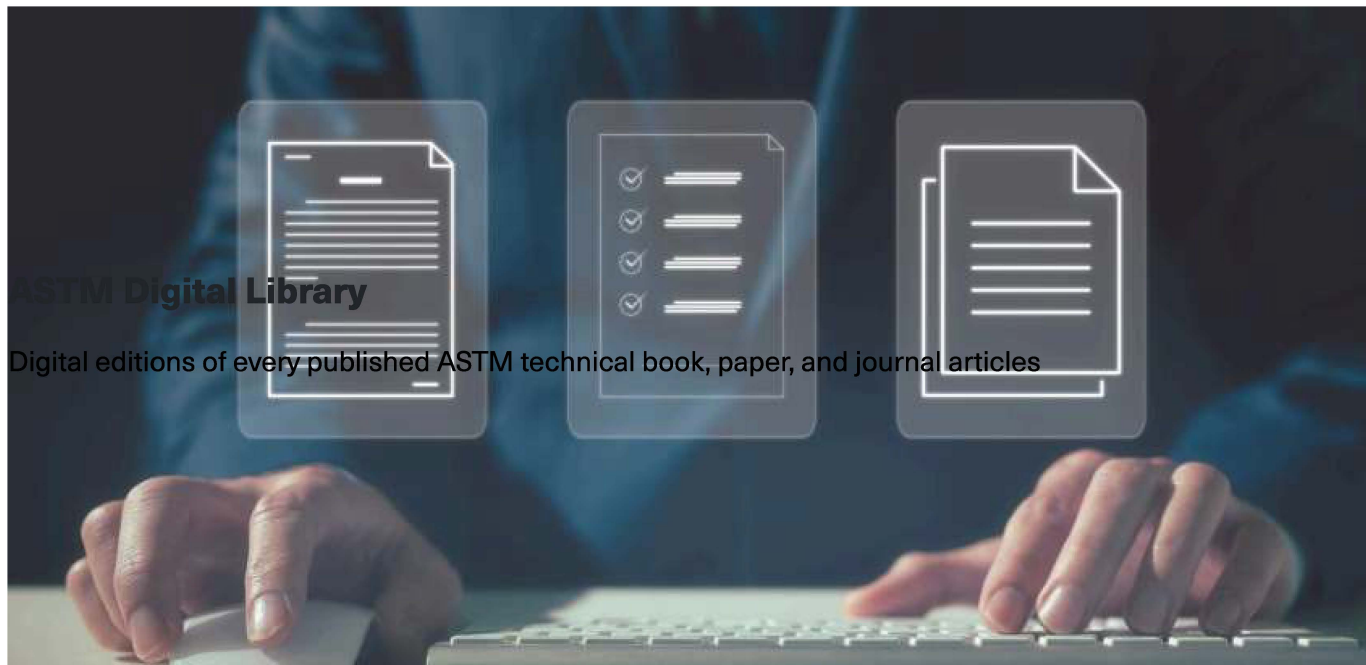


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AB30 LEGISLATION PASSAGE AND STEPS TO OBTAIN E15 CERTIFICATION OF VAPOR RECOVERY COMPONENTS AND ECO NOZZLE/LOW-PERM HOSES

February 24, 2026

Background

The passage of AB30, signed by Governor Newsom on October 2, 2025, authorized the immediate sale of E15 (gasoline blends containing 10.5 percent to 15 percent ethanol by volume). Existing state law requires the California Air Resources Board (CARB) to certify components that accept or transfer gasoline at dispensing facilities. Before CARB certifies such components state law requires prior approvals from four state agencies – the State Water Resources Control Board, California Office of Safety and Health Administration, California Department of Food and Agriculture, and Office of the State Fire Marshal. Currently, there are no components certified as E15 compatible.

These are the steps that manufacturers must take to expeditiously certify E15 compatible equipment. Since the Governor and Legislature made the sale of E15 a priority, each agency will expedite the certification of E15 compatible components consistent with each agency's regulations.

Note: The procedures for each agency listed below can be done concurrently, but only once all other state agencies have provided their respective approvals can CARB then issue an Executive Order certifying a component (or system) is E15 compatible.

CARB Certification Process

1. Submit application requesting system/components be certified as compatible with E15.
2. Identify any changes needed to ensure E15 compatibility.
3. CARB staff determine if testing is needed or approval can be done through an engineering evaluation.
4. Continue to step 5 if testing is successful.
5. Verification that approvals from the four state agencies have been provided.
6. Issue Executive Order certifying system.
7. Payment of required fee.

Contact: George Lew (george.lew@arb.ca.gov) or Paul Marzilli (paul.marzilli@arb.ca.gov)

State Water Resources Control Board (SWRCB) Certification Process

1. In 2008, SWRCB issued a memorandum outlining vapor recovery components that were exempt from additional review requirements. See attachment A.
2. If a manufacturer's component does not fit into the criteria of the exempt memorandum, or the component had to be modified to be compatible with E15 fuel blends, there is information within the letter on the information that is needed to obtain SWRCB approval consistent with Health and Safety Code 6.7, section 25290.1.2.

3. If there are no modifications to the EVR components and the manufacturer wants to confirm the device is compatible with E15, then compatibility documents only need to be provided. Such documents are as follows for spill containment, overfill prevention equipment and ancillary equipment:
 - a. Approval from an independent testing organization for compatibility with the hazardous substance(s) stored.
 - b. Manufacturer affirmative statement of compatibility with the hazardous substance stored.
 - c. Approval by a California registered professional engineer, or
 - d. An industry code or engineering standard demonstrating compatibility with the hazardous substances stored.
4. Additional information on the steps to obtain SWRCB approval can be found at the following link - https://www.waterboards.ca.gov/ust/tank_testers/.

Contact: Tom Henderson (Tom.Henderson@Waterboards.ca.gov)

California Office of Safety and Health Administration (Cal/OSHA) Certification Process

1. Request Letter written to Cal/OSHA for which part/product requires approval with associated name and model #
2. What is the function of the part you are seeking the approval(s) for (e.g. the xxxx nozzle allows the safe dispensing of fuel into the vehicle etc..)
3. Submit any previous letters from Cal/OSHA approving any previous model(s).
4. Answer the following questions:
 - A. Is this new model like any previous models?
 - B. What are the main differences between the two models (if applicable)?
 - C. Why are the modifications being made between the new model and previous models?
 - D. Provide the parts being modified, name and model #s
 - E. Provide diagrams/cut sheets showing the existing part and the new part showing the differences and overall, where the part is located.
5. Provide the Underwriters Laboratories (UL) Approval testing certificate with number for your product.
6. Provide installation manual.
7. Payment of applicable fees.

Contact: Amit Gupta (AGupta@dir.ca.gov)

California Department of Food and Agriculture (CDFA) Division of Measurement Standards (DMS) Certification Process

Note: The link to CDFA's Frequently Asked Questions pertaining to E15 is: https://www.cdfa.ca.gov/dms/programs/Petroleum/docs/e15_faq.pdf

1. Fuel delivery nozzles with balance or assist vapor recovery systems must to be type evaluated by the California Type Evaluation Program (CTEP) and approved for use with gasoline blends containing 10.5% to 15% ethanol by volume (California Code, BPC 12500.5.).
2. If your nozzle has been type evaluated and approved, provide the make, model, and the CTEP Certificate of Approval number to CTEP.

3. If requirements are met, CTEP will provide a letter to CARB (fee required).
4. If your nozzle needs to be type evaluated, please contact CTEP.
5. Payment of applicable fees.

Contact: Beth Nordeen (Elizabeth.Nordeen@cdfa.ca.gov)

Office of the State Fire Marshal (OSFM) Vapor Recovery (VR) Program's Certification Process

1. To update existing OSFM VR certifications for compatibility with E15 fuel, manufacturers are required to submit an application, a complete test report issued by an OSFM approved testing laboratory, and the required fees to the OSFM's VR Program.
2. The VR Program reviews and evaluates their application for compliance to ensure E15 compatibility.
3. During the VR Program's review, if we discover any issues, then we will reach out and work with the manufacturer.
4. If there are no issues, the next step is to issue a draft VR certification to the manufacturer to review and sign.
5. After the manufacturer signs the draft VR certification, then a final VR certification is issued, and an official copy is sent to the manufacturer and a courtesy copy to CARB.
6. The "Design" section of the OSFM VR certification will clearly indicate the product is compatible for use with E15 fuel.
7. Additional information on the steps to obtain OSFM VR Certification can be found at the State Fire Marshal's website: <https://osfm.fire.ca.gov/what-we-do/fire-engineering-and-investigations/vapor-recovery-program>

Contact: Galileo (Leo) Atalig (Galileo.Atalig@fire.ca.gov)

SWRCB Attachment A

Page 1 of 2



Linda S. Adams
Secretary for
Environmental Protection

State Water Resources Control Board

Division of Water Quality

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Arnold Schwarzenegger
Governor

TO: Mr. George Lew, Chief
California Air Resources Board
Vapor Recovery Engineering and Certification Division
1927 13th Street, Sacramento, CA 95812

FROM: 
Laura Fisher-Chaddock, Chief UST Leak Prevention
DIVISION OF WATER QUALITY

DATE: APR 25 2008

SUBJECT: EVR COMPONENTS NOT SUBJECT TO STATE WATER BOARD REVIEW

As you know, Health and Safety Code (HSC), chapter 6.7, section 25290.1.2(a) requires the Air Resources Board (ARB) and State Water Resources Control Board (State Water Board) to determine collaboratively, to the best of their knowledge and using existing resources, that the equipment that meets the ARB's Enhanced Vapor Recovery (EVR) requirements also meets the State Water Board's underground storage tank (UST) statutory requirements. To implement this statutory requirement, EVR equipment manufacturers must submit a Professional Engineer's review and supporting documentation to the State Water Board, as described in the "Enhanced Vapor Recovery Multi Agency Review Process Guidelines for Determination of Compliance of Enhanced Vapor Recovery Systems with Underground Storage Tank Statutes."

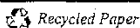
Pursuant to these guidelines, EVR equipment manufacturers must submit a Professional Engineer's review and supporting documentation to the State Water Board for review. In order to minimize the burden of the *Multi Agency Review Process* on manufacturers, we have identified the following EVR components that are exempt from State Water Board regulations.¹

1. Unburied delivery hoses, vapor recovery hoses, and nozzles that are subject to unobstructed visual inspection for leakage.
2. Pressure / Vacuum vent valves that are installed above ground on tank vent piping.

Because they are not regulated by the State Water Board and we do foresee them having any adverse impact on the operation of regulated portions of the UST system, we have determined that review of these components on an individual basis is not

¹ Components exempt from State Water Board regulation per Health and Safety Code, Chapter 6.7, section 25281.5(a)(3) and (4)

California Environmental Protection Agency



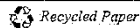
SWRCB Attachment A

Page 2 of 2

Mr. George Lew, Air Resources Board - 2 -

necessary. For revised EVR Executive Orders where only these components have been added or modified, the formal *Multi-Agency Review Process* and associated determination letter will not be used. In such cases, please accept this memo as fulfilling the CP-201, section 1.1.4 requirement for a State Water Board determination letter.

California Environmental Protection Agency



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Title 40 —Protection of Environment
Chapter I —Environmental Protection Agency
Subchapter U —Air Pollution Controls

Part 1090 Regulation of Fuels, Fuel Additives, and Regulated Blendstocks

Subpart A General Provisions

- § 1090.1 Applicability and relationship to other parts.
- § 1090.5 Implementation dates.
- § 1090.10 Contacting EPA.
- § 1090.15 Confidential business information.
- § 1090.20 Approval of submissions under this part.
- § 1090.50 Rounding.
- § 1090.55 Requirements for independent parties.
- § 1090.80 Definitions.
- § 1090.85 Explanatory terms.
- § 1090.90 Acronyms and abbreviations.
- § 1090.95 Incorporation by reference.

Subpart B General Requirements and Provisions for Regulated Parties

- § 1090.100 General provisions.
- § 1090.105 Fuel manufacturers.
- § 1090.110 Detergent blenders.
- § 1090.115 Oxygenate blenders.
- § 1090.120 Oxygenate producers.
- § 1090.125 Certified butane producers.
- § 1090.130 Certified butane blenders.
- § 1090.135 Certified pentane producers.
- § 1090.140 Certified pentane blenders.
- § 1090.145 Transmix processors.
- § 1090.150 Transmix blenders.
- § 1090.155 Fuel additive manufacturers.
- § 1090.160 Distributors, carriers, and resellers.
- § 1090.165 Retailers and WPCs.
- § 1090.170 Independent surveyors.
- § 1090.175 Auditors.
- § 1090.180 Pipeline operators.

Subpart C Gasoline Standards

- § 1090.200 Overview and general requirements.

- § 1090.205 Sulfur standards.
- § 1090.210 Benzene standards.
- § 1090.215 Gasoline RVP standards.
- § 1090.220 RFG standards.
- § 1090.225 Anti-dumping standards.
- § 1090.230 Limitation on use of gasoline-ethanol blends.
- § 1090.250 Certified butane standards.
- § 1090.255 Certified pentane standards.
- § 1090.260 Gasoline deposit control standards.
- § 1090.265 Gasoline additive standards.
- § 1090.270 Gasoline oxygenate standards.
- § 1090.275 Ethanol denaturant standards.
- § 1090.285 RFG covered areas.
- § 1090.290 Changes to RFG covered areas and procedures for opting out of RFG.
- § 1090.295 Procedures for relaxing the federal 7.8 psi RVP standard.
- § 1090.297 Procedures for reinstating the 1.0 psi RVP allowance for E10.

Subpart D Diesel Fuel and ECA Marine Fuel Standards

- § 1090.300 Overview and general requirements.
- § 1090.305 ULSD standards.
- § 1090.310 Diesel fuel additives standards.
- § 1090.315 Heating oil, kerosene, ECA marine fuel, and jet fuel provisions.
- § 1090.320 500 ppm LM diesel fuel standards.
- § 1090.325 ECA marine fuel standards.

Subpart E [Reserved]

Subpart F Transmix and Pipeline Interface Provisions

- § 1090.500 Gasoline produced from blending transmix into PCG.
- § 1090.505 Gasoline produced from TGP.
- § 1090.510 Diesel fuel and distillate fuel produced from TDP.
- § 1090.515 500 ppm LM diesel fuel produced from TDP.
- § 1090.520 Handling practices for pipeline interface that is not transmix.

Subpart G Exemptions

- § 1090.600 General provisions.
- § 1090.605 Exemptions for national security and military use.
- § 1090.610 Exemptions for temporary research, development, and testing.
- § 1090.615 Exemptions for racing and aviation.
- § 1090.620 Exemptions for Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands.
- § 1090.625 Exemptions for California gasoline and diesel fuel.
- § 1090.630 Exemptions for Alaska, Hawaii, Puerto Rico, and the U.S. Virgin Islands summer

gasoline.

§ 1090.635 Exemptions for refinery extreme, unusual, and unforeseen hardship.

§ 1090.640 Exemptions for E85.

§ 1090.645 Exemptions for exports of fuel, fuel additive, and regulated blendstock.

§ 1090.650 Exemptions for distillate global marine fuel.

Subpart H Averaging, Banking, and Trading Provisions

§ 1090.700 Compliance with average standards.

§ 1090.705 Facility level compliance.

§ 1090.710 Downstream oxygenate accounting.

§ 1090.715 Deficit carryforward.

§ 1090.720 Credit use.

§ 1090.725 Credit generation.

§ 1090.730 Credit transfers.

§ 1090.735 Invalid credits and remedial actions.

§ 1090.740 Downstream BOB recertification.

§ 1090.745 Informational annual average calculations.

Subpart I Registration

§ 1090.800 General provisions.

§ 1090.805 Contents of registration.

§ 1090.810 Voluntary cancellation of company or facility registration.

§ 1090.815 Deactivation (involuntary cancellation) of registration.

§ 1090.820 Changes of ownership.

Subpart J Reporting

§ 1090.900 General provisions.

§ 1090.905 Reports by gasoline manufacturers.

§ 1090.910 Reports by gasoline manufacturers that recertify BOB to gasoline.

§ 1090.915 Reports by oxygenate producers and importers.

§ 1090.920 Reports by certified pentane producers.

§ 1090.925 Reports by independent surveyors.

§ 1090.930 Reports by auditors.

§ 1090.935 Reports by diesel fuel manufacturers.

Subpart K Batch Certification and Designation

§ 1090.1000 Batch certification requirements.

§ 1090.1005 Designation of batches of fuel, fuel additive, and regulated blendstock.

§ 1090.1010 Designation requirements for gasoline and regulated blendstocks.

§ 1090.1015 Designation requirements for diesel fuel and distillate fuel.

§ 1090.1020 Batch numbering.

Subpart L Product Transfer Documents

§ 1090.1100 General requirements.

§ 1090.1105 PTD requirements for exempt fuel, fuel additive, and regulated blendstock.

§ 1090.1110 PTD requirements for gasoline, gasoline additives, and gasoline regulated blendstocks.

§ 1090.1115 PTD requirements for distillate fuel and residual fuel.

§ 1090.1120 PTD requirements for diesel fuel additives.

§ 1090.1125 Alternative PTD language.

Subpart M Recordkeeping

§ 1090.1200 General recordkeeping requirements.

§ 1090.1205 Recordkeeping requirements for all regulated parties.

§ 1090.1210 Recordkeeping requirements for gasoline manufacturers.

§ 1090.1215 Recordkeeping requirements for diesel fuel, ECA marine fuel, and distillate global marine fuel manufacturers.

§ 1090.1220 Recordkeeping requirements for oxygenate blenders.

§ 1090.1225 Recordkeeping requirements for gasoline additives.

§ 1090.1230 Recordkeeping requirements for oxygenate producers.

§ 1090.1235 Recordkeeping requirements for ethanol denaturant.

§ 1090.1240 Recordkeeping requirements for gasoline detergent blenders.

§ 1090.1245 Recordkeeping requirements for independent surveyors.

§ 1090.1250 Recordkeeping requirements for auditors.

§ 1090.1255 Recordkeeping requirements for transmix, 500 ppm LM diesel fuel, and pipeline interface.

Subpart N Sampling, Testing, and Retention

§ 1090.1300 General provisions.

Scope of Testing

§ 1090.1310 Testing to demonstrate compliance with standards.

§ 1090.1315 In-line blending.

§ 1090.1320 Adding blendstock to PCG.

§ 1090.1325 Adding blendstock or PCG to TGP.

§ 1090.1330 Preparing denatured fuel ethanol.

Handling and Preparing Samples

§ 1090.1335 Collecting, preparing, and testing samples.

§ 1090.1337 Demonstrating homogeneity.

§ 1090.1340 Preparing a hand blend from BOB.

§ 1090.1345 Retaining samples.

Measurement Procedures

§ 1090.1350 Overview of test procedures.

§ 1090.1355 Calculation adjustments and corrections.

§ 1090.1360 Performance-based Measurement System.

§ 1090.1365 Qualifying criteria for alternative measurement procedures.

§ 1090.1370 Qualifying criteria for reference installations.

§ 1090.1375 Quality control procedures.

Testing Related to Gasoline Deposit Control

§ 1090.1390 Requirement for automated detergent blending equipment calibration.

§ 1090.1395 Gasoline deposit control test procedures.

Subpart O Survey Provisions

§ 1090.1400 General provisions.

§ 1090.1405 National fuels survey program.

§ 1090.1410 Independent surveyor requirements.

§ 1090.1415 Survey program plan design requirements.

§ 1090.1420 Additional requirements for E15 misfueling mitigation surveying.

§ 1090.1450 National sampling and testing oversight program.

Subpart P Retailer and Wholesale Purchaser-Consumer Provisions

§ 1090.1500 Overview.

Labeling

§ 1090.1510 E15 labeling provisions.

§ 1090.1515 Diesel fuel sulfur labeling provisions.

Refueling Hardware

§ 1090.1550 Requirements for gasoline dispensing nozzles used with motor vehicles.

§ 1090.1555 Requirements for gasoline dispensing nozzles used primarily with marine vessels.

§ 1090.1560 Requirements related to dispensing natural gas.

§ 1090.1565 Requirements related to dispensing liquefied petroleum gas.

Subpart Q Importer and Exporter Provisions

§ 1090.1600 General provisions for importers.

§ 1090.1605 Importation by marine vessel.

§ 1090.1610 Importation by rail or truck.

§ 1090.1615 Gasoline treated as a blendstock.

§ 1090.1650 General provisions for exporters.

Subpart R Compliance and Enforcement Provisions

§ 1090.1700 Prohibited acts.

§ 1090.1705 Evidence related to violations.

§ 1090.1710 Penalties.

§ 1090.1715 Liability provisions.

§ 1090.1720 Affirmative defense provisions.

Subpart S Attestation Engagements

§ 1090.1800 General provisions.

§ 1090.1805 Representative samples.

§ 1090.1810 General procedures for gasoline manufacturers.

- § 1090.1815 General procedures for gasoline importers.
- § 1090.1820 Additional procedures for GTAB.
- § 1090.1825 Additional procedures for PCG used to produce gasoline.
- § 1090.1830 Alternative procedures for certified butane blenders.
- § 1090.1835 Alternative procedures for certified pentane blenders.
- § 1090.1840 Additional procedures related to compliance with gasoline average standards.
- § 1090.1845 Procedures related to meeting performance-based measurement and statistical quality control for test methods.
- § 1090.1850 Procedures related to in-line blending waivers.

PART 1090—REGULATION OF FUELS, FUEL ADDITIVES, AND REGULATED BLENDSTOCKS

Authority: 42 U.S.C. 7414, 7521, 7522-7525, 7541, 7542, 7543, 7545, 7547, 7550, and 7601.

Source: 85 FR 78469, Dec. 4, 2020, unless otherwise noted.

Subpart A—General Provisions

§ 1090.1 Applicability and relationship to other parts.

- (a) This part specifies fuel quality standards for gasoline and diesel fuel introduced into commerce in the United States. Additional requirements apply for fuel used in certain marine applications, as specified in paragraph (b) of this section.
 - (1) The regulations include standards for fuel parameters that directly or indirectly affect vehicle, engine, and equipment emissions, air quality, and public health. The regulations also include standards and requirements for fuel additives and regulated blendstocks that are components of any fuel regulated under this part.
 - (2) This part also specifies requirements for any person who engages in activities associated with the production, distribution, storage, and sale of any fuel, fuel additive, or regulated blendstock, such as collecting and testing samples for regulated parameters, reporting information to EPA to demonstrate compliance with fuel quality requirements, and performing other compliance measures to implement the standards. A party that produces and distributes other related products, such as heating oil, may need to meet certain reporting, recordkeeping, labeling, or other requirements of this part.
- (b)
 - (1) The International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 Annex VI ("MARPOL Annex VI") is an international treaty that sets maximum sulfur content for fuel used in marine vessels, including separate standards for marine vessels navigating in a designated Emission Control Area (ECA). These standards and related requirements are specified in 40 CFR part 1043. This part also sets corresponding sulfur standards that apply to any person who produces or handles ECA marine fuel.

- (2) This part also includes requirements for parties involved in the production and distribution of IMO marine fuel, such as collecting and testing samples of fuels for regulated parameters, reporting information to EPA to demonstrate compliance with fuel quality requirements, and performing other compliance measures to implement the standards.
- (c) The requirements for the registration of fuel and fuel additives under 42 U.S.C. 7545(a), (b), and (e) are specified in 40 CFR part 79. A party that must meet the requirements of this part may also need to comply with the requirements for the registration of fuel and fuel additives under 40 CFR part 79.
- (d) The requirements for the Renewable Fuel Standard (RFS) are specified in 40 CFR part 80, subpart M. A party that must meet the requirements of this part may also need to comply with the requirements for the RFS program under 40 CFR part 80, subpart M.
- (e) Nothing in this part is intended to preempt the ability of state or local governments to control or prohibit any fuel or fuel additive for use in motor vehicles and motor vehicle engines that is not explicitly regulated by this part.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4340, Jan. 15, 2025]

§ 1090.5 Implementation dates.

- (a) The provisions of this part apply beginning January 1, 2021, unless otherwise specified.
- (b) The following provisions of 40 CFR part 80 are applicable after December 31, 2020:
 - (1) Gasoline sulfur and benzene credit balances and deficits from the 2020 compliance period carry forward for demonstrating compliance with requirements of this part. Any restrictions that apply to credits and deficits under 40 CFR part 80, such as a maximum credit life of 5 years, continue to apply under this part.
 - (2) Unless otherwise specified (e.g., in-line blending waivers for gasoline as specified in paragraph (b)(8) of this section), any approval granted under 40 CFR part 80 continues to be in effect under this part. For example, if EPA approved the use of an alternative label under 40 CFR part 80, that approval continues to be valid under this part, subject to any conditions specified for the approval.
 - (3) Unless otherwise specified, a regulated party must use the provisions of 40 CFR part 80 in 2021 to demonstrate compliance with regulatory requirements for the 2020 calendar year. This applies to calculating credits for the 2020 compliance period, and to any sampling, testing, reporting, or auditing related to any fuel, fuel additive, or regulated blendstock produced or imported in 2020.
 - (4) Any testing to establish the precision and accuracy of alternative test procedures under 40 CFR part 80 continues to be valid under this part.
 - (5) Requirements to keep records and retain fuel samples related to actions taken before January 1, 2021, continue to be in effect, as specified in 40 CFR part 80.
 - (6) A party may comply with the PTD requirements of 40 CFR part 80 instead of the requirements of subpart L of this part until May 1, 2021.
 - (7) A party may comply with the automatic sampling provisions of 40 CFR 80.8 instead of the requirements in § 1090.1335(c) until January 1, 2022.

- (8) A gasoline manufacturer may operate under an in-line blending waiver issued under 40 CFR part 80 until January 1, 2022, or until EPA approves a revised in-line blending waiver under § 1090.1315, whichever is earlier. The following provisions apply:
 - (i) A gasoline manufacturer operating under an in-line blending waiver under 40 CFR 80.65 must monitor and test for sulfur content, benzene content, and for summer gasoline, RVP, and may discontinue monitoring and testing for other properties that are included in their in-line blending waiver.
 - (ii) The auditing requirements in § 1090.1850 do not apply to an in-line blending waiver issued under 40 CFR part 80.
- (c) The following requirements apply for the 2021 compliance period:
 - (1) The NSTOP specified in § 1090.1450 must begin no later than June 1, 2021.
 - (2) A gasoline manufacturer that accounts for oxygenate added downstream under § 1090.710 is deemed compliant with the requirement to participate in the NSTOP specified in § 1090.710(a)(3) until June 1, 2021, if the gasoline manufacturer meets all other applicable requirements specified in § 1090.710.
 - (3) The independent surveyor conducting the NSTOP must submit the proof of contract required under § 1090.1400(b) no later than April 15, 2021.
 - (4) The independent surveyor may collect only one summer or winter gasoline sample for each participating gasoline manufacturing facility instead of the minimum two samples required under § 1090.1450(c)(2)(i).
- (d) The following requirements apply beginning with the 2025 or 2026 compliance period:
 - (1) Fuel manufacturers operating under an approved in-line blending waiver under § 1090.1315 as of July 1, 2025, must have an approved in-line blending waiver that complies with all the provisions of § 1090.1315(a)(7) through (13) no later than January 1, 2026. Such fuel manufacturers must comply with the in-line blending waiver auditing requirements of § 1090.1850(b) starting with either the 2025 or 2026 compliance period, whichever is the earliest compliance period for which they have an approved in-line blending waiver that complies with all the provisions of § 1090.1315(a)(7) through (13).
 - (2) Gasoline manufacturers must comply with the batch reporting requirements in § 1090.905(c)(1)(viii)(A)(2), (c)(2)(viii)(A)(2), and (c)(8)(vii)(A)(2) beginning with the 2026 compliance period.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4340, Jan. 15, 2025]

§ 1090.10 Contacting EPA.

A party must submit all reports, registrations, and documents for approval required under this part electronically to EPA using forms and procedures specified by EPA via the following website: <https://www.epa.gov/fuels-registration-reporting-and-compliance-help>.

§ 1090.15 Confidential business information.

- (a) Except as specified in paragraphs (b) through (d) of this section, any information submitted under this part claimed as confidential remains subject to evaluation by EPA under 40 CFR part 2, subpart B.
- (b) The following information contained in submissions under this part is not entitled to confidential treatment under 40 CFR part 2, subpart B or 5 U.S.C. 552(b)(4):
 - (1) Submitter's name.
 - (2) The name and location of the facility, if applicable.
 - (3) The general nature of a request.
 - (4) The relevant time period for a request, if applicable.
- (c) The following information incorporated into EPA determinations on submissions under this part is not entitled to confidential treatment under 40 CFR part 2, subpart B or 5 U.S.C. 552(b)(4):
 - (1) Submitter's name.
 - (2) The name and location of the facility, if applicable.
 - (3) The general nature of a request.
 - (4) The relevant time period for a request, if applicable.
 - (5) The extent to which EPA either granted or denied the request and any relevant terms and conditions.
- (d)
 - (1) The following information contained in any enforcement action taken under this part is not entitled to confidential treatment under 40 CFR part 2, subpart B:
 - (i) The company's name.
 - (ii) The facility's name.
 - (iii) Any EPA-issued company and facility identification numbers.
 - (iv) The time or time period when any violation occurred.
 - (v) The quantity of fuel, fuel additive, or regulated blendstock affected by the violation.
 - (vi) Information relating to the exceedance of the fuel standard associated with the violation.
 - (vii) Information relating to the generation, transfer, or use of credits associated with the violation.
 - (viii) Any other information relevant to describing the violation.
 - (2) Enforcement actions within the scope of paragraph (d)(1) of this section include notices of violation, settlement agreements, administrative complaints, civil complaints, criminal information, and criminal indictments.
- (e) EPA may disclose the information specified in paragraphs (b) through (d) of this section on its website, or otherwise make it available to interested parties, without additional notice, notwithstanding any claims that the information is entitled to confidential treatment under 40 CFR part 2, subpart B or 5 U.S.C. 552(b)(4).

[85 FR 78469, Dec. 4, 2020, as amended at 87 FR 39677, July 1, 2022; 90 FR 4341, Jan. 15, 2025]

§ 1090.20 Approval of submissions under this part.

- (a) EPA may approve any submission required or allowed under this part if the request for approval satisfies all specified requirements.
- (b) EPA may impose terms and conditions on any approval of any submission required or allowed under this part.
- (c) EPA will deny any request for approval if the submission is incomplete, contains inaccurate or misleading information, or does not meet all specified requirements.
- (d) EPA may revoke any prior approval under this part for cause. For cause includes, but is not limited to, any of the following:
 - (1) The approval has proved inadequate in practice.
 - (2) The party fails to notify EPA if information that the approval was based on substantively changed after the approval was granted.
- (e) EPA may also revoke and void any approval under this part effective from the approval date for cause. Cause for voiding an approval includes, but is not limited to, any of the following:
 - (1) The approval was not fully or diligently implemented.
 - (2) The approval was based on false, misleading, or inaccurate information.
 - (3) Failure of a party to fulfill or cause to be fulfilled any term or condition of an approval under this part.
- (f) Any person who has an approval revoked or voided under this part is liable for any resulting violation of the requirements of this part.
- (g) Submitting false, misleading, or incomplete information is a violation of law.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4341, Jan. 15, 2025]

§ 1090.50 Rounding.

- (a) Unless otherwise specified, round values to the number of significant digits necessary to match the number of decimal places of the applicable standard or specification. Perform all rounding as specified in 40 CFR 1065.20(e)(1) through (6).
- (b) Do not round intermediate values to transfer data unless the rounded number has at least 6 significant digits.
- (c) When calculating a specified percentage of a given value, the specified percentage is understood to have infinite precision. For example, if an allowable limit is specified as a fuel volume representing 1 percent of total volume produced, calculate the allowable volume by multiplying total volume by exactly 0.01.
- (d) Measurement devices that incorporate internal rounding may be used, consistent with the following provisions:
 - (1) Devices may use any rounding convention if they report 6 or more significant digits.

- (2) Devices that report fewer than 6 significant digits may be used, consistent with the accuracy and repeatability specifications of the procedures specified in subpart N of this part.
- (e) Use one of the following rounding conventions for all batch volumes in a given compliance period, and for all reporting under this part:
 - (1) Identify batch volume in gallons to the nearest whole gallon.
 - (2)
 - (i) Round batch volumes between 1,000 and 11,000 gallons to the nearest 10 gallons.
 - (ii) Round batch volumes above 11,000 gallons to the nearest 100 gallons.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4341, Jan. 15, 2025]

§ 1090.55 Requirements for independent parties.

This section specifies how a third party demonstrates their independence from the regulated party that hires them and their technical ability to perform the specified services.

- (a) **Independence.** The independent third party, their contractors, subcontractors, and their organizations must be independent of the regulated party. All the criteria listed in paragraphs (a)(1) and (2) of this section must be met by each person involved in the specified activities in this part that the independent third party is hired to perform for a regulated party, except that an internal auditor may instead meet the requirements in § 1090.1800(b)(1)(i).
- (1) **Employment criteria.** No person employed by an independent third party, including contractor and subcontractor personnel, who is involved in a specified activity performed by the independent third party under the provisions of this part, may be employed, currently or previously, by the regulated party for any duration within the 12 months preceding the date when the regulated party hired the independent third party to provide services under this part.
- (2) **Financial criteria.**
 - (i) The third-party's personnel, the third-party's organization, or any organization or individual that may be contracted or subcontracted by the third party must meet all the following requirements:
 - (A) Have received no more than one-quarter of their revenue from the regulated party during the year prior to the date of hire of the third party by the regulated party for any purpose.
 - (B) Have no interest in the regulated party's business. Income received from the third party to perform specified activities under this part is excepted.
 - (C) Not receive compensation for any specified activity in this part that is dependent on the outcome of the specified activity.
 - (ii) The regulated party must be free from any interest in the third-party's business.
- (b) **Technical ability.** The third party must meet all the following requirements in order to demonstrate their technical capability to perform specified activities under this part:

- (1) An independent surveyor that conducts a survey under subpart O of this part must have personnel familiar with petroleum marketing, the sampling and testing of gasoline and diesel fuel at retail outlets, and the designing of surveys to estimate compliance rates for fuel parameters nationwide. The independent surveyor must demonstrate this technical ability in plans submitted under subpart O of this part.
 - (2) A laboratory attempting to qualify alternative procedures must contract with an independent third party to verify the accuracy and precision of measured values as specified in § 1090.1365. The independent third party must demonstrate work experience and a good working knowledge of the VCSB methods specified in §§ 1090.1335, 1090.1365, and 1090.1370, with training and expertise corresponding to a bachelor's degree in chemical engineering, or combined bachelor's degrees in chemistry and statistics.
 - (3) Any person auditing in-line blending operations must be familiar with the waiver provisions of § 1090.1315 and be proficient with the sampling procedures specified in § 1090.1335(c).
- (c) **Suspension and disbarment.** Any person suspended or disbarred under 2 CFR part 1532 or 48 CFR part 9, subpart 9.4, is not qualified to perform review functions under this part.

[85 FR 78469, Dec. 4, 2020, as amended at 88 FR 44593, July 12, 2023; 90 FR 4341, Jan. 15, 2025]

§ 1090.80 Definitions.

500 ppm LM diesel fuel means diesel fuel subject to the alternative sulfur standards in § 1090.320 that is produced by a transmix processor under § 1090.515.

Additization means the addition of detergent to gasoline to create detergent-additized gasoline.

Aggregated import facility means all import facilities within a PADD owned or operated by an importer and treated as a single fuel manufacturing facility in order to comply with the maximum benzene average standards under § 1090.210(b).

Anhydrous ethanol means ethanol that contains no more than 1.0 volume percent water.

Auditor means any person who conducts audits under subpart S of this part.

Automated detergent blending facility means any facility (including, but not limited to, a truck or individual storage tank) at which detergent is blended with gasoline by means of an injector system calibrated to automatically deliver a specified amount of detergent.

Average standard means a fuel standard applicable over a compliance period.

Batch means a quantity of fuel, fuel additive, or regulated blendstock with properties that can be characterized by a single set of values using the measurement procedures in subpart N of this part.

Biodiesel means a diesel fuel composed of mono-alkyl esters made from nonpetroleum feedstocks.

Blender pump means any fuel dispenser where PCG is blended with E85 (made only with PCG and DFE) or DFE to produce gasoline that has an ethanol content greater than that of the PCG. A fuel dispenser that produces gasoline with anything other than PCG and DFE (e.g., natural gas liquids) is a fuel blending facility.

Blending manufacturer means any person who owns, leases, operates, controls, or supervises a fuel blending facility in the United States.

Blendstock means any liquid compound or mixture of compounds (not including fuel or fuel additive) that is used or intended for use as a component of a fuel.

Business day means Monday through Friday, except the legal public holidays specified in 5 U.S.C. 6103 or any other day declared to be a holiday by federal statute or executive order.

Butane means an organic compound with the formula C_4H_{10} .

Butane blending facility means a fuel manufacturing facility where butane is blended into PCG.

California diesel fuel means diesel fuel designated by a diesel fuel manufacturer as for use in California.

California gasoline means gasoline designated by a gasoline manufacturer as for use in California.

Carrier means any distributor who transports or stores or causes the transportation or storage of fuel, fuel additive, or regulated blendstock without taking title to or otherwise having any ownership of the fuel, fuel additive, or regulated blendstock, and without altering either the quality or quantity of the fuel, fuel additive, or regulated blendstock.

Category 1 (C1) marine vessel means a vessel that is propelled by an engine(s) that meets the definition of "Category 1" in 40 CFR part 1042.901.

Category 2 (C2) marine vessel means a vessel that is propelled by an engine(s) that meets the definition of "Category 2" in 40 CFR part 1042.901.

Category 3 (C3) marine vessel means a vessel that is propelled by an engine(s) that meets the definition of "Category 3" in 40 CFR part 1042.901.

CBOB means a BOB produced or imported for use outside of an RFG covered area.

Certified butane means butane that is certified to meet the requirements in § 1090.250.

Certified butane blender means a blending manufacturer that produces gasoline by blending certified butane into PCG and that uses the provisions of § 1090.1320(b) to meet the applicable sampling and testing requirements.

Certified butane producer means a regulated blendstock producer that certifies butane as meeting the requirements in § 1090.250.

Certified ethanol denaturant means ethanol denaturant that is certified to meet the requirements in § 1090.275.

Certified ethanol denaturant producer means any person who certifies ethanol denaturant as meeting the requirements in § 1090.275.

Certified non-transportation 15 ppm distillate fuel or certified NTDF has the meaning given in 40 CFR 80.1401.

Certified pentane means pentane that is certified to meet the requirements in § 1090.255.

Certified pentane blender means a blending manufacturer that produces gasoline by blending certified pentane into PCG and that uses the provisions of § 1090.1320 to meet the applicable sampling and testing requirements.

Certified pentane producer means a regulated blendstock producer that certifies pentane as meeting the requirements in § 1090.255.

Compliance period means the calendar year (January 1 through December 31).

Conventional gasoline (CG) means gasoline that is not certified to meet the requirements for RFG in § 1090.220.

Crosscheck program means an arrangement for laboratories to perform measurements from test samples prepared from a single homogeneous fuel batch to establish an accepted reference value for evaluating accuracy of individual laboratories and measurement systems.

Days means calendar days, including weekends and holidays.

Denatured fuel ethanol (DFE) means anhydrous ethanol that contains a denaturant to make it unfit for human consumption, that is produced or imported for use in gasoline, and that meets the standards and requirements in § 1090.270.

Detergent means any chemical compound or combination of chemical compounds that is added to gasoline to control deposit formation and meets the requirements in § 1090.260. Detergent may be part of a detergent additive package.

Detergent additive package means an additive package containing detergent and may also contain carrier oils and other active components such as corrosion inhibitors, antioxidants, metal deactivators, and handling solvents.

Detergent blender means any person who owns, leases, operates, controls, or supervises the blending operation of a detergent blending facility, or who imports detergent-additized gasoline.

Detergent blending facility means any facility (including, but not limited to, a truck or individual storage tank) at which detergent is blended with gasoline.

Detergent manufacturer means any person who owns, leases, operates, controls, or supervises a facility that produces detergent. A detergent manufacturer is a fuel additive manufacturer.

Detergent-additized gasoline or detergent gasoline means any gasoline that contains a detergent.

Diesel fuel means any of the following:

- (1) Any fuel commonly or commercially known as diesel fuel.
- (2) Any fuel (including nonpetroleum diesel fuel or a fuel blend that contains nonpetroleum diesel fuel) that is intended or used to power a vehicle or engine that is designed to operate using diesel fuel.
- (3) Any fuel that conforms to the specifications of ASTM D975 (incorporated by reference in § 1090.95) and is made available for use in a vehicle or engine designed to operate using diesel fuel.

Diesel fuel manufacturer means a fuel manufacturer that owns, leases, operates, controls, or supervises a diesel fuel manufacturing facility.

Distillate fuel means diesel fuel and other petroleum fuels with a T90 temperature below 700 °F that can be used in vehicles or engines that are designed to operate using diesel fuel. For example, diesel fuel, jet fuel, heating oil, No. 1 fuel (kerosene), No. 4 fuel, DMX, DMA, DMB, and DMC are distillate fuels. These specific fuel grades are identified in ASTM D975 and ISO 8217. Natural gas, LPG, and gasoline are not distillate fuels. T90 temperature is based on the distillation test method specified in § 1090.1350.

Distillate global marine fuel means global marine fuel that is distillate fuel.

Distributor means any person who transports, stores, or causes the transportation or storage of fuel, fuel additive, or regulated blendstock at any point between any fuel manufacturing facility, fuel additive manufacturing facility, or regulated blendstock production facility and any retail outlet or WPC facility.

Downstream location means any point in the fuel distribution system other than a fuel manufacturing facility through which fuel passes after it leaves the fuel manufacturing facility gate at which it was certified (e.g., fuel at facilities of distributors, pipelines, terminals, carriers, retailers, oxygenate blenders, and WPCs).

E0 means gasoline that contains no ethanol.

E10 means gasoline that contains at least 9 and no more than 10 volume percent ethanol.

E15 means gasoline that contains more than 10 and no more than 15 volume percent ethanol.

E85 means a fuel that contains more than 50 and no more than 83 volume percent ethanol and is used, intended for use, or made available for use in flex-fuel vehicles or flex-fuel engines. E85 is not gasoline.

ECA associated area has the meaning given in 40 CFR 1043.20.

ECA marine fuel means diesel fuel, distillate fuel, or residual fuel used, intended for use, or made available for use in C3 marine vessels while the vessels are operating within an ECA, or an ECA associated area.

Emission control area (ECA) has the meaning given in 40 CFR 1043.20.

Ethanol means an alcohol of the chemical formula C_2H_5OH .

Ethanol denaturant means PCG, gasoline blendstocks, or natural gas liquids that are added to anhydrous ethanol to make the ethanol unfit for human consumption as required and defined in 27 CFR parts 19 through 21.

Facility means any place, or series of places, where any fuel, fuel additive, or regulated blendstock is produced, imported, blended, transported, distributed, stored, or sold.

Flex-fuel engine has the same meaning as *flexible-fuel engine* in 40 CFR 1054.801.

Flex-fuel vehicle has the same meaning as *flexible-fuel vehicle* in 40 CFR 86.1803-01.

Fuel means only the fuels regulated under this part.

Fuel additive has the same meaning as *additive* in 40 CFR 79.2(e).

Fuel additive blender means any person who blends fuel additive into fuel in the United States, or any person who owns, leases, operates, controls, or supervises such an operation in the United States.

Fuel additive manufacturer means any person who owns, leases, operates, controls, or supervises a fuel additive manufacturing facility.

Fuel additive manufacturing facility means any facility where fuel additive is produced or imported.

Fuel blending facility means any facility, other than a refinery or transmix processing facility, where fuel is produced by combining blendstocks or by combining blendstocks with fuel. Types of blending facilities include, but are not limited to, terminals, storage tanks, plants, tanker trucks, retail outlets, and marine vessels.

Fuel dispenser means any apparatus used to dispense fuel into motor vehicles, nonroad vehicles, engines, equipment, or portable fuel containers (as defined in 40 CFR 59.680).

Fuel manufacturer means any person who owns, leases, operates, controls, or supervises a fuel manufacturing facility. Fuel manufacturers include refiners, importers, blending manufacturers, and transmix processors.

Fuel manufacturing facility means any facility where fuel is produced, imported, or recertified. Fuel manufacturing facilities include refineries, fuel blending facilities, transmix processing facilities, import facilities, and any facility where fuel is recertified.

Fuel manufacturing facility gate means the point where the fuel leaves the fuel manufacturing facility at which the fuel manufacturer certified the fuel.

Gasoline means any of the following:

- (1) Any fuel commonly or commercially known as gasoline, including BOB.
- (2) Any fuel intended or used to power a vehicle or engine designed to operate on gasoline.
- (3) Any fuel that conforms to the specifications of ASTM D4814 (incorporated by reference in § 1090.95) and is made available for use in a vehicle or engine designed to operate on gasoline.

Gasoline before oxygenate blending (BOB) means gasoline for which a gasoline manufacturer has accounted for oxygenate added downstream under § 1090.710. BOB is subject to all the requirements and standards that apply to gasoline, unless subject to a specific alternative standard or requirement under this part.

Gasoline manufacturer means a fuel manufacturer that owns, leases, operates, controls, or supervises a gasoline manufacturing facility.

Gasoline regulated blendstock means a regulated blendstock that is used or intended for use as a component of gasoline.

Gasoline treated as blendstock (GTAB) means a gasoline regulated blendstock that is imported and used to produce gasoline as specified in § 1090.1615.

Global marine fuel means diesel fuel, distillate fuel, or residual fuel used, intended for use, or made available for use in steamships or Category 3 marine vessels while the vessels are operating in international waters or in any waters outside the boundaries of an ECA. Global marine fuel is subject to the provisions of MARPOL Annex VI. (Note: This part regulates only distillate global marine fuel.)

Heating oil means a combustible product that is used, intended for use, or made available for use in furnaces, boilers, or similar applications. Kerosene and jet fuel are not heating oil.

IMO marine fuel means fuel that is ECA marine fuel or global marine fuel.

Importer means any person who imports fuel, fuel additive, or regulated blendstock into the United States.

Import facility means any facility where an importer imports fuel, fuel additive, or regulated blendstock.

Independent surveyor means any person who meets the independence requirements in § 1090.55 and conducts a survey under subpart O of this part.

Intake valve deposits (IVD) means the deposits formed on the intake valve(s) of a gasoline-fueled engine during operation.

Jet fuel means any distillate fuel used, intended for use, or made available for use in aircraft.

Kerosene means any No. 1 distillate fuel that is used, intended for use, or made available for use as kerosene.

Liquefied petroleum gas (LPG) means a liquid hydrocarbon fuel that is stored under pressure and is composed primarily of compounds that are gases at atmospheric conditions (temperature = 25 °C and pressure = 1 atm), excluding natural gas.

Locomotive engine means an engine used in a locomotive as defined in 40 CFR 92.2.

Marine engine has the meaning given in 40 CFR 1042.901.

Methanol means any fuel sold for use in motor vehicles and engines and commonly known or commercially sold as methanol or MXX, where XX represents the percent methanol (CH₃OH) by volume.

Natural gas means a fuel that is primarily composed of methane.

Natural gas liquids (NGLs) means natural gasoline or other mixtures of hydrocarbons (primarily but not limited to propane, butane, pentane, hexane, and heptane) that are separated from the gaseous state of natural gas in the form of liquids at a facility, such as a natural gas production facility, gas processing plant, natural gas pipeline, refinery, or similar facility.

Non-automated detergent blending facility means any facility (including a truck or individual storage tank) at which detergent additive is blended using a hand-blending technique or any other non-automated method.

Nonpetroleum diesel fuel means renewable diesel fuel or biodiesel. Nonpetroleum diesel fuel also includes other renewable fuel under 40 CFR part 80, subpart M, that is used or intended for use to power a vehicle or engine that is designed to operate using diesel fuel or that is made available for use in a vehicle or engine designed to operate using diesel fuel.

Oxygenate means a liquid compound that consists of one or more oxygenated compounds. Examples include DFE and isobutanol.

Oxygenate blender means any person who adds oxygenate to gasoline in the United States, or any person who owns, leases, operates, controls, or supervises such an operation in the United States.

Oxygenate blending facility means any facility (including but not limited to a truck) at which oxygenate is added to gasoline (including BOB), and at which the quality or quantity of gasoline is not altered in any other manner except for the addition of deposit control additives.

Oxygenate import facility means any facility where oxygenate, including DFE, is imported into the United States.

Oxygenate producer means any person who produces or imports oxygenate for gasoline in the United States, or any person who owns, leases, operates, controls, or supervises an oxygenate production or import facility in the United States.

Oxygenate production facility means any facility where oxygenate is produced, including DFE.

Oxygenated compound means an oxygen-containing, ashless organic compound, such as an alcohol or ether, which may be used as a fuel or fuel additive.

PADD means Petroleum Administration for Defense District. These districts are the same as the PADDs used by other federal agencies, except for the addition of PADDs VI and VII. The individual PADDs are identified by region, state, and territory as follows:

PADD	Regional description	State or territory
I	East Coast	Connecticut, Delaware, District of Columbia, Florida, Georgia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina, Vermont, Virginia, West Virginia.
II	Midwest	Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee,

PADD	Regional description	State or territory
III	Gulf Coast	Wisconsin Alabama, Arkansas, Louisiana, Mississippi, New Mexico, Texas.
IV	Rocky Mountain	Colorado, Idaho, Montana, Utah, Wyoming.
V	West Coast	Alaska, Arizona, California, Hawaii, Nevada, Oregon, Washington.
VI	Antilles	Puerto Rico, U.S. Virgin Islands.
VII	Pacific Territories	American Samoa, Guam, Northern Mariana Islands.

Pentane means an organic compound with the formula C₅H₁₂.

Pentane blending facility means a fuel manufacturing facility where pentane is blended into PCG.

Per-gallon standard means the maximum or minimum value for any parameter that applies to every volume unit of a specified fuel, fuel additive, or regulated blendstock.

Person has the meaning given in 42 U.S.C. 7602(e).

Pipeline interface means the mixture between different fuels and products that abut each other during shipment by a refined petroleum products pipeline system.

Pipeline operator means any person who owns, leases, operates, controls, or supervises a pipeline that transports fuel, fuel additive, or regulated blendstock in the United States.

Previously certified gasoline (PCG) means CG, RFG, or BOB that has been certified as a batch by a gasoline manufacturer.

Product transfer documents (PTDs) mean documents that reflect the transfer of title or physical custody of fuel, fuel additive, or regulated blendstock (e.g., invoices, receipts, bills of lading, manifests, pipeline tickets) between a transferor and a transferee.

RBOB means a BOB produced or imported for use in an RFG covered area.

Refiner means any person who owns, leases, operates, controls, or supervises a refinery in the United States.

Refinery means a facility where fuels are produced from feedstocks, including crude oil or renewable feedstocks, through physical or chemical processing equipment.

Reformulated gasoline (RFG) means gasoline that is certified under § 1090.1000(b) and that meets the standards and requirements in § 1090.220.

Regulated blendstock means certified butane, certified pentane, TGP, TDP, and GTAB.

Regulated blendstock import facility means any facility where regulated blendstock is imported into the United States.

Regulated blendstock producer means any person who produces or imports regulated blendstock in the United States, or any person who owns, leases, operates, controls, or supervises a facility where regulated blendstock is produced or imported.

Regulated blendstock production facility means any facility where regulated blendstock is produced.

Renewable diesel fuel means diesel fuel that is made from renewable (nonpetroleum) feedstocks and is not a mono-alkyl ester.

Reseller means any person who purchases fuel identified by the corporate, trade, or brand name of a fuel manufacturer from such manufacturer or a distributor and resells or transfers it to a retailer or WPC, and whose assets or facilities are not substantially owned, leased, or controlled by such manufacturer.

Residual fuel means a petroleum fuel with a T90 temperature at or above 700 °F. For example, No. 5 fuels and No. 6 fuels are residual fuels. Residual fuel grades are specified in ASTM D396 and ISO 8217. T90 temperature is based on the distillation test method specified in § 1090.1350.

Responsible corporate officer (RCO) means a person who is authorized by the regulated party to make representations on behalf of, or obligate the company as ultimately responsible for, any activity regulated under this part (e.g., refining, importing, blending). An example is an officer of a corporation under the laws of incorporation of the state in which the company is incorporated. Examples of positions in non-corporate business structures that qualify are owner, chief executive officer, or president.

Retail outlet means any establishment at which fuel is sold or offered for sale for use in motor vehicles, nonroad engines, nonroad vehicles, or nonroad equipment, including locomotive or marine engines.

Retailer means any person who owns, leases, operates, controls, or supervises a retail outlet.

RFG covered area means the geographic areas specified in § 1090.285 in which only RFG may be sold or dispensed to ultimate consumers.

RFG opt-in area means an area that becomes a covered area under 42 U.S.C. 7545(k)(6) as listed in § 1090.285.

Round (rounded, rounding) has the meaning given in § 1090.50.

Sampling strata means the following types of areas sampled during a survey:

- (1) Densely populated areas.
- (2) Transportation corridors.
- (3) Rural areas.

State Implementation Plan (SIP) means a plan approved or promulgated under 42 U.S.C. 7410 or 7502.

Summer gasoline means gasoline that is subject to the RVP standards in § 1090.215.

Summer season or high ozone season means the period from June 1 through September 15 for retailers and WPCs, and May 1 through September 15 for all other persons, or an RVP control period specified in a SIP if it is longer.

Tank truck means a truck used for transporting fuel, fuel additive, or regulated blendstock.

Transmix means any of the following mixtures of fuels, which no longer meet the specifications for a fuel that can be used or sold as a fuel without further processing:

- (1) Pipeline interface that is not cut into the adjacent products.

- (2) Mixtures produced by unintentionally combining gasoline and distillate fuels.
- (3) Mixtures of gasoline and distillate fuel produced from normal business operations at terminals or pipelines, such as gasoline or distillate fuel drained from a tank or drained from piping or hoses used to transfer gasoline or distillate fuel to tanks or trucks, or gasoline or distillate fuel discharged from a safety relief valve that are segregated for further processing.

Transmix blender means any person who owns, leases, operates, controls, or supervises a transmix blending facility.

Transmix blending facility means any facility that produces gasoline by blending transmix into PCG under § 1090.500.

Transmix distillate product (TDP) means the diesel fuel blendstock that is produced when transmix is separated into blendstocks at a transmix processing facility.

Transmix gasoline product (TGP) means the gasoline blendstock that is produced when transmix is separated into blendstocks at a transmix processing facility.

Transmix processing facility means any facility that produces TGP or TDP from transmix by distillation or other refining processes, but does not produce gasoline or diesel fuel by processing crude oil or other products.

Transmix processor means any person who owns, leases, operates, controls, or supervises a transmix processing facility in the United States. A transmix processor is a fuel manufacturer.

Ultra-low-sulfur diesel (ULSD) means diesel fuel that is certified to meet the standards in § 1090.305.

United States means the 50 states, the District of Columbia, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, Guam, American Samoa, and the U.S. Virgin Islands.

Volume additive reconciliation (VAR) period means the following:

- (1) For an automated detergent blending facility, the VAR period is a time period lasting no more than 31 days or until an adjustment to a detergent concentration rate that increases the initial rate by more than 10 percent, whichever occurs first. The concentration setting for a detergent injector may be adjusted by more than 10 percent above the initial rate without terminating the VAR period, provided the purpose of the change is to correct a batch misadditization prior to the transfer of the batch to another party, or to correct an equipment malfunction and the concentration is immediately returned to no more than 10 percent above the initial rate of concentration after the correction.
- (2) For a non-automated detergent blending facility, the VAR period constitutes the blending of one batch of gasoline.

Voluntary consensus standards body (VCSB) means an organization that follows consistent protocols to adopt standards reflecting a wide range of input from interested parties. ASTM International and the International Organization for Standardization are examples of VCSB organizations.

Wholesale purchaser-consumer (WPC) means any person who is an ultimate consumer of fuels and who purchases or obtains fuels for use in motor vehicles, nonroad vehicles, nonroad engines, or nonroad equipment, including locomotive or marine engines, and, in the case of liquid fuels, receives delivery of that product into a storage tank of at least 550-gallon capacity substantially under the control of that person.

Winter season means any duration outside of the summer season or high ozone season.

[85 FR 78469, Dec. 4, 2020, as amended at 88 FR 44593, July 12, 2023; 90 FR 4341, Jan. 15, 2025; 91 FR 16498, Apr. 1, 2026]

§ 1090.85 Explanatory terms.

This section explains how certain phrases and terms are used in this part, especially those used to clarify and explain regulatory provisions. They do not, however, constitute specific regulatory requirements and as such do not impose any compliance obligation on regulated parties.

- (a) **Types of provisions.** The term “provision” includes all aspects of the regulations in this part. As specified in this section, regulatory provisions include standards, requirements, and prohibitions, along with a variety of other types of provisions.
 - (1) A standard is a limit on the formulation, components, or characteristics of any fuel, fuel additive, or regulated blendstock, established by regulation under this part. Compliance with or conformance to a standard is a specific type of requirement. Thus, a statement about the requirements of a part or section also applies with respect to the standards in the part or section. Examples of standards include the sulfur per-gallon standards for gasoline and diesel fuel.
 - (2) While requirements state what someone must do, prohibitions state what someone must not do. Failing to meet any requirement that applies to a person under this part is a prohibited act.
 - (3) The regulations in this part include provisions that are not standards, requirements, or prohibitions, such as definitions.
- (b) **Subject to.** A fuel is considered “subject to” a specific provision if that provision applies, even if it falls within an exemption authorized under a different part of this regulation. For example, gasoline is subject to the provisions of this part even if it is exempt from the standards under subpart G of this part.
- (c) **Singular and plural.** Unless stated otherwise or unless it is clear from the regulatory context, provisions written in singular form include the plural form and provisions written in plural form include the singular form.
- (d) **Inclusive lists.** Lists in the regulations in this part prefaced by “including” or “this includes” are not exhaustive. The terms “including” and “this includes” should be read to mean “including but not limited to” and “this includes but is not limited to.”
- (e) **Notes.** Statements that begin with “Note:” or “Note that” are intended to clarify specific regulatory provisions stated elsewhere in the regulations in this part. By themselves, such statements are not intended to specify regulatory requirements.
- (f) **Examples.** Examples provided in the regulations in this part are typically introduced by either “for example” or “such as.” Specific examples given in the regulations do not necessarily represent the most common examples. The regulations may specify examples conditionally (that is, specifying that they are applicable only if certain criteria or conditions are met). Lists of examples are not exhaustive.
- (g) **Generic terms.** Certain terms that are generically defined in this part (e.g., “fuel manufacturing facility” or “importer”) may also be used to refer to a specific fuel, fuel additive, or regulated blendstock type (e.g., “diesel fuel manufacturing facility” or “gasoline importer”).

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4342, Jan. 15, 2025]

§ 1090.90 Acronyms and abbreviations.

500 ppm LM diesel fuel	As defined in § 1090.80.
ABT	averaging, banking, and trading.
ARV	accepted reference value.
BOB	gasoline before oxygenate blending.
CARB	California Air Resources Board.
CFR	Code of Federal Regulations.
CG	conventional gasoline.
DFE	denatured fuel ethanol.
E0	As defined in § 1090.80.
E10	As defined in § 1090.80.
E15	As defined in § 1090.80.
ECA marine fuel	As defined in § 1090.80.
EPA	Environmental Protection Agency.
GTAB	gasoline treated as blendstock.
IMO marine fuel	As defined in § 1090.80.
LAC	lowest additive concentration.
LLOQ	laboratory limit of quantitation.
MARPOL Annex VI	The International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 Annex VI.
NAAQS	National Ambient Air Quality Standard.
NARA	National Archives and Records Administration.
NFSP	national fuels survey program.
NGL	natural gas liquids.
NIST	National Institute for Standards and Technology.
NSTOP	national sampling and testing oversight program.
PCG	previously certified gasoline.
PLOQ	pooled limit of quantitation.
ppm (mg/kg)	parts per million (or milligram per kilogram).
PTD	product transfer document.
R&D	research and development.
RCO	responsible corporate officer.
RFG	reformulated gasoline.
RFS	Renewable Fuel Standard.
RVP	Reid vapor pressure.
SIP	state implementation plan.
SQC	statistical quality control.

T10, T50, T90	temperatures representing the points in a distillation process where 10, 50, and 90 percent of the sample evaporates, respectively.
TDP	transmix distillate product.
TGP	transmix gasoline product.
U.S.	United States.
U.S.C.	United States Code.
ULSD	ultra-low-sulfur diesel fuel.
VAR	volume additive reconciliation.
VCSB	voluntary consensus standards body.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4342, Jan. 15, 2025]

§ 1090.95 Incorporation by reference.

- (a) Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. All approved incorporation by reference (IBR) material is available for inspection at the U.S. EPA and at the National Archives and Records Administration (NARA). Contact the U.S. EPA at: U.S. EPA, Air and Radiation Docket and Information Center, WJC West Building, Room 3334, 1301 Constitution Ave. NW, Washington, DC 20460; (202) 566-1742; a-and-r-Docket@epa.gov. For information on the availability of this material at NARA, visit www.archives.gov/federal-register/cfr/ibr-locations or email fr.inspection@nara.gov. The material may be obtained from the sources in the following paragraphs of this section.
- (b) American Institute of Certified Public Accountants, 220 Leigh Farm Rd., Durham, NC 27707-8110; (919) 402-4500; www.aicpa-cima.org.
- (1) AICPA Code of Professional Conduct, updated through December 2023; IBR approved for § 1090.1800(b).
 - (2) Statements on Quality Control Standards (SQCS) No. 8, QC Section 10: A Firm's System of Quality Control, current as of July 1, 2019; IBR approved for § 1090.1800(b).
 - (3) Statement on Quality Management Standards (SQMS) No. 1, A Firm's System of Quality Management, Issued June 2022; IBR approved for § 1090.1800(b).
 - (4) Statement on Quality Management Standards (SQMS) No. 2, Engagement Quality Reviews, Issued June 2022; IBR approved for § 1090.1800(b).
 - (5) Statement on Quality Management Standards (SQMS) No. 3, *Amendments to QM Sections 10, A Firm's System of Quality Management, and 20, Engagement Quality Reviews*, Issued March 2023; IBR approved for § 1090.1800(b).
 - (6) Statement on Standards for Attestation Engagements (SSAE) No. 19, *Agreed-Upon Procedures Engagement*, Issued December 2019; IBR approved for § 1090.1800(b).
- (c) ASTM International (ASTM), 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428-2959; (877) 909-2786; www.astm.org.

- (1) ASTM D86-23ae2, Standard Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure, approved December 1, 2023 (ASTM D86); IBR approved for § 1090.1350(b).
- (2) ASTM D287-22, Standard Test Method for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer/Method), approved December 1, 2022 (ASTM D287); IBR approved for § 1090.1337(d).
- (3) ASTM D975-24a, Standard Specification for Diesel Fuel, approved August 1, 2024 (ASTM D975); IBR approved for § 1090.80.
- (4) ASTM D976-21e1, Standard Test Method for Calculated Cetane Index of Distillate Fuels, approved November 1, 2021 (ASTM D976); IBR approved for § 1090.1350(b).
- (5) ASTM D1298-24, Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method, approved November 1, 2024 (ASTM D1298); IBR approved for § 1090.1337(d).
- (6) ASTM D1319-20a, Standard Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption, approved August 1, 2020 (ASTM D1319); IBR approved for § 1090.1350(b).
- (7) ASTM D2163-23e1, Standard Test Method for Determination of Hydrocarbons in Liquefied Petroleum (LP) Gases and Propane/Propene Mixtures by Gas Chromatography, approved March 1, 2023 (ASTM D2163); IBR approved for § 1090.1350(b).
- (8) ASTM D2622-24a, Standard Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry, approved December 1, 2024 (ASTM D2622); IBR approved for §§ 1090.1350(b); 1090.1360(d); 1090.1375(c).
- (9) ASTM D3231-25, Standard Test Method for Phosphorus in Gasoline, approved May 1, 2025 (ASTM D3231); IBR approved for § 1090.1350(b).
- (10) ASTM D3237-22, Standard Test Method for Lead in Gasoline by Atomic Absorption Spectroscopy, approved October 1, 2022 (ASTM D3237); IBR approved for § 1090.1350(b).
- (11) ASTM D3606-24a, Standard Test Method for Determination of Benzene and Toluene in Spark Ignition Fuels by Gas Chromatography, approved November 1, 2024 (ASTM D3606); IBR approved for § 1090.1360(c).
- (12) ASTM D4052-22, Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter, approved May 1, 2022 (ASTM D4052); IBR approved for § 1090.1337(d) and (f).
- (13) ASTM D4057-22, Standard Practice for Manual Sampling of Petroleum and Petroleum Products, approved May 1, 2022 (ASTM D4057); IBR approved for §§ 1090.1335(b); 1090.1605(b).
- (14) ASTM D4177-22e1, Standard Practice for Automatic Sampling of Petroleum and Petroleum Products, approved July 1, 2022 (ASTM D4177); IBR approved for §§ 1090.1315(a); 1090.1335(c).
- (15) ASTM D4737-21, Standard Test Method for Calculated Cetane Index by Four Variable Equation, approved November 1, 2021 (ASTM D4737); IBR approved for § 1090.1350(b).
- (16) ASTM D4806-25, Standard Specification for Denatured Fuel Ethanol, approved April 1, 2025 (ASTM D4806); IBR approved for § 1090.1395(a).

- (17) ASTM D4814-25a, Standard Specification for Automotive Spark-Ignition Engine Fuel, approved December 15, 2025 (ASTM D4814); IBR approved for §§ 1090.80; 1090.1395(a).
- (18) ASTM D5134-21 (Reapproved 2025), Standard Test Method for Detailed Analysis of Petroleum Naphthas through n-Nonane by Capillary Gas Chromatography, approved October 1, 2025 (ASTM D5134); IBR approved for § 1090.1350(b).
- (19) ASTM D5186-24, Standard Test Method for Determination of the Aromatic Content and Polynuclear Aromatic Content of Diesel Fuels By Supercritical Fluid Chromatography, approved July 1, 2024 (ASTM D5186); IBR approved for § 1090.1350(b).
- (20) ASTM D5191-22, Standard Test Method for Vapor Pressure of Petroleum Products and Liquid Fuels (Mini Method), approved July 1, 2022 (ASTM D5191); IBR approved for § 1090.1360(d).
- (21) ASTM D5453-25, Standard Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence, approved July 1, 2025 (ASTM D5453); IBR approved for § 1090.1350(b).
- (22) ASTM D5500-20a, Standard Test Method for Vehicle Evaluation of Unleaded Automotive Spark-Ignition Engine Fuel for Intake Deposit Formation, approved June 1, 2020 (ASTM D5500); IBR approved for § 1090.1395(c).
- (23) ASTM D5599-22, Standard Test Method for Determination of Oxygenates in Gasoline by Gas Chromatography and Oxygen Selective Flame Ionization Detection, approved April 1, 2022 (ASTM D5599); IBR approved for § 1090.1360(d).
- (24) ASTM D5769-25, Standard Test Method for Determination of Benzene, Toluene, and Total Aromatics in Finished Gasolines by Gas Chromatography/Mass Spectrometry, approved October 1, 2025 (ASTM D5769); IBR approved for §§ 1090.1350(b); 1090.1360(d).
- (25) ASTM D5842-23, Standard Practice for Sampling and Handling of Fuels for Volatility Measurement, approved October 1, 2023 (ASTM D5842); IBR approved for § 1090.1335(d).
- (26) ASTM D5854-25, Standard Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products, approved July 1, 2025 (ASTM D5854); IBR approved for § 1090.1315(a).
- (27) ASTM D6201-19a, Standard Test Method for Dynamometer Evaluation of Unleaded Spark-Ignition Engine Fuel for Intake Valve Deposit Formation, approved December 1, 2019 (ASTM D6201); IBR approved for § 1090.1395(a).
- (28) ASTM D6259-23, Standard Practice for Determination of a Pooled Limit of Quantitation for a Test Method, approved May 1, 2023 (ASTM D6259); IBR approved for § 1090.1355(b).
- (29) ASTM D6299-25a, Standard Practice for Applying Statistical Quality Assurance and Control Charting Techniques to Evaluate Analytical Measurement System Performance, approved July 1, 2025 (ASTM D6299); IBR approved for §§ 1090.1300(d); 1090.1370(c); 1090.1375(a), (b), (c), and (d); 1090.1450(c).
- (30) ASTM D6550-25, Standard Test Method for Determination of Olefin Content of Gasolines by Supercritical-Fluid Chromatography, approved October 1, 2025 (ASTM D6550); IBR approved for § 1090.1350(b).

- (31) ASTM D6667-21, Standard Test Method for Determination of Total Volatile Sulfur in Gaseous Hydrocarbons and Liquefied Petroleum Gases by Ultraviolet Fluorescence, approved April 1, 2021 (ASTM D6667); IBR approved for §§ 1090.1360(d); 1090.1375(c).
- (32) ASTM D6708-24, Standard Practice for Statistical Assessment and Improvement of Expected Agreement Between Two Test Methods that Purport to Measure the Same Property of a Material, approved March 1, 2024 (ASTM D6708); IBR approved for §§ 1090.1360(c); 1090.1365(d) and (f); 1090.1375(c).
- (33) ASTM D6729-25, Standard Test Method for Determination of Individual Components in Spark Ignition Engine Fuels by 100 Metre Capillary High Resolution Gas Chromatography, approved October 1, 2025 (ASTM D6729); IBR approved for § 1090.1350(b).
- (34) ASTM D6730-22, Standard Test Method for Determination of Individual Components in Spark Ignition Engine Fuels by 100-Metre Capillary (with Precolumn) High-Resolution Gas Chromatography, approved November 1, 2022 (ASTM D6730); IBR approved for § 1090.1350(b).
- (35) ASTM D6751-24, Standard Specification for Biodiesel Fuel Blendstock (B100) for Middle Distillate Fuels, approved March 1, 2024 (ASTM D6751); IBR approved for §§ 1090.300(a); 1090.1350(b).
- (36) ASTM D6792-25, Standard Practice for Quality Management Systems in Petroleum Products, Liquid Fuels, and Lubricants Testing Laboratories, approved November 1, 2025 (ASTM D6792); IBR approved for § 1090.1450(c).
- (37) ASTM D7717-11 (Reapproved 2021), Standard Practice for Preparing Volumetric Blends of Denatured Fuel Ethanol and Gasoline Blendstocks for Laboratory Analysis, approved October 1, 2021 (ASTM D7717); IBR approved for § 1090.1340(b).
- (38) ASTM D7777-24, Standard Test Method for Density, Relative Density, or API Gravity of Liquid Petroleum by Portable Digital Density Meter, approved July 1, 2024 (ASTM D7777); IBR approved for § 1090.1337(d).
- (d) Environmental Protection Agency, Air and Radiation Docket and Information Center, WJC West Building, Room 3334, 1301 Constitution Ave. NW, Washington, DC 20460, (202) 566-1742.
 - (1) CARB Test Method, 13 CA ADC § 2257; California Code of Regulations Title 13. Motor Vehicles, Division 3. Air Resources Board, Chapter 5. Standards for Motor Vehicle Fuels, Article 1. Standards for Gasoline, Subarticle 1. Gasoline Standards that Became Applicable Before 1996, § 2257. Required Additives in Gasoline; amendment filed May 17, 1999; IBR approved for § 1090.1395(b).
 - (2) [Reserved]
- (e) The Institute of Internal Auditors, 1035 Greenwood Blvd., Suite 401, Lake Mary, FL 32746, (407) 937-1111, or www.theiia.org.
 - (1) International Standards for the Professional Practice of Internal Auditing (Standards), Revised October 2016; IBR approved for § 1090.1800(b).
 - (2) [Reserved]
- (f) National Institute of Standards and Technology, 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, (301) 975-6478, or www.nist.gov.

- (1) NIST Handbook 158, Field Sampling Procedures for Fuel and Motor Oil Quality Testing—A Handbook for Use by Fuel and Oil Quality Regulatory Officials, 2016 Edition, April 2016; IBR approved for § 1090.1410(b).
- (2) [Reserved]

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4343, Jan. 15, 2025; 91 FR 16498, Apr. 1, 2026]

Subpart B—General Requirements and Provisions for Regulated Parties

§ 1090.100 General provisions.

This subpart provides an overview of the general requirements and provisions applicable to any regulated party under this part. A person who meets the definition of more than one type of regulated party must comply with the requirements applicable to each of those types of regulated parties. For example, a fuel manufacturer that also transports fuel must meet the requirements applicable to a fuel manufacturer and a distributor. A regulated party is required to comply with all applicable requirements of this part, regardless of whether they are identified in this subpart. Any person who produces, sells, transfers, supplies, dispenses, or distributes fuel, fuel additive, or regulated blendstock must comply with all applicable requirements.

- (a) **Recordkeeping.** Any party that engages in activities that are regulated under this part must comply with recordkeeping requirements under subpart M of this part.
- (b) **Compliance and enforcement.** Any party that engages in activities that are regulated under this part is subject to compliance and enforcement provisions under subpart R of this part.
- (c) **Hardships and exemptions.** Some regulated parties under this part may be eligible, or eligible to petition, for a hardship or exemption under subpart G of this part.
- (d) **Importers.** In addition to the requirements of paragraphs (a) through (c) of this section and §§ 1090.105 and 1090.155, an importer must also comply with subpart Q of this part.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4344, Jan. 15, 2025]

§ 1090.105 Fuel manufacturers.

This section provides an overview of general requirements applicable to a fuel manufacturer. A gasoline manufacturer must comply with the requirements of paragraph (a) of this section. A diesel fuel or IMO marine fuel manufacturer must comply with the requirements of paragraph (b) of this section.

- (a) **Gasoline manufacturers.** Except as specified otherwise in this subpart, a gasoline manufacturer must comply with the following requirements:
 - (1) **Producing compliant gasoline.** A gasoline manufacturer must produce or import gasoline that meets the standards in subpart C of this part and must comply with the ABT requirements of subpart H of this part.
 - (2) **Registration.** A gasoline manufacturer must register with EPA under subpart I of this part.
 - (3) **Reporting.** A gasoline manufacturer must submit reports to EPA under subpart J of this part.

- (4) **Certification and designation.** A gasoline manufacturer must certify and designate the gasoline they produce under subpart K of this part.
 - (5) **PTDs.** On each occasion when a gasoline manufacturer transfers custody of or title to any gasoline, the transferor must provide to the transferee PTDs under subpart L of this part.
 - (6) **Sampling, testing, and sample retention.** A gasoline manufacturer must conduct sampling, testing, and sample retention in accordance with subpart N of this part.
 - (7) **Surveys.** A gasoline manufacturer may participate in applicable fuel surveys under subpart O of this part.
 - (8) **Annual attestation engagement.** A gasoline manufacturer must submit annual attestation engagement reports to EPA under subpart S of this part.
- (b) **Diesel fuel and IMO marine fuel manufacturers.** A diesel fuel or IMO marine fuel manufacturer must comply with the following requirements, as applicable:
- (1) **Producing compliant diesel fuel and ECA marine fuel.** A diesel fuel or ECA marine fuel manufacturer must produce or import diesel fuel or ECA marine fuel that meets the requirements of subpart D of this part.
 - (2) **Registration.** A diesel fuel or ECA marine fuel manufacturer must register with EPA under subpart I of this part.
 - (3) **Reporting.** A diesel fuel manufacturer must submit reports to EPA under subpart J of this part.
 - (4) **Certification and designation.**
 - (i) A diesel fuel or ECA marine fuel manufacturer must certify and designate the diesel fuel or ECA marine fuel they produce under subpart K of this part.
 - (ii) A distillate global marine fuel manufacturer must designate the distillate global marine fuel they produce under subpart K of this part.
 - (5) **PTDs.** On each occasion when a diesel fuel or IMO marine fuel manufacturer transfers custody or title to any diesel fuel or IMO marine fuel, the transferor must provide to the transferee PTDs under subpart L of this part.
 - (6) **Sampling, testing, and retention requirements.** A diesel fuel or ECA marine fuel manufacturer must conduct sampling, testing, and sample retention in accordance with subpart N of this part.
 - (7) **Surveys.** A diesel fuel manufacturer may participate in applicable fuel surveys under subpart O of this part.
 - (8) **Distillate global marine fuel manufacturers.** A distillate global marine fuel manufacturer does not need to comply with the requirements of paragraphs (b)(1), (2), (3), and (6) of this section for distillate global marine fuel that is exempt from the standards in subpart D of this part, as specified in § 1090.650.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4344, Jan. 15, 2025]

§ 1090.110 Detergent blenders.

A detergent blender must comply with the requirements of this section.

- (a) **Gasoline standards.** A detergent blender must comply with the applicable requirements of subpart C of this part.
- (b) **PTDs.** On each occasion when a detergent blender transfers custody of or title to any fuel, fuel additive, or regulated blendstock, the transferor must provide to the transferee PTDs under subpart L of this part. P>
- (c) **Equipment calibration.** A detergent blender at an automated detergent blending facility must calibrate their detergent blending equipment in accordance with subpart N of this part.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4344, Jan. 15, 2025]

§ 1090.115 Oxygenate blenders.

An oxygenate blender must comply with the requirements of this section.

- (a) **Gasoline standards.** An oxygenate blender must comply with the applicable requirements of subpart C of this part.
- (b) **Registration.** An oxygenate blender must register with EPA under subpart I of this part.
- (c) **PTDs.** On each occasion when an oxygenate blender transfers custody or title to any fuel, fuel additive, or regulated blendstock, the transferor must provide to the transferee PTDs under subpart L of this part.
- (d) **Oxygenate blending requirements.** An oxygenate blender must follow the blending instructions specified by the gasoline manufacturer under § 1090.710(a)(5) unless the oxygenate blender recertifies BOBs under § 1090.740.

§ 1090.120 Oxygenate producers.

This section provides an overview of general requirements applicable to an oxygenate producer (e.g., a DFE or isobutanol producer). A DFE producer must comply with the requirements for an oxygenate producer in paragraph (a) of this section and the additional requirements specified in paragraph (b) of this section.

- (a) **Oxygenate producers.** An oxygenate producer must comply with the following requirements:
 - (1) **Gasoline standards.** An oxygenate producer must comply with the applicable requirements of subpart C of this part.
 - (2) **Registration.** An oxygenate producer must register with EPA under subpart I of this part.
 - (3) **Reporting.** An oxygenate producer must submit reports to EPA under subpart J of this part.
 - (4) **Certification and designation.** An oxygenate producer must certify and designate the oxygenate they produce under subpart K of this part.
 - (5) **PTDs.** On each occasion when an oxygenate producer transfers custody or title to any fuel, fuel additive, or regulated blendstock, the transferor must provide to the transferee PTDs under subpart L of this part.
 - (6) **Sampling, testing, and retention requirements.** An oxygenate producer must conduct sampling, testing, and sample retention in accordance with subpart N of this part.
- (b) **DFE producers.** In addition to the requirements specified in paragraph (a) of this section, a DFE producer must meet all the following requirements:

- (1) Use denaturant that complies with the requirements specified in §§ 1090.270(b) and 1090.275.
- (2) Participate in a survey program conducted by an independent surveyor under subpart O of this part if the DFE producer produces DFE made available for use in the production of E15.

§ 1090.125 Certified butane producers.

A certified butane producer must comply with the requirements of this section.

- (a) **Gasoline standards.** A certified butane producer must comply with the applicable requirements of subpart C of this part.
- (b) **Certification and designation.** A certified butane producer must certify and designate the certified butane they produce under subpart K of this part.
- (c) **PTDs.** On each occasion when a certified butane producer transfers custody of or title to any certified butane, the transferor must provide to the transferee PTDs under subpart L of this part.
- (d) **Sampling, testing, and retention requirements.** A certified butane producer must conduct sampling, testing, and sample retention in accordance with subpart N of this part.

§ 1090.130 Certified butane blenders.

A certified butane blender that blends certified butane into PCG is a gasoline manufacturer that may comply with the requirements of this section in lieu of the requirements in § 1090.105.

- (a) **Gasoline standards.** A certified butane blender must comply with the applicable requirements of subpart C of this part.
- (b) **Registration.** A certified butane blender must register with EPA under subpart I of this part.
- (c) **Reporting.** A certified butane blender must submit reports to EPA under subpart J of this part.
- (d) **PTDs.** On each occasion when a certified butane blender transfers custody of or title to any gasoline blended with certified butane, the transferor must provide to the transferee PTDs under subpart L of this part.
- (e) **Sampling and testing requirements.** A certified butane blender must comply with the alternative sampling and testing approach in § 1090.1320(b).
- (f) **Survey.** A certified butane blender may participate in the applicable fuel surveys under subpart O of this part.
- (g) **Annual attestation engagement.** A certified butane blender must submit annual attestation engagement reports to EPA under subpart S of this part.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4344, Jan. 15, 2025]

§ 1090.135 Certified pentane producers.

A certified pentane producer must comply with the requirements of this section.

- (a) **Gasoline standards.** A certified pentane producer must comply with the applicable requirements of subpart C of this part.

- (b) **Registration.** A certified pentane producer must register with EPA under subpart I of this part.
- (c) **Reporting.** A certified pentane producer must submit reports to EPA under subpart J of this part.
- (d) **Certification and designation.** A certified pentane producer must certify and designate the certified pentane they produce under subpart K of this part.
- (e) **PTDs.** On each occasion when a certified pentane producer transfers custody of or title to any certified pentane, the transferor must provide to the transferee PTDs under subpart L of this part.
- (f) **Sampling, testing, and retention requirements.** A certified pentane producer must conduct sampling, testing, and sample retention in accordance with subpart N of this part.

§ 1090.140 Certified pentane blenders.

A certified pentane blender that blends certified pentane into PCG is a gasoline manufacturer that may comply with the requirements of this section in lieu of the requirements in § 1090.105.

- (a) **Gasoline standards.** A certified pentane blender must comply with the applicable requirements of subpart C of this part.
- (b) **Registration.** A certified pentane blender must register with EPA under subpart I of this part.
- (c) **Reporting.** A certified pentane blender must submit reports to EPA under subpart J of this part.
- (d) **PTDs.** On each occasion when a certified pentane blender transfers custody of or title to any gasoline blended with certified pentane, the transferor must provide to the transferee PTDs under subpart L of this part.
- (e) **Sampling, testing, and retention requirements.** A certified pentane blender must comply with the alternative sampling and testing approach in § 1090.1320(b).
- (f) **Survey.** A certified pentane blender may participate in the applicable fuel surveys under subpart O of this part.
- (g) **Annual attestation engagement.** A certified pentane blender must submit annual attestation engagement reports to EPA under subpart S of this part.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4344, Jan. 15, 2025]

§ 1090.145 Transmix processors.

A transmix processor must comply with the requirements of this section.

- (a) **Transmix requirements.** A transmix processor must comply with the transmix requirements of subpart F of this part.
- (b) **Registration.** A transmix processor must register with EPA under subpart I of this part.
- (c) **Certification and designation.** A transmix processor must certify and designate the fuel they produce under subpart K of this part.
- (d) **PTDs.** On each occasion when a transmix processor produces a batch of fuel or transfers custody of or title to any fuel, fuel additive, or regulated blendstock, the transferor must provide to the transferee PTDs under subpart L of this part.

- (e) **Sampling, testing, and retention requirements.** A transmix processor must conduct sampling, testing, and sample retention in accordance with subparts F and N of this part.
- (f) **Reporting.** A transmix processor must submit reports to EPA under subpart J of this part.
- (g) **Annual attestation engagement.** A transmix processor must submit annual attestation engagement reports to EPA under subpart S of this part.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4344, Jan. 15, 2025]

§ 1090.150 Transmix blenders.

A transmix blender must comply with the requirements of this section.

- (a) **Transmix requirements.** A transmix blender must comply with the transmix requirements of subpart F of this part.
- (b) **PTDs.** On each occasion when a transmix blender produces a batch of fuel or transfers custody or title to any fuel, fuel additive, or regulated blendstock, the transferor must provide to the transferee PTDs under subpart L of this part.
- (c) **Sampling, testing, and retention requirements.** A transmix blender must conduct sampling, testing, and sample retention in accordance with subparts F and N of this part.

§ 1090.155 Fuel additive manufacturers.

This section provides an overview of general requirements applicable to a fuel additive manufacturer. A gasoline additive manufacturer must comply with the requirements of paragraph (a) of this section. A diesel fuel additive manufacturer must comply with the requirements of paragraph (b) of this section. A certified ethanol denaturant producer must comply with the requirements of paragraph (c) of this section.

- (a) **Gasoline additive manufacturers.** A gasoline additive manufacturer must meet the following requirements:
 - (1) **Gasoline additive standards.** A gasoline additive manufacturer must comply with the applicable requirements of subpart C of this part.
 - (2) **Certification.** A gasoline additive manufacturer must certify the gasoline additives they produce under subpart K of this part.
 - (3) **PTDs.** On each occasion when a gasoline additive manufacturer transfers custody of or title to any gasoline additive, the transferor must provide to the transferee PTDs under subpart L of this part.
 - (4) **Gasoline detergent manufacturers.** A gasoline detergent manufacturer must comply with the following requirements:
 - (i) **Part 79 registration and LAC determination.** A gasoline detergent manufacturer must register gasoline detergent(s) under 40 CFR 79.21 at a concentration that is greater than or equal to the LAC reported by the gasoline detergent manufacturer under 40 CFR 79.21(j). Note: EPA provides a list on EPA's website of detergents that have been certified by the gasoline detergent manufacturer as meeting the deposit control requirement (Search for "List of Certified Detergent Additives").

- (ii) **Gasoline detergent standards.** Report the LAC determined under § 1090.260(b) and provide specific composition information as part of the gasoline detergent manufacturer's registration of the detergent under 40 CFR 79.21(j).
 - (iii) **PTDs.** On each occasion when a gasoline detergent manufacturer transfers custody of or title to any gasoline detergent, the transferor must provide to the transferee PTDs under subpart L of this part.
 - (iv) **Sampling, testing, and retention requirements.** A gasoline detergent manufacturer that registers detergents must conduct sampling, testing, and sample retention in accordance with subpart N of this part.
- (b) **Diesel fuel additive manufacturers.** A diesel fuel additive manufacturer must meet the following requirements:
- (1) **Diesel fuel additive standards.** A diesel fuel additive manufacturer must comply with the applicable requirements of subpart D of this part.
 - (2) **Certification.** A diesel fuel additive manufacturer must certify the diesel fuel additives they produce under subpart K of this part.
 - (3) **PTDs.** On each occasion when a diesel fuel additive manufacturer transfers custody of or title to any diesel fuel additive, the transferor must provide to the transferee PTDs under subpart L of this part.
- (c) **Certified ethanol denaturant producers and importers.** A certified ethanol denaturant producer or importer must meet the following requirements:
- (1) **Certification.** A certified ethanol denaturant producer or importer must certify that certified ethanol denaturant meets the requirements in § 1090.275 using the procedures specified at § 1090.1000(g).
 - (2) **Registration.** A certified ethanol denaturant producer or importer must register with EPA under subpart I of this part.
 - (3) **PTDs.** On each occasion when a certified ethanol denaturant producer transfers custody or title to any fuel, fuel additive, or regulated blendstock, the transferor must provide to the transferee PTDs under subpart L of this part.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4344, Jan. 15, 2025]

§ 1090.160 Distributors, carriers, and resellers.

A distributor, carrier, or reseller must comply with the requirements of this section.

- (a) **Gasoline and diesel fuel standards.** A distributor, carrier, or reseller must comply with the applicable requirements of subparts C and D of this part.
- (b) **Registration.** A distributor or carrier must register with EPA under subpart I of this part if they are part of the 500 ppm LM diesel fuel distribution chain in a compliance plan submitted under § 1090.515(g).
- (c) **PTDs.** On each occasion when a distributor, carrier, or reseller transfers custody or title to any fuel, fuel additive, or regulated blendstock, the transferor must provide to the transferee PTDs under subpart L of this part.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4344, Jan. 15, 2025]

§ 1090.165 Retailers and WPCs.

A retailer or WPC must comply with the requirements of this section.

- (a) **Gasoline and diesel fuel standards.** A retailer or WPC must comply with the applicable requirements of subparts C and D of this part.
- (b) **Labeling.** A retailer or WPC that dispenses fuels requiring a label under this part must display fuel labels under subpart P of this part.
- (c) **Fuels produced through fuel dispensers.** A retailer or WPC that produces gasoline (e.g., E15) through a fuel dispenser with anything other than PCG and DFE is also a blending manufacturer and must comply with the applicable requirements in § 1090.105.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4344, Jan. 15, 2025]

§ 1090.170 Independent surveyors.

An independent surveyor that conducts fuel surveys must comply with the requirements of this section.

- (a) **Survey provisions.** An independent surveyor must conduct fuel surveys under subpart O of this part.
- (b) **Registration.** An independent surveyor must register with EPA under subpart I of this part.
- (c) **Reporting.** An independent surveyor must submit reports to EPA under subpart J of this part.
- (d) **Sampling, testing, and retention requirements.** An independent surveyor must conduct sampling, testing, and sample retention in accordance with subpart N of this part.
- (e) **Independence requirements.** In order to perform a survey program under subpart O of this part, an independent surveyor must meet the independence requirements in § 1090.55.

§ 1090.175 Auditors.

An auditor that conducts an audit for a responsible party under this part must comply with the requirements of this section.

- (a) **Registration.** An auditor must register with EPA under subpart I of this part.
- (b) **Reporting.** An auditor must submit reports to EPA under subpart J of this part.
- (c) **Attestation engagements.** An auditor must conduct audits under subpart S of this part.
- (d) **Independence requirements.** In order to perform an annual attestation engagement under subpart S of this part, an auditor must meet the independence requirements in § 1090.55 unless they are a certified internal auditor under § 1090.1800(b)(1)(i).

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4345, Jan. 15, 2025]

§ 1090.180 Pipeline operators.

A pipeline operator must comply with the requirements of this section.

- (a) **Gasoline and diesel fuel standards.** A pipeline operator must comply with the applicable requirements of subparts C and D of this part.
- (b) **PTDs.** On each occasion when a pipeline operator transfers custody or title to any fuel, fuel additive, or regulated blendstock, the transferor must provide to the transferee PTDs under subpart L of this part.
- (c) **Transmix requirements.** A pipeline operator must comply with all applicable requirements of subpart F of this part.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4345, Jan. 15, 2025]

Subpart C—Gasoline Standards

§ 1090.200 Overview and general requirements.

- (a) Except as specified in subpart G of this part, gasoline, gasoline additives, and gasoline regulated blendstocks are subject to the standards in this subpart.
- (b) Except for the sulfur average standard in § 1090.205(a) and the benzene average standards in § 1090.210(a) and (b), the standards in this part apply to gasoline, gasoline additives, and gasoline regulated blendstocks on a per-gallon basis. A gasoline manufacturer, gasoline additive manufacturer (e.g., an oxygenate or certified ethanol denaturant producer), or gasoline regulated blendstock producer (e.g., a certified butane or certified pentane producer) must demonstrate compliance with the per-gallon standards in this subpart by measuring fuel parameters in accordance with subpart N of this part.
- (c)
 - (1) Except as specified in paragraph (c)(2) of this section, the sulfur average standard in § 1090.205(a) and the benzene average standards in § 1090.210(a) and (b) apply to all gasoline produced or imported by a fuel manufacturer during a compliance period. A fuel manufacturer must demonstrate compliance with average standards by measuring fuel parameters in accordance with subpart N of this part and by determining compliance under subpart H of this part.
 - (2) The sulfur average standard in § 1090.205(a) and the benzene average standards in § 1090.210(a) and (b) do not apply to gasoline produced by the following:
 - (i) Importers that import gasoline by rail or truck using the provisions of § 1090.1610 to meet the alternative per-gallon standards of §§ 1090.205(d) and 1090.210(c).
 - (ii) Certified butane blenders.
 - (iii) Certified pentane blenders.
 - (iv) Transmix blenders.
 - (v) Transmix processors that produce gasoline from only TGP or both TGP and PCG.
- (d) No person may produce, import, sell, offer for sale, distribute, offer to distribute, supply, offer for supply, dispense, store, transport, or introduce into commerce any gasoline, gasoline additive, or gasoline regulated blendstock that does not comply with any per-gallon standard set forth in this subpart.
- (e) No person may sell, offer for sale, supply, offer for supply, dispense, transport, or introduce into commerce for use as fuel in any motor vehicle (as defined in Section 216(2) of the Clean Air Act, 42 U.S.C. 7550(2)) any gasoline that is produced with the use of additives containing lead, that contains more than 0.05 gram of lead per gallon, or that contains more than 0.005 grams of phosphorous per gallon.

- (f) No fuel or fuel additive manufacturer may introduce into commerce gasoline or gasoline additives (including oxygenates) that are not “substantially similar” under 42 U.S.C. 7545(f)(1) or permitted under a waiver granted under 42 U.S.C. 7545(f)(4).

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4345, Jan. 15, 2025]

§ 1090.205 Sulfur standards.

Except as specified in subpart G of this part, all gasoline is subject to the following sulfur standards:

- (a) **Sulfur average standard.** A gasoline manufacturer must meet a sulfur average standard of 10.00 ppm for each compliance period.
- (b) **Fuel manufacturing facility gate sulfur per-gallon standard.** Gasoline at any fuel manufacturing facility gate is subject to a maximum sulfur per-gallon standard of 80 ppm. A gasoline manufacturer must not account for the downstream addition of oxygenates in determining compliance with this standard.
- (c) **Downstream location sulfur per-gallon standard.** Gasoline at any downstream location is subject to a maximum sulfur per-gallon standard of 95 ppm.
- (d) **Sulfur standard for importers that import gasoline by rail or truck.**
 - (1) An importer that imports gasoline by rail or truck under § 1090.1610 must comply with a maximum sulfur per-gallon standard of 10 ppm instead of the standards in paragraphs (a) through (c) of this section.
 - (2) An importer that imports gasoline by rail or truck but does not comply with the alternative sampling and testing requirements in § 1090.1610 must conduct sampling, testing, and sample retention in accordance with subpart N of this part and comply with the sulfur standards in paragraphs (a) and (b) of this section.

§ 1090.210 Benzene standards.

Except as specified in subpart G of this part, all gasoline is subject to the following benzene standards:

- (a) **Benzene average standard.** A gasoline manufacturer must meet a benzene average standard of 0.62 volume percent for each compliance period.
- (b) **Maximum benzene average standard.** A gasoline manufacturer must meet a maximum benzene average standard of 1.30 volume percent without the use of credits for each compliance period.
- (c) **Benzene standard for importers that import gasoline by rail or truck.**
 - (1) An importer that imports gasoline by rail or truck under § 1090.1610 must comply with a benzene per-gallon standard of 0.62 volume percent instead of the standards specified in paragraphs (a) and (b) of this section.
 - (2) An importer that imports gasoline by rail or truck that does not comply with the alternative sampling and testing requirements in § 1090.1610 must conduct sampling, testing, and sample retention in accordance with subpart N of this part and comply with the benzene standards in paragraphs (a) and (b) of this section.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4345, Jan. 15, 2025]

§ 1090.215 Gasoline RVP standards.

Except as specified in subpart G of this part and paragraph (d) of this section, all gasoline designated as summer gasoline or located at any location in the United States during the summer season is subject to a maximum RVP per-gallon standard in this section.

(a)

- (1) **Federal 9.0 psi maximum RVP per-gallon standard.** Gasoline designated as summer gasoline or located at any location in the United States during the summer season must meet a maximum RVP per-gallon standard of 9.0 psi unless the gasoline is subject to one of the lower maximum RVP per-gallon standards specified in paragraphs (a)(2) through (5) of this section.
- (2) **Federal 7.8 maximum RVP per-gallon standard.**
 - (i) Except as specified in paragraph (a)(2)(ii) of this section, gasoline designated as 7.8 psi summer gasoline, or located in the following areas during the summer season, must meet a maximum RVP per-gallon standard of 7.8 psi:

TABLE 1 TO PARAGRAPH (a)(2)(i)—FEDERAL 7.8 psi RVP AREAS

Area designation	State	Counties
Denver-Boulder-Greeley-Ft. Collins-Loveland	Colorado	Adams Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson, Larimer, ¹ Weld. ²
Reno	Nevada	Washoe.
Portland	Oregon	Clackamas (only the Air Quality Maintenance Area), Multnomah (only the Air Quality Maintenance Area), Washington (only the Air Quality Maintenance Area).
Salem	Oregon	Marion (only the Salem Area Transportation Study), Polk (only the Salem Area Transportation Study).
Beaumont-Port	Texas	Hardin, Jefferson, Orange.

¹ That portion of Larimer County, CO that lies south of a line described as follows: Beginning at a point on Larimer County's eastern boundary and Weld County's western boundary intersected by 40 degrees, 42 minutes, and 47.1 seconds north latitude, proceed west to a point defined by the intersection of 40 degrees, 42 minutes, 47.1 seconds north latitude and 105 degrees, 29 minutes, and 40.0 seconds west longitude, thence proceed south on 105 degrees, 29 minutes, 40.0 seconds west longitude to the intersection with 40 degrees, 33 minutes and 17.4 seconds north latitude, thence proceed west on 40 degrees, 33 minutes, 17.4 seconds north latitude until this line intersects Larimer County's western boundary and Grand County's eastern boundary. (Includes part of Rocky Mtn. Nat. Park.)

² That portion of Weld County, CO that lies south of a line described as follows: Beginning at a point on Weld County's eastern boundary and Logan County's western boundary intersected by 40 degrees, 42 minutes, 47.1 seconds north latitude, proceed west on 40 degrees, 42 minutes, 47.1 seconds north latitude until this line intersects Weld County's western boundary and Larimer County's eastern boundary.

Area designation	State	Counties
Arthur Salt Lake City	Utah	Davis, Salt Lake.

¹ That portion of Larimer County, CO that lies south of a line described as follows: Beginning at a point on Larimer County's eastern boundary and Weld County's western boundary intersected by 40 degrees, 42 minutes, and 47.1 seconds north latitude, proceed west to a point defined by the intersection of 40 degrees, 42 minutes, 47.1 seconds north latitude and 105 degrees, 29 minutes, and 40.0 seconds west longitude, thence proceed south on 105 degrees, 29 minutes, 40.0 seconds west longitude to the intersection with 40 degrees, 33 minutes and 17.4 seconds north latitude, thence proceed west on 40 degrees, 33 minutes, 17.4 seconds north latitude until this line intersects Larimer County's western boundary and Grand County's eastern boundary. (Includes part of Rocky Mtn. Nat. Park.)

² That portion of Weld County, CO that lies south of a line described as follows: Beginning at a point on Weld County's eastern boundary and Logan County's western boundary intersected by 40 degrees, 42 minutes, 47.1 seconds north latitude, proceed west on 40 degrees, 42 minutes, 47.1 seconds north latitude until this line intersects Weld County's western boundary and Larimer County's eastern boundary.

(ii) Gasoline designated as 9.0 psi summer gasoline may be located in the areas specified in table 1 to paragraph (a)(2)(i) of this section between May 1 and May 31.

- (3) **RFG maximum RVP per-gallon standard.** Gasoline designated as Summer RFG or located in an RFG covered area during the summer season must meet a maximum RVP per-gallon standard of 7.4 psi.
- (4) **California gasoline.** Gasoline designated as California gasoline or used in areas subject to the California reformulated gasoline regulations must comply with those regulations under Title 13, California Code of Regulations, sections 2250-2273.5.
- (5) **SIP-controlled gasoline.** Gasoline designated as SIP-controlled gasoline or used in areas subject to a SIP-approved state fuel rule that requires an RVP of less than 9.0 psi must meet the requirements of the federally approved SIP.

(b) **Ethanol 1.0 psi waiver.**

- (1) Except as specified in paragraph (b)(3) of this section, any gasoline subject to a federal 9.0 psi or 7.8 psi RVP standard in paragraph (a)(1) or (2) of this section that meets the requirements of paragraph (b)(2) of this section is not in violation of this section if its RVP does not exceed the applicable standard by more than 1.0 psi.
- (2) To qualify for the special regulatory treatment specified in paragraph (b)(1) of this section, gasoline must meet the applicable RVP standard in paragraph (a)(1) or (2) of this section prior to the addition of ethanol and must contain ethanol at a concentration of at least 9 volume percent and no more than 10 volume percent.
- (3)
 - (i) RFG and SIP-controlled gasoline that does not allow for the ethanol 1.0 psi waiver does not qualify for the special regulatory treatment specified in paragraph (b)(1) of this section.

- (ii) Gasoline subject to the 9.0 psi RVP standard in paragraph (a)(1) of this section in the following areas is excluded from the special regulatory treatment specified in paragraph (b)(1) of this section:

**TABLE 2 TO PARAGRAPH (b)(3)(ii)—AREAS EXCLUDED FROM THE ETHANOL 1.0 PSI
WAIVER**

State	Counties	Effective date
Illinois	All	April 28, 2025.
Iowa	All	April 28, 2025.
Minnesota	All	April 28, 2025.
Missouri	All	April 28, 2025.
Nebraska	All	April 28, 2025.
South Dakota	All except Butte, Custer, Fall River, Harding, Lawrence, Meade, Oglala Lakota, Pennington, and Perkins	April 28, 2025.
South Dakota	Butte, Custer, Fall River, Harding, Lawrence, Meade, Oglala Lakota, Pennington, and Perkins	April 28, 2026.
Wisconsin	All	April 28, 2025.

- (c) **Gasoline subject to more than one RVP standard.** Gasoline located in an area of the United States subject to more than one RVP standard specified in paragraphs (a)(1) through (5) of this section must meet the most stringent standard.
- (d) **Exceptions.** The RVP standard in paragraph (a) of this section for the area in which the gasoline is located does not apply to that gasoline if the person(s) who produced, imported, sold, offered for sale, distributed, offered to distribute, supplied, offered for supply, dispensed, stored, transported, or introduced the gasoline into commerce can demonstrate one of the following:
- (1) The gasoline is designated as winter gasoline and was not sold, offered for sale, supplied, offered for supply, dispensed, or introduced into commerce for use during the summer season and was not delivered to any retail outlet or WPC during the summer season.
 - (2) The gasoline is designated as summer gasoline for use in an area other than the area in which it is located and was not sold, offered for sale, supplied, offered for supply, dispensed, or introduced into commerce in the area in which the gasoline is located. In this case, the standard that applies to the gasoline is the standard applicable to the area for which the gasoline is designated.

[85 FR 78469, Dec. 4, 2020, as amended at 89 FR 14774, Feb. 29, 2024; 90 FR 13097, Mar. 20, 2025; 90 FR 4345, Jan. 15, 2025; 91 FR 16499, Apr. 1, 2026]

§ 1090.220 RFG standards.

The standards in this section apply to gasoline that is designated as RFG or RBOB or that is used in an RFG covered area. Gasoline that meets the requirements of this section is deemed to be in compliance with the requirements of 42 U.S.C. 7545(k).

- (a) **Sulfur standards.** RFG or RBOB must comply with the sulfur average standard in § 1090.205(a) and the sulfur per-gallon standards in § 1090.205(b) and (c).
- (b) **Benzene standards.** RFG or RBOB must comply with the benzene average standards in § 1090.210(a) and (b).
- (c) **RVP standard.** Summer RFG or Summer RBOB must comply with the RFG RVP standard in § 1090.215(a)(3).
- (d) **Heavy metals standard.** RFG or RBOB must not contain any heavy metals, including but not limited to lead or manganese. EPA may waive this prohibition for a heavy metal (other than lead) if EPA determines that addition of the heavy metal to the gasoline will not increase, on an aggregate mass or cancer-risk basis, toxic air pollutant emissions from motor vehicles.
- (e) **Certified butane and certified pentane blending limitation.** Certified butane and certified pentane must not be blended with Summer RFG or Summer RBOB under § 1090.1320(b).

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4346, Jan. 15, 2025]

§ 1090.225 Anti-dumping standards.

Gasoline that meets all applicable standards in this subpart is deemed to be in compliance with the anti-dumping requirements of 42 U.S.C. 7545(k)(8).

§ 1090.230 Limitation on use of gasoline-ethanol blends.

- (a) No person may sell, introduce, cause, or permit the sale or introduction of gasoline containing greater than 10 volume percent ethanol (e.g., E15) into any model year 2000 or older light-duty gasoline motor vehicle, any heavy-duty gasoline motor vehicle or engine, any highway or off-highway motorcycle, or any gasoline-powered nonroad engine, vehicle, or equipment.
- (b) Paragraph (a) of this section does not prohibit a person from producing, selling, introducing, causing, or allowing the sale or introduction of gasoline containing greater than 10 volume percent ethanol into any flex-fuel vehicle or flex-fuel engine.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4346, Jan. 15, 2025]

§ 1090.250 Certified butane standards.

Butane designated as certified butane under § 1090.1000(e) for use under the butane blending provisions of § 1090.1320(b) must meet the following per-gallon standards:

- (a) **Butane content.** Minimum 85 volume percent.
- (b) **Benzene content.** Maximum 0.03 volume percent.
- (c) **Sulfur content.** Maximum 10 ppm.
- (d) **Chemical composition.** Be composed solely of carbon, hydrogen, oxygen, nitrogen, and sulfur.

§ 1090.255 Certified pentane standards.

Pentane designated as certified pentane under § 1090.1000(f) for use under the pentane blending provisions of § 1090.1320(b) must meet the following per-gallon standards:

- (a) **Pentane content.** Minimum 95 volume percent.
- (b) **Benzene content.** Maximum 0.03 volume percent.
- (c) **Sulfur content.** Maximum 10 ppm.
- (d) **Chemical composition.** Be composed solely of carbon, hydrogen, oxygen, nitrogen, and sulfur.

§ 1090.260 Gasoline deposit control standards.

- (a) Except as specified in subpart G of this part, all gasoline that is sold, offered for sale, dispensed, supplied, offered for supply, or transported to the ultimate consumer for use in motor vehicles or in any off-road engines, or that is transported to a gasoline retailer or WPC must be treated with a detergent that meets the requirements of paragraph (b) of this section at a rate at least as high as the detergent's LAC over the VAR period.
- (b) The LAC of the detergent must be determined by the gasoline detergent manufacturer using one of the following methods:
 - (1) The detergent must comply with one of the deposit control testing methods specified in § 1090.1395.
 - (2) The detergent must have been certified prior to January 1, 2021, under the intake valve deposit control requirements of 40 CFR 80.165(b) for any of the detergent certification options under 40 CFR 80.163. Di-tertiary butyl disulfide may have been used to meet the test fuel specifications under 40 CFR 80.164 associated with the intake valve deposit control requirements of 40 CFR 80.165(b). A party compliant with this paragraph (b)(2) is exempt from the port fuel injector deposit control requirements of 40 CFR 80.165(a).
 - (3) A gasoline detergent manufacturer must produce detergents consistent with their detergent certifications for detergents certified prior to January 1, 2021, and with the specific composition information submitted as part of the registration of detergents under 40 CFR 79.21(j) thereafter.

§ 1090.265 Gasoline additive standards.

- (a) Any gasoline additive that is added to, intended for adding to, used in, or offered for use in gasoline at any downstream location must meet all the following requirements:
 - (1) **Registration.** The gasoline additive must be registered by a gasoline additive manufacturer under 40 CFR part 79.
 - (2) **Sulfur content.** The gasoline additive must contribute less than or equal to 3 ppm on a per-gallon basis to the sulfur content of gasoline when used at the maximum recommended concentration.

- (3) **Treatment rate.** Except for oxygenates, the gasoline additive(s) must be used at a maximum treatment rate less than or equal to a combined total of 1.0 volume percent.
- (b) Any fuel additive blender that is not otherwise subject to any other requirement in this part and only blends a gasoline additive that meets the requirements of paragraph (a) of this section into gasoline is not subject to any requirement in this part solely due to this gasoline additive blending, except the downstream sulfur per-gallon standard in § 1090.205(c), if all the following conditions are met:
 - (1) The fuel additive blender blends gasoline additives into gasoline at a concentration less than or equal to a combined total of 1.0 volume percent.
 - (2) The fuel additive blender does not add any other blendstock into the gasoline except for oxygenates that meet the requirements in § 1090.270.
- (c) Any person who blends any fuel additive that does not meet the requirements of paragraphs (a) and (b) of this section is a gasoline manufacturer and must comply with all the requirements applicable to a gasoline manufacturer under this part.
- (d) Any gasoline additive used or intended for use to comply with the gasoline deposit control requirement in § 1090.260(a) must meet the gasoline deposit control standards under § 1090.260(b).

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4346, June 15, 2025]

§ 1090.270 Gasoline oxygenate standards.

- (a) All oxygenates designated for blending with gasoline or blended with gasoline must meet the following per-gallon standards:
 - (1) **Sulfur content.** Maximum 10 ppm.
 - (2) **Chemical composition.** Be composed solely of carbon, hydrogen, oxygen, nitrogen, and sulfur.
- (b) DFE designated for blending into gasoline or blended with gasoline must meet the following additional requirements:
 - (1) **Denaturant type.** Only PCG, gasoline blendstocks, NGLs, or certified ethanol denaturant that meets the requirements in § 1090.275 may be used as denaturants.
 - (2) **Denaturant concentration.** The concentration of all denaturants used in DFE must not exceed 3.0 volume percent.

§ 1090.275 Ethanol denaturant standards.

- (a) **Standard for all ethanol denaturant.** All ethanol denaturant, certified or uncertified, used to produce DFE must be composed solely of carbon, hydrogen, nitrogen, oxygen, and sulfur.
- (b) **Standards for certified ethanol denaturant.** In addition to the requirements of paragraph (a) of this section, certified ethanol denaturant must meet the following requirements:
 - (1) **Sulfur content per-gallon standard.** Maximum 330 ppm. If the certified ethanol denaturant producer represents a batch of denaturant as having a maximum sulfur content less than 330 ppm on the PTD (for example, less than or equal to 120 ppm), then the actual sulfur content must be less than or equal to the stated value.

- (2) **Denaturant type.** Only PCG, gasoline blendstocks, or NGLs may be used to produce certified ethanol denaturant.

§ 1090.285 RFG covered areas.

The RFG covered areas are as follows:

- (a) RFG covered areas specified in 42 U.S.C. 7545(k)(10)(D):

TABLE 1 TO PARAGRAPH (a)—RFG COVERED AREAS UNDER 42 U.S.C. 7545(k)(10)(D)

Area designation	State	Counties	Independent cities
Los Angeles-Anaheim-Riverside	California	Los Angeles, Orange, Ventura, San Bernardino, ¹ Riverside ²	
San Diego County	California	San Diego	
Greater Connecticut	Connecticut	Hartford, Middlesex, New Haven, New London, Tolland, Windham, Fairfield (only the City of Shelton), Litchfield (all except the towns of	

¹ That portion of San Bernardino County, CA that lies south of latitude 35 degrees, 10 minutes north and west of longitude 115 degrees, 45 minutes west.

² That portion of Riverside County, CA that lies to the west of a line described as follows: Beginning at the northeast corner of Section 4, Township 2 South, Range 5 East, a point on the boundary line common to Riverside and San Bernardino Counties; then southerly along section lines to the centerline of the Colorado River Aqueduct; then southeasterly along the centerline of said Colorado River Aqueduct to the southerly line of Section 36, Township 3 South, Range 7 East; then easterly along the township line to the northeast corner of Section 6, Township 4 South, Range 9 East; then southerly along the easterly line of Section 6 to the southeast corner thereof; then easterly along section lines to the northeast corner of Section 10, Township 4 South, Range 9 East; then southerly along section lines to the southeast corner of Section 15, Township 4 South, Range 9 East; then easterly along the section lines to the northeast corner of Section 21, Township 4 South, Range 10 East; then southerly along the easterly line of Section 21 to the southeast corner thereof; then easterly along the northerly line of Section 27 to the northeast corner thereof; then southerly along section lines to the southeast corner of Section 34, Township 4 South, Range 10 East; then easterly along the township line to the northeast corner of Section 2, Township 5 South, Range 10 East; then southerly along the easterly line of Section 2, to the southeast corner thereof; then easterly along the northerly line of Section 12 to the northeast corner thereof; then southerly along the range line to the southwest corner of Section 18, Township 5 South, Range 11 East; then easterly along section lines to the northeast corner of Section 24, Township 5 South, Range 11 East; and then southerly along the range line to the southeast corner of Section 36, Township 8 South, Range 11 East, a point on the boundary line common to Riverside and San Diego Counties.

Area designation	State	Counties	Independent cities
New York-Northern New Jersey-Long Island-Connecticut	Connecticut	Bridgewater and New Milford Fairfield (all except the City of Shelton), Litchfield (only the towns of Bridgewater and New Milford)	
	New Jersey	Bergen, Essex, Hudson, Hunterdon, Middlesex, Monmouth, Morris, Ocean, Passaic, Somerset, Sussex, Union	
	New York	Bronx, Kings, Nassau, New York, Orange, Putnam, Queens, Richmond, Rockland, Suffolk, Westchester	
Philadelphia-Wilmington-Trenton	Delaware	Kent, New Castle	
	Maryland	Cecil	
	New Jersey	Burlington, Camden, Cumberland, Gloucester, Mercer, Salem	
	Pennsylvania	Bucks, Chester, Delaware, Montgomery, Philadelphia	
Chicago-Gary-Lake County	Illinois	Cook, Du Page, Kane, Lake, McHenry, Will, Grundy (only Aux Sable Township and Goose Lake	

¹ That portion of San Bernardino County, CA that lies south of latitude 35 degrees, 10 minutes north and west of longitude 115 degrees, 45 minutes west.

² That portion of Riverside County, CA that lies to the west of a line described as follows: Beginning at the northeast corner of Section 4, Township 2 South, Range 5 East, a point on the boundary line common to Riverside and San Bernardino Counties; then southerly along section lines to the centerline of the Colorado River Aqueduct; then southeasterly along the centerline of said Colorado River Aqueduct to the southerly line of Section 36, Township 3 South, Range 7 East; then easterly along the township line to the northeast corner of Section 6, Township 4 South, Range 9 East; then southerly along the easterly line of Section 6 to the southeast corner thereof; then easterly along section lines to the northeast corner of Section 10, Township 4 South, Range 9 East; then southerly along section lines to the southeast corner of Section 15, Township 4 South, Range 9 East; then easterly along the section lines to the northeast corner of Section 21, Township 4 South, Range 10 East; then southerly along the easterly line of Section 21 to the southeast corner thereof; then easterly along the northerly line of Section 27 to the northeast corner thereof; then southerly along section lines to the southeast corner of Section 34, Township 4 South, Range 10 East; then easterly along the township line to the northeast corner of Section 2, Township 5 South, Range 10 East; then southerly along the easterly line of Section 2, to the southeast corner thereof; then easterly along the northerly line of Section 12 to the northeast corner thereof; then southerly along the range line to the southwest corner of Section 18, Township 5 South, Range 11 East; then easterly along section lines to the northeast corner of Section 24, Township 5 South, Range 11 East; and then southerly along the range line to the southeast corner of Section 36, Township 8 South, Range 11 East, a point on the boundary line common to Riverside and San Diego Counties.

Area designation	State	Counties	Independent cities
Baltimore	Indiana	Township), Kendall (only Oswego Township)	Baltimore.
Houston-	Maryland	Lake, Porter	
Galveston-	Texas	Anne Arundel, Baltimore, Carroll, Harford, Howard	
Brazoria		Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller	
Milwaukee-	Wisconsin	Kenosha, Milwaukee, Ozaukee, Racine,	

¹ That portion of San Bernardino County, CA that lies south of latitude 35 degrees, 10 minutes north and west of longitude 115 degrees, 45 minutes west.

² That portion of Riverside County, CA that lies to the west of a line described as follows: Beginning at the northeast corner of Section 4, Township 2 South, Range 5 East, a point on the boundary line common to Riverside and San Bernardino Counties; then southerly along section lines to the centerline of the Colorado River Aqueduct; then southeasterly along the centerline of said Colorado River Aqueduct to the southerly line of Section 36, Township 3 South, Range 7 East; then easterly along the township line to the northeast corner of Section 6, Township 4 South, Range 9 East; then southerly along the easterly line of Section 6 to the southeast corner thereof; then easterly along section lines to the northeast corner of Section 10, Township 4 South, Range 9 East; then southerly along section lines to the southeast corner of Section 15, Township 4 South, Range 9 East; then easterly along the section lines to the northeast corner of Section 21, Township 4 South, Range 10 East; then southerly along the easterly line of Section 21 to the southeast corner thereof; then easterly along the northerly line of Section 27 to the northeast corner thereof; then southerly along section lines to the southeast corner of Section 34, Township 4 South, Range 10 East; then easterly along the township line to the northeast corner of Section 2, Township 5 South, Range 10 East; then southerly along the easterly line of Section 2, to the southeast corner thereof; then easterly along the northerly line of Section 12 to the northeast corner thereof; then southerly along the range line to the southwest corner of Section 18, Township 5 South, Range 11 East; then easterly along section lines to the northeast corner of Section 24, Township 5 South, Range 11 East; and then southerly along the range line to the southeast corner of Section 36, Township 8 South, Range 11 East, a point on the boundary line common to Riverside and San Diego Counties.

Area designation	State	Counties	Independent cities
Racine		Washington, Waukesha	

¹ That portion of San Bernardino County, CA that lies south of latitude 35 degrees, 10 minutes north and west of longitude 115 degrees, 45 minutes west.

² That portion of Riverside County, CA that lies to the west of a line described as follows: Beginning at the northeast corner of Section 4, Township 2 South, Range 5 East, a point on the boundary line common to Riverside and San Bernardino Counties; then southerly along section lines to the centerline of the Colorado River Aqueduct; then southeasterly along the centerline of said Colorado River Aqueduct to the southerly line of Section 36, Township 3 South, Range 7 East; then easterly along the township line to the northeast corner of Section 6, Township 4 South, Range 9 East; then southerly along the easterly line of Section 6 to the southeast corner thereof; then easterly along section lines to the northeast corner of Section 10, Township 4 South, Range 9 East; then southerly along section lines to the southeast corner of Section 15, Township 4 South, Range 9 East; then easterly along the section lines to the northeast corner of Section 21, Township 4 South, Range 10 East; then southerly along the easterly line of Section 21 to the southeast corner thereof; then easterly along the northerly line of Section 27 to the northeast corner thereof; then southerly along section lines to the southeast corner of Section 34, Township 4 South, Range 10 East; then easterly along the township line to the northeast corner of Section 2, Township 5 South, Range 10 East; then southerly along the easterly line of Section 2, to the southeast corner thereof; then easterly along the northerly line of Section 12 to the northeast corner thereof; then southerly along the range line to the southwest corner of Section 18, Township 5 South, Range 11 East; then easterly along section lines to the northeast corner of Section 24, Township 5 South, Range 11 East; and then southerly along the range line to the southeast corner of Section 36, Township 8 South, Range 11 East, a point on the boundary line common to Riverside and San Diego Counties.

(b) RFG covered areas based on being reclassified as Severe ozone nonattainment areas under 42 U.S.C.
7511(b):

TABLE 2 TO PARAGRAPH (b)—ADDITIONAL RFG COVERED AREAS UNDER 42 U.S.C. 7545(k)(10)(D)

Area designation	State or district	Counties	Independent cities
Washington, DC-Maryland-Virginia	District of Columbia Maryland Virginia	Washington Calvert, Charles, Frederick, Montgomery, Prince George's Arlington, Fairfax, Loudoun, Prince William, Stafford	Alexandria, Fairfax, Falls Church, Manassas, Manassas Park.
Sacramento Metro	California	Sacramento, Yolo, El Dorado (except Lake Tahoe and its drainage area), Placer, ¹ Solano, ² Sutter ³	
San Joaquin Valley	California	Fresno, Kings, Madera, Merced, San Joaquin, Stanislaus, Tulare, Kern ⁴	
Eastern Kern County	California	Kern County ⁵	
Dallas	Texas	Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Wise	
Denver-Boulder-Greeley-Ft. Collins-Loveland	Colorado	Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson, Larimer County, ⁶ Weld County ⁷	

¹ All portions of Placer County except that portion of the County within the drainage area naturally tributary to Lake Tahoe including said Lake, plus that area in the vicinity of the head of the Truckee River described as follows: Commencing at the point common to the aforementioned drainage area crestline and the line common to Townships 15 North and 16 North, Mount Diablo Base and Meridian (M.D.B.&M.), and following that line in a westerly direction to the northwest corner of Section 3, Township 15 North, Range 16 East, M.D.B.&M., thence south along the west line of Sections 3 and 10, Township 15 North, Range 16 East, M.D.B.&M., to the intersection with the said drainage area crestline, thence following the said drainage area boundary in a southeasterly, then northeasterly direction to and along the Lake Tahoe Dam, thence following the said drainage area crestline in a northeasterly, then northwesterly direction to the point of beginning.

² That portion of Solano County that lies north and east of a line described as follows: Beginning at the intersection of the westerly boundary of Solano County and the ¹/₄ section line running east and west through the center of Section 34; T. 6 N., R. 2 W., M.D.B.&M.; thence east along said ¹/₄ section line to the east boundary of Section 36, T. 6 N., R. 2 W.; thence south ¹/₂ mile and east 2.0 miles, more or less, along the west and south boundary of Los Putos Rancho to the northwest corner of Section 4, T. 5 N., R. 1 W.; thence east along a line common to T. 5 N. and T. 6 N. to the northeast corner of Section 3, T. 5 N., R. 1 E.; thence south along section lines to the southeast corner of Section 10, T. 3 N., R. 1 E.; thence east along section lines to the south ¹/₄ corner of Section 8, T. 3 N., R. 2 E.; thence east to the

boundary between Solano and Sacramento Counties.

³ *That portion of Sutter County south of a line connecting the northern border of Yolo Co. to the SW tip of Yuba Co. and continuing along the southern Yuba Co. border to Placer Co.*

⁴ *Boundary between the Kern County and San Joaquin Valley air districts that generally follows the ridge line of the Sierra Nevada and Tehachapi Mountain Ranges. That portion of Kern County that lies west and north of a line described as follows: Beginning at the Kern-Los Angeles County boundary and running north and east along the northwest boundary of the Rancho La Liebre Land Grant to the point of intersection with the range line common to Range 16 West and Range 17 West, San Bernardino Base and Meridian; north along the range line to the point of intersection with the Rancho El Tejon Land Grant boundary; then southeast, northeast, and northwest along the boundary of the Rancho El Tejon Grant to the northwest corner of Section 3, Township 11 North, Range 17 West; then west 1.2 miles; then north to the Rancho El Tejon Land Grant boundary; then northwest along the Rancho El Tejon line to the southeast corner of Section 34, Township 32 South, Range 30 East, Mount Diablo Base and Meridian; then north to the northwest corner of Section 35, Township 31 South, Range 30 East; then northeast along the boundary of the Rancho El Tejon Land Grant to the southwest corner of Section 18, Township 31 South, Range 31 East; then east to the southeast corner of Section 13, Township 31 South, Range 31 East; then north along the range line common to Range 31 East and Range 32 East, Mount Diablo Base and Meridian, to the northwest corner of Section 6, Township 29 South, Range 32 East; then east to the southwest corner of Section 31, Township 28 South, Range 32 East; then north along the range line common to Range 31 East and Range 32 East to the northwest corner of Section 6, Township 28 South, Range 32 East; then west to the southeast corner of Section 36, Township 27 South, Range 31 East; then north along the range line common to Range 31 East and Range 32 East to the Kern-Tulare County boundary.*

⁵ *That portion of the county (with the exception of that portion in Hydrologic Unit Number 18090205 the Indian Wells Valley) east and south of a line described as follows: Beginning at the Kern-Los Angeles County boundary and running north and east along the northwest boundary of the Rancho La Liebre Land Grant to the point of intersection with the range line common to Range 16 West and Range 17 West, San Bernardino Base and Meridian; north along the range line to the point of intersection with the Rancho El Tejon Land Grant boundary; then southeast, northeast, and northwest along the boundary of the Rancho El Tejon Grant to the northwest corner of Section 3, Township 11 North, Range 17 West; then west 1.2 miles; then north to the Rancho El Tejon Land Grant boundary; then northwest along the Rancho El Tejon line to the southeast corner of Section 34, Township 32 South, Range 30 East, Mount Diablo Base and Meridian; then north to the northwest corner of Section 35, Township 31 South, Range 30 East; then northeast along the boundary of the Rancho El Tejon Land Grant to the southwest corner of Section 18, Township 31 South, Range 31 East; then east to the southeast corner of Section 13, Township 31 South, Range 31 East; then north along the range line common to Range 31 East and Range 32 East, Mount Diablo Base and Meridian, to the northwest corner of Section 6, Township 29 South, Range 32 East; then east to the southwest corner of Section 31, Township 28 South, Range 32 East; then north along the range line common to Range 31 East and Range 32 East to the northwest corner of Section 6, Township 28 South, Range 32 East, then west to the southeast corner of Section 36, Township 27 South, Range 31 East, then north along the range line common to Range 31 East and Range 32 East to the Kern-Tulare County boundary.*

⁶ *That portion of the county that lies south of a line described as follows: Beginning at a point on Larimer County's eastern boundary and Weld County's western boundary intersected by latitude 40 degrees, 42 minutes, and 47.1 seconds north, proceed west to a point defined by the intersection of latitude 40 degrees, 42 minutes, 47.1 seconds north and longitude 105 degrees, 29 minutes, and 40.0*

seconds west, proceeding south on longitude 105 degrees, 29 minutes, 40.0 seconds west to the intersection with latitude 40 degrees, 33 minutes and 17.4 seconds north, proceeding west on latitude 40 degrees, 33 minutes, 17.4 seconds north until this line intersects Larimer County's western boundary and Grand County's eastern boundary.

⁷ *That portion of the county that lies south of a line described as follows: Beginning at a point on Weld County's eastern boundary and Logan County's western boundary intersected by latitude 40 degrees, 42 minutes, 47.1 seconds north, proceeding west on latitude 40 degrees, 42 minutes, 47.1 seconds*

north until this line intersects Weld County's western boundary and Larimer County's eastern boundary.

- (c) RFG covered areas based on being classified ozone nonattainment areas at the time that the state requested to opt into RFG under 42 U.S.C. 7545(k)(6)(A)(i):

**TABLE 3 TO PARAGRAPH (c)—RFG COVERED AREAS UNDER 42 U.S.C.
7545(k)(6)(A)(i)**

Area designation at the time of opt- in	State	Counties	Independent cities
Sussex County	Delaware	Sussex	St. Louis.
St. Louis, Missouri-Illinois	Illinois	Jersey, Madison, Monroe, St. Clair	
	Missouri	Franklin, Jefferson, St. Charles, St. Louis	
Kentucky portion of Louisville	Kentucky	Jefferson, Bullitt, ¹ Oldham ²	
Kent and Queen Anne's Counties	Maryland	Kent, Queen Anne's	
Statewide	Massachusetts	All	
Strafford, Merrimack, Hillsborough, Rockingham Counties	New Hampshire	Hillsborough, Merrimack, Rockingham, Strafford	
Atlantic City	New Jersey	Atlantic, Cape May	
New Jersey portion of Allentown- Bethlehem-Easton	New Jersey	Warren	
Dutchess County	New York	Dutchess	
Essex County	New York	Essex (the portion of Whiteface Mountain above 4,500 feet in elevation)	
Statewide	Rhode Island	All	
Norfolk-Virginia Beach, Newport News (Hampton Roads)	Virginia	James City, York	Chesapeake, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, Williamsburg.
Richmond	Virginia	Charles City, Chesterfield, Hanover, Henrico	Colonial Heights, Hopewell, Richmond.

¹ In Bullitt County, KY, beginning at the intersection of Ky 1020 and the Jefferson-Bullitt County Line proceeding to the east along the county line to the intersection of county road 567 and the Jefferson-Bullitt County Line; proceeding south on county road 567 to the junction with Ky 1116 (also known as Zoneton Road); proceeding to the south on KY 1116 to the junction with Hebron Lane; proceeding to

the south on Hebron Lane to Cedar Creek; proceeding south on Cedar Creek to the confluence of Floyds Fork turning southeast along a creek that meets Ky 44 at Stallings Cemetery; proceeding west along Ky 44 to the eastern most point in the Shepherdsville city limits; proceeding south along the Shepherdsville city limits to the Salt River and west to a point across the river from Mooney Lane; proceeding south along Mooney Lane to the junction of Ky 480; proceeding west on Ky 480 to the junction with Ky 2237; proceeding south on Ky 2237 to the junction with Ky 61 and proceeding north on Ky 61 to the junction with Ky 1494; proceeding south on Ky 1494 to the junction with the perimeter of the Fort Knox Military Reservation; proceeding north along the military reservation perimeter to Castleman Branch Road; proceeding north on Castleman Branch Road to Ky 44; proceeding a very short distance west on Ky 44 to a junction with Ky 1020 and proceeding north on Ky 1020 to the beginning.

² *In Oldham County, KY, beginning at the intersection of the Oldham-Jefferson County Line with the southbound lane of Interstate 71; proceeding to the northeast along the southbound lane of Interstate 71 to the intersection of Ky 329 and the southbound lane of Interstate 71; proceeding to the northwest on Ky 329 to the intersection of Zaring Road on Ky 329; proceeding to the east-northeast on Zaring Road to the junction of Cedar Point Road and Zaring Road; proceeding to the north-northeast on Cedar Point Road to the junction of Ky 393 and Cedar Point Road; proceeding to the south-southeast on Ky 393 to the junction of county road 746 (the road on the north side of Reformatory Lake and the Reformatory); proceeding to the east-northeast on county road 746 to the junction with Dawkins Lane (also known as Saddlers Mill Road) and county road 746; Proceeding to follow an electric power line east-northeast across from the junction of county road 746 and Dawkins Lane to the east-northeast across Ky 53 on to the La Grange Water Filtration Plant; proceeding on to the east-southeast along the power line then south across Fort Pickens Road to a power substation on Ky 146; proceeding along the power line south across Ky 146 and the Seaboard System Railroad track to adjoin the incorporated city limits of La Grange; then proceeding east then south along the La Grange city limits to a point abutting the north side of Ky 712; proceeding east-southeast on Ky 712 to the junction of Massie School Road and Ky 712; proceeding to the south-southwest and then north-northwest on Massie School Road to the junction of Ky 53 and Massie School Road; proceeding on Ky 53 to the north-northwest to the junction of Moody Lane and Ky 53; proceeding on Moody Lane to the south-southwest until meeting the city limits of La Grange; then briefly proceeding north following the La Grange city limits to the intersection of the northbound lane of Interstate 71 and the La Grange city limits; proceeding southwest on the northbound lane of Interstate 71 until intersecting with the North Fork of Currys Fork; proceeding south-southwest beyond the confluence of Currys Fork to the south-southwest beyond the confluence of Floyds Fork continuing on to the Oldham-Jefferson County Line and proceeding northwest along the Oldham-Jefferson County Line to the beginning.*

- (d) RFG covered areas located in the ozone transport region established by 42 U.S.C. 7511c(a) that a state has requested to opt into RFG under 42 U.S.C. 7545(k)(6)(B)(i)(I).

[85 FR 78469, Dec. 4, 2020, as amended at 87 FR 52484, Aug. 26, 2022; 88 FR 70604, Oct. 12, 2023; 90 FR 4346, Jan. 15, 2025]

§ 1090.290 Changes to RFG covered areas and procedures for opting out of RFG.

- (a) **New RFG covered areas.**

- (1) Effective 1 year after an area has been reclassified as a Severe ozone nonattainment area under 42 U.S.C. 7511(b), such Severe area will become a covered area under the RFG program as required by 42 U.S.C. 7545(k)(10)(D). The geographic extent of each such covered area must be the nonattainment area boundaries as specified in 40 CFR part 81, subpart C, for the ozone NAAQS that was the subject of the reclassification.
- (2) Any classified ozone nonattainment area identified in 40 CFR part 81, subpart C, as Marginal, Moderate, Serious, or Severe may be included as a covered area upon the request of the governor of the state in which the area is located. EPA must do all the following:
 - (i) Publish the governor's request in the FEDERAL REGISTER upon receipt.
 - (ii) Establish an effective date that is not later than 1 year after the request is received unless EPA determines that there is insufficient capacity to supply RFG as required by 42 U.S.C. 7545(k)(6)(A)(ii).
- (3) Any ozone attainment area in the ozone transport region established by 42 U.S.C. 7511c(a) may be included as a covered area upon petition by the governor of the state in which the area is located as required by 42 U.S.C. 7545(k)(6)(B)(i). EPA must do all the following:
 - (i) Publish the governor's request in the FEDERAL REGISTER as soon as practicable after it is received.
 - (ii) Establish an effective date that is not later than 180 days after the request is received unless EPA determines that there is insufficient capacity to supply RFG as required by 42 U.S.C. 7545(k)(6)(B)(iii).
- (b) **Opting out of RFG.** Any area that opted into RFG under 42 U.S.C. 7545(k)(6)(A) or (B) and has not subsequently been reclassified as a Severe ozone nonattainment area may opt out of RFG using the opt-out procedure in paragraph (d) of this section.
- (c) **Eligibility for opting out of RFG.** The governor of the state in which a covered area under 42 U.S.C. 7545(k)(10)(D) is located may request that EPA remove the prohibition specified in 42 U.S.C. 7545(k)(5) in such area by following the opt-out procedure specified in paragraph (d) of this section upon one of the following:
 - (1) Redesignation to attainment for such area for the most stringent ozone NAAQS in effect at the time of redesignation.
 - (2) Designation as an attainment area for the most stringent ozone NAAQS in effect at the time of the designation. The area must also be redesignated to attainment for the prior ozone NAAQS.
- (d) **Procedure for opting out of RFG.** EPA may approve a request from a state asking for either the removal of an RFG opt-in area (or portion of an RFG opt-in area), or the removal of a covered area (or portion of a covered area) under 42 U.S.C. 7545(k)(10)(D) that meets the criteria in paragraph (c) of this section, from the list of RFG covered areas in § 1090.285 if it meets the requirements of paragraph (d)(1) of this section. If EPA approves such a request, an effective date will be set as specified in paragraph (d)(2) of this section. EPA will notify the state in writing of EPA's action on the request and the effective date of the removal when the request is approved.
 - (1) An opt-out request must be signed by the governor of a state, or the governor's authorized representative, and must include all the following:

- (i) A geographic description of each RFG area (or portion of each RFG area) that is covered by the request.
 - (ii) A description of all the means in which emissions reductions from RFG are relied upon in any approved SIP or any submitted SIP that has not yet been approved by EPA.
 - (iii) For an RFG area covered by the request where emissions reductions from RFG are relied upon as specified in paragraph (d)(1)(ii) of this section, the request must include all the following information:
 - (A) Identify whether the state is withdrawing any submitted SIP that has not yet been approved.
 - (B)
 - (1) Identify whether the state intends to submit a SIP revision to any approved SIP or any submitted SIP that has not yet been approved, which relies on emissions reductions from RFG, and describe any control measures that the state plans to submit to EPA for approval to replace the emissions reductions from RFG.
 - (2) A description of the state's plans and schedule for adopting and submitting any revision to any approved SIP or any submitted SIP that has not yet been approved.
 - (C) If the state is not withdrawing any submitted SIP that has not yet been approved and does not intend to submit a revision to any approved SIP or any submitted SIP that has not yet been approved, describe why no revision is necessary.
 - (iv) The governor of a state, or the governor's authorized representative, must submit additional information upon request by EPA.
- (2)
- (i) Except as specified in paragraph (d)(2)(ii) of this section, EPA will set an effective date of the RFG opt-out as requested by the governor, or the governor's authorized representative, but no less than 90 days from EPA's written notification to the state approving the RFG opt-out request.
 - (ii) Where emissions reductions from RFG are included in an approved SIP or any submitted SIP that has not yet been approved, other than as a contingency measure consisting of a future opt-in to RFG, EPA will set an effective date of the RFG opt-out as requested by the governor, or the governor's authorized representative, but no less than 90 days from the effective date of EPA approval of the SIP revision that removes the emissions reductions from RFG, and, if necessary, provides emissions reductions to make up for those from RFG opt-out.
 - (iii) Notwithstanding the provisions of paragraphs (d)(2)(i) and (ii) of this section, for an area in the ozone transport region that opted into RFG under 42 U.S.C. 7545(k)(6)(B), EPA will not set the effective date for removal of the area earlier than 4 years after the commencement date of opt-in.
- (4) EPA will publish a document in the FEDERAL REGISTER announcing the approval of an RFG opt-out request and its effective date.
 - (5) Upon the effective date for the removal of an RFG area (or portion of an RFG area) included in an approved request, such geographic area will no longer be considered an RFG covered area.

- (e) **Revising list of RFG covered areas.** EPA will periodically publish a final rule revising the list of RFG covered areas in § 1090.285.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4346, Jan. 15, 2025]

§ 1090.295 Procedures for relaxing the federal 7.8 psi RVP standard.

- (a) EPA may approve a request from a state asking for relaxation of the federal 7.8 psi RVP standard for any area (or portion of an area) required to use such gasoline, if it meets the requirements of paragraph (b) of this section. If EPA approves such a request, an effective date will be set as specified in paragraph (c) of this section. EPA will notify the state in writing of EPA's action on the request and the effective date of the relaxation when the request is approved.
- (b) The request must be signed by the governor of the state, or the governor's authorized representative, and must include all the following:
 - (1) A geographic description of each federal 7.8 psi gasoline area (or portion of such area) that is covered by the request.
 - (2) A description of all the means in which emissions reduction from the federal 7.8 psi gasoline are relied upon in any approved SIP or in any submitted SIP that has not yet been approved by EPA.
 - (3) For any federal 7.8 psi gasoline area covered by the request where emissions reductions from the federal 7.8 psi gasoline are relied upon as specified in paragraph (b)(2) of this section, the request must include the following information:
 - (i) Identify whether the state is withdrawing any submitted SIP that has not yet been approved.
 - (ii)
 - (A) Identify whether the state intends to submit a SIP revision to any approved SIP or any submitted SIP that has not yet been approved, which relies on emissions reductions from federal 7.8 psi gasoline, and describe any control measures that the state plans to submit to EPA for approval to replace the emissions reductions from federal 7.8 psi gasoline.
 - (B) A description of the state's plans and schedule for adopting and submitting any revision to any approved SIP or any submitted SIP that has not yet been approved.
 - (iii) If the state is not withdrawing any submitted SIP that has not yet been approved and does not intend to submit a revision to any approved SIP or any submitted SIP that has not yet been approved, describe why no revision is necessary.
 - (4) The governor of a state, or the governor's authorized representative, must submit additional information upon request by EPA.
- (c)
 - (1) Except as specified in paragraph (c)(2) of this section, EPA will set an effective date of the relaxation of the federal 7.8 psi RVP standard as requested by the governor, or the governor's authorized representative, but no less than 90 days from EPA's written notification to the state approving the relaxation request.

- (2) Where emissions reductions from the federal 7.8 psi gasoline are included in an approved SIP or any submitted SIP that has not yet been approved, EPA will set an effective date of the relaxation of the federal 7.8 psi RVP standard as requested by the governor, or the governor's authorized representative, but no less than 90 days from the effective date of EPA approval of the SIP revision that removes the emissions reductions from the federal 7.8 psi gasoline, and, if necessary, provides emissions reductions to make up for those from the federal 7.8 psi gasoline relaxation.
- (d) EPA will publish a document in the FEDERAL REGISTER announcing the approval of any federal 7.8 psi gasoline relaxation request and its effective date.
- (e) Upon the effective date for the relaxation of the federal 7.8 psi RVP standard in a subject area (or portion of a subject area) included in an approved request, such geographic area will no longer be considered a federal 7.8 psi gasoline area.
- (f) EPA will periodically publish a final rule revising the list of areas subject to the federal 7.8 psi RVP standard in § 1090.215(a)(2).

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4346, Jan. 15, 2025]

§ 1090.297 Procedures for reinstating the 1.0 psi RVP allowance for E10.

- (a) EPA may approve a request from a State asking to reinstate the ethanol 1.0 psi waiver specified in § 1090.215(b)(1) for any area (or portion of an area) specified in § 1090.215(b)(3)(ii) if it meets the requirements of paragraph (b) of this section. If EPA approves such a request, an effective date will be set as specified in paragraph (c) of this section. EPA will notify the State in writing of EPA's action on the request and the effective date of the reinstatement upon approval of the request.
- (b) The request must be signed by the Governor of the State, or the Governor's authorized representative, and must include all the following:
 - (1) A geographic description of each area (or portion of such area) that is covered by the request.
 - (2) A description of all the means in which emissions reduction from the removal of the ethanol 1.0 psi waiver are relied upon in any approved SIP or in any submitted SIP that has not yet been approved by EPA, if applicable.
 - (3) For any area covered by the request where emissions reductions from the removal of the ethanol 1.0 psi waiver are relied upon as specified in paragraph (b)(2) of this section, the request must include the following information:
 - (i) Identify whether the State is withdrawing any submitted SIP that has not yet been approved.
 - (ii)
 - (A) Identify whether the State intends to submit a SIP revision to any approved SIP or any submitted SIP that has not yet been approved, which relies on emissions reductions from the removal of the ethanol 1.0 psi waiver, and describe any control measures that the State plans to submit to EPA for approval to replace the emissions reductions from the removal of the ethanol 1.0 psi waiver.
 - (B) A description of the State's plans and schedule for adopting and submitting any revision to any approved SIP or any submitted SIP that has not yet been approved.

(iii) If the State is not withdrawing any submitted SIP that has not yet been approved and does not intend to submit a revision to any approved SIP or any submitted SIP that has not yet been approved, describe why no revision is necessary.

(4) A requested effective date of the reinstatement of the ethanol 1.0 psi waiver.

(5) The Governor of a State, or the Governor's authorized representative, must submit additional information needed to administer the reinstatement of the ethanol 1.0 psi waiver upon request by EPA.

(c)

(1) Except as specified in paragraph (c)(2) of this section, EPA will set an effective date of the reinstatement of the ethanol 1.0 psi waiver as requested by the Governor, or the Governor's authorized representative, but no less than 90 days from EPA's written notification to the State approving the reinstatement request.

(2) Where emissions reductions from the removal of the ethanol 1.0 psi waiver are included in an approved SIP or any submitted SIP that has not yet been approved, EPA will set an effective date of the reinstatement of the ethanol 1.0 psi waiver as requested by the Governor, or the Governor's authorized representative, but no less than 90 days from the effective date of EPA approval of the SIP revision that removes the emissions reductions from the ethanol 1.0 psi waiver, and, if necessary, provides emissions reductions to make up for those from the ethanol 1.0 psi waiver reinstatement.

(d) EPA will publish a document in the FEDERAL REGISTER announcing the approval of any ethanol 1.0 psi waiver reinstatement request and its effective date.

(e) Upon the effective date for the reinstatement of the ethanol 1.0 psi waiver in a subject area (or portion of a subject area) included in an approved request, the ethanol 1.0 psi waiver will apply in such subject area.

[89 FR 14774, Feb. 29, 2024]

Subpart D—Diesel Fuel and ECA Marine Fuel Standards

§ 1090.300 Overview and general requirements.

(a) Diesel fuel is subject to the ULSD standards in § 1090.305, except as follows:

(1) Alternative sulfur standards apply for 500 ppm LM diesel fuel and ECA marine fuel as specified in §§ 1090.320 and 1090.325, respectively.

(2) Exemption provisions apply as specified in subpart G of this part.

(3) Biodiesel that meets ASTM D6751 (incorporated by reference, see § 1090.95) is not subject to the cetane index or aromatic content standards in § 1090.305(c). Biodiesel blends or biodiesel that does not meet ASTM D6751 remain subject to the cetane index or aromatic content standards in § 1090.305(c).

(b) Diesel fuel additives must meet the requirements in § 1090.310.

(c) A diesel fuel manufacturer or diesel fuel additive manufacturer must demonstrate compliance with the standards in this subpart by measuring fuel parameters in accordance with subpart N of this part.

(d) All the standards in this part apply to diesel fuel and diesel fuel additives on a per-gallon basis.

(e)

- (1) No person may produce, import, sell, offer for sale, distribute, offer to distribute, supply, offer for supply, dispense, store, transport, or introduce into commerce any diesel fuel, ECA marine fuel, or diesel fuel additive that does not meet any standard set forth in this subpart.
- (2) Notwithstanding paragraph (e)(1) of this section, an importer may import diesel fuel that does not comply with the standards set forth in this subpart if all the following conditions are met:
 - (i) The importer offloads the imported diesel fuel into one or more tanks that are physically located at the same import facility at which the imported diesel fuel first arrives in the United States or at a facility to which the imported diesel fuel is directly transported from the import facility at which the imported diesel fuel first arrived in the United States.
 - (ii) The importer uses the imported diesel fuel to produce one or more new batches of diesel fuel.
 - (iii) The importer certifies each new batch of diesel fuel under § 1090.1000(c) and demonstrates that it complies with the standards in this subpart by measuring fuel parameters in accordance with subpart N of this part before custody or title to each new batch of diesel fuel is transferred.
- (f) No fuel or fuel additive manufacturer may introduce into commerce diesel fuel or diesel fuel additives that are not “substantially similar” under 42 U.S.C. 7545(f)(1) or permitted under a waiver granted under 42 U.S.C. 7545(f)(4).
- (g) Distillate global marine fuel that does not qualify for an exemption under § 1090.650 is subject to the standards, requirements, and prohibitions that apply for ULSD under this part.
- (h) No person may introduce used motor oil, or used motor oil blended with diesel fuel, into the fuel system of model year 2007 or later diesel fuel motor vehicles or engines or model year 2011 or later nonroad diesel fuel vehicles or engines (not including locomotive or marine engines).

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4346, Jan. 15, 2025; 91 FR 16499, Apr. 1, 2026]

§ 1090.305 ULSD standards.

- (a) **Overview.** Except as specified in § 1090.300(a), all diesel fuel (including nonpetroleum diesel fuel) must meet the ULSD per-gallon standards of this section.
- (a) **Overview.** Except as specified in § 1090.300(a), diesel fuel must meet the ULSD per-gallon standards of this section.
- (b) **Sulfur standard.** Maximum sulfur content of 15 ppm.
- (c) **Cetane index or aromatic content.** Diesel fuel must meet one of the following standards:
 - (1) Minimum cetane index of 40.
 - (2) Maximum aromatic content of 35 volume percent.

[85 FR 78469, Dec. 4, 2020, as amended at 91 FR 16500, Apr. 1, 2026]

§ 1090.310 Diesel fuel additives standards.

- (a) Except as specified in paragraph (b) and (c) of this section, diesel fuel additives blended into diesel fuel that is subject to the standards in § 1090.305 must have a sulfur concentration less than or equal to 15 ppm on a per-gallon basis.
- (b) Diesel fuel additives do not have to comply with paragraph (a) of this section if all the following conditions are met:
 - (1) The additive is added to diesel fuel in a quantity less than 1.0 volume percent of the resultant mixture of additive and diesel fuel.
 - (2) The PTD for the diesel fuel additive complies with the requirements in § 1090.1120(b).
 - (3) The additive is not commercially available as a retail product for ultimate consumers.
- (c) The provisions of this section do not apply to additives used in 500 ppm LM diesel fuel or ECA marine fuel.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4346, Jan. 15, 2025]

§ 1090.315 Heating oil, kerosene, ECA marine fuel, and jet fuel provisions.

Heating oil, kerosene, ECA marine fuel, or jet fuel must not be sold for use in motor vehicles or nonroad equipment and are not subject to the ULSD standards in § 1090.305 unless it is also designated as ULSD under § 1090.1015(a).

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4346, Jan. 15, 2025]

§ 1090.320 500 ppm LM diesel fuel standards.

- (a) **Overview.** 500 ppm LM diesel fuel produced or distributed by a transmix processor or pipeline operator under § 1090.515 must meet the per-gallon standards of this section.
- (b) **Sulfur standard.** Maximum sulfur content of 500 ppm.
- (c) **Cetane index or aromatic content.** The standard for cetane index or aromatic content in § 1090.305(c).

§ 1090.325 ECA marine fuel standards.

- (a) **Overview.** Except as specified in paragraph (c) of this section, ECA marine fuel must meet the per-gallon standards of this section.
- (b) **Sulfur standard.** Maximum sulfur content of 1,000 ppm.
- (c) **Exceptions.** The standards in paragraph (b) of this section do not apply to the following:
 - (1) Residual fuel made available for use in a steamship or C3 marine vessel if the U.S. government exempts or excludes the vessel from MARPOL Annex VI fuel standards. Diesel fuel and other distillate fuel used in diesel fuel engines operated on such vessels is subject to the standards in this section instead of the standards in § 1090.305 or § 1090.320.
 - (2) Distillate global marine fuel that is exempt under § 1090.650.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4347, Jan. 15, 2025]

Subpart E [Reserved]

Subpart F—Transmix and Pipeline Interface Provisions

§ 1090.500 Gasoline produced from blending transmix into PCG.

(a) *Applicability.*

- (1) Except as specified in paragraph (a)(2) of this section, a transmix blender that blends transmix into PCG must comply with the requirements of this section.
- (2) Small volumes of fuel that are captured in pipeline sumps or trapped in pipeline pumps or valve manifolds and that are injected back into batches of gasoline or diesel fuel are exempt from the requirements in this section.

(b) *Requirements.*

- (1) The distillation end-point of the resultant transmix-blended gasoline must not exceed 437 degrees Fahrenheit.
- (2) The resultant transmix-blended gasoline must meet the downstream sulfur per-gallon standard in § 1090.205(c) and the applicable RVP standard in § 1090.215.
- (3) The transmix blender must comply with the recordkeeping requirements in § 1090.1255.
- (4) The transmix blender must maintain and follow a written quality assurance program that meets the requirements of paragraph (c) of this section.
- (5) In the event that the test result for any sample collected under the quality assurance program specified in paragraph (c) of this section indicates that the gasoline does not comply with any of the applicable standards in this part, the transmix blender must do all the following:
 - (i) Immediately take steps to stop the sale of the gasoline that was sampled.
 - (ii) Take reasonable steps to determine the cause of the noncompliance and prevent future instances of noncompliance.
 - (iii) Notify EPA of the noncompliance.
 - (iv) If the transmix was blended by a computer controlled in-line blending system, increase the rate of sampling and testing to a minimum frequency of once per week and a maximum frequency of once per day and continue the increased frequency of sampling and testing until the results of 10 consecutive samples and tests indicate that the gasoline complies with applicable standards, at which time the sampling and testing may be conducted at the original frequency.

(c) *Quality assurance program.*

- (1) The quality assurance program must be designed to assure that the type and amount of transmix blended into PCG will not cause violations of the applicable fuel quality standards.
- (2) Except as specified in paragraph (c)(3) of this section, as a part of the quality assurance program, a transmix blender must collect samples of gasoline after blending transmix and test the samples to ensure the end-point temperature of the resultant transmix-blended gasoline does not exceed 437 degrees Fahrenheit, using one of the following sampling methods:

- (i) For transmix that is blended in a tank (including a tank on a barge), collect a representative sample of the resultant transmix-blended gasoline following each occasion transmix is blended.
 - (ii) For transmix that is blended by a computer controlled in-line blending system, the transmix blender must collect composite samples of the resultant transmix-blended gasoline at least twice each calendar month during which transmix is blended.
- (3) Any transmix blender may petition EPA for approval of a quality assurance program that does not include the minimum sampling and testing requirements of paragraph (c)(2) of this section. To seek approval for such an alternative quality assurance program, the transmix blender must submit a petition to EPA that includes all the following:
 - (i) A detailed description of the quality assurance procedures to be carried out at each location where transmix is blended into PCG, including a description of how the transmix blender proposes to determine the ratio of transmix that can be blended with PCG without violating any of the applicable standards in this part, and a description of how the transmix blender proposes to determine that the gasoline produced by the transmix blending operation meets the applicable standards.
 - (ii) A letter signed by the RCO, or their delegate, stating that the information contained in the submission is true to the best of their belief must accompany the petition.
 - (iii) A transmix blender that petitions EPA to use an alternative quality assurance program must comply with any request by EPA for additional information or any other requirements that EPA includes as part of EPA's evaluation of the petition. However, the transmix blender may withdraw their petition or approved use of an alternative quality assurance program at any time, upon notice to EPA.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4347, Jan. 15, 2025]

§ 1090.505 Gasoline produced from TGP.

(a) *General provisions.*

- (1) A transmix processor or blending manufacturer that produces gasoline from TGP must meet the requirements of this section.
- (2) A transmix processor must not use any feedstock other than transmix to produce TGP.
- (3) A transmix processor or blending manufacturer may produce gasoline using only TGP, a combination of TGP and PCG, a combination of TGP and blendstock(s), or a combination TGP, PCG, and blendstock(s) under the provisions of this section. A transmix processor or blending manufacturer may also blend fuel additives into gasoline in accordance with §§ 1090.260 and 1090.265.

(b) *Demonstration of compliance with sulfur per-gallon standard.*

- (1) A transmix processor or blending manufacturer that produces gasoline with TGP must meet one of the following sulfur standards for each batch of gasoline they produce, as applicable:
 - (i) Each batch of gasoline produced from only TGP or both TGP and PCG must comply with the downstream sulfur per-gallon standard in § 1090.205(c).

- (ii) Each batch of gasoline produced from a combination of TGP and any blendstock must comply with the fuel manufacturing facility gate sulfur per-gallon standard in § 1090.205(b).
- (2) A transmix processor or blending manufacturer that produces gasoline with TGP must demonstrate compliance with the applicable sulfur standard in paragraph (b)(1) of this section by measuring the sulfur content of each batch of gasoline they produce in accordance with subpart N of this part.
- (c) **Demonstration of compliance with sulfur and benzene average standards.**
 - (1) A transmix processor or blending manufacturer that produces gasoline with TGP must exclude TGP and PCG used to produce gasoline under the provisions of this section from their compliance calculations to demonstrate compliance with the sulfur and benzene average standards in §§ 1090.205(a) and 1090.210(a) and (b), respectively. A transmix processor or blending manufacturer that exclusively produces gasoline from only TGP or both TGP and PCG is deemed to be in compliance with the sulfur and benzene average standards in §§ 1090.205(a) and 1090.210(a) and (b), respectively.
 - (2) A transmix processor or blending manufacturer that produces gasoline with TGP must include all blendstocks other than TGP and PCG in their compliance calculations to demonstrate compliance with the sulfur and benzene average standards in §§ 1090.205(a) and 1090.210(a) and (b), respectively.
 - (3) A transmix processor or blending manufacturer that produces gasoline by adding blendstock to TGP must comply with § 1090.1325.
- (d) **Demonstration of compliance with RVP standard.** A transmix processor or blending manufacturer that produces gasoline with TGP must demonstrate that each batch of gasoline they produce meets the applicable RVP standard in § 1090.215 by measuring the RVP of each batch in accordance with subpart N of this part.
- (e) **Distillation point determination.** A transmix processor or blending manufacturer that produces gasoline with TGP must determine the following distillation parameters for each batch of gasoline they produce in accordance with subpart N of this part:
 - (1) T10.
 - (2) T50.
 - (3) T90.
 - (4) End-point.
 - (5) Distillation residue.

§ 1090.510 Diesel fuel and distillate fuel produced from TDP.

- (a) A transmix processor must not use any feedstock other than transmix to produce TDP.
- (b) A transmix processor must demonstrate that each batch of diesel fuel or distillate fuel produced from TDP meets the applicable standard in subpart D of this part and must comply with all other requirements applicable to a diesel fuel or distillate fuel manufacturer under this part.
- (c) A transmix processor that produces 500 ppm LM diesel fuel from TDP must also comply with the requirements in § 1090.515.

§ 1090.515 500 ppm LM diesel fuel produced from TDP.

- (a) **Applicability.** A transmix processor that produces 500 ppm LM diesel fuel from TDP must comply with the requirements of this section and the standards for 500 ppm LM diesel fuel specified in § 1090.320.
- (b) **Blending component limitation.** A transmix processor may only use the following components to produce 500 ppm LM diesel fuel:
 - (1) TDP.
 - (2) ULSD.
 - (3) Diesel fuel additives that comply with the requirements in § 1090.310.
- (c) **Volume requirements.** A party that handles 500 ppm LM diesel fuel must calculate the volume of 500 ppm LM diesel fuel received versus the volume delivered and used on a compliance period basis. An increase in the volume of 500 ppm LM diesel fuel delivered compared to the volume received must be due solely to one or more of the following:
 - (1) Normal pipeline interface cutting practices under paragraph (e)(1) of this section.
 - (2) The addition of ULSD to a retail outlet or WPC 500 ppm LM diesel fuel storage tank under paragraph (e)(2) of this section.
- (d) **Use restrictions.** 500 ppm LM diesel fuel may only be used in locomotive or marine engines that are not required to use ULSD under 40 CFR 1033.815 or 40 CFR 1042.660, respectively. No person may use 500 ppm LM diesel fuel in locomotive or marine engines that are required to use ULSD, in any other nonroad vehicle or engine, or in any motor vehicle engine.
- (e) **Segregation requirement.** A transmix processor or distributor must segregate 500 ppm LM diesel fuel from other fuels except as follows:
 - (1) A pipeline operator may ship 500 ppm LM diesel fuel by pipeline provided that the 500 ppm LM diesel fuel does not come into physical contact in the pipeline with distillate fuels that have a sulfur content greater than 15 ppm. If 500 ppm LM diesel fuel is shipped by pipeline adjacent to ULSD, the pipeline operator must cut ULSD into the 500 ppm LM diesel fuel.
 - (2) A WPC or retailer of 500 ppm LM diesel fuel may introduce ULSD into a storage tank that contains 500 ppm LM diesel fuel, provided that the other requirements of this section are satisfied. The resultant mixture must be designated as 500 ppm LM diesel fuel.
- (f) **Party limit.** No more than 4 separate parties may handle the 500 ppm LM diesel fuel between the producer and the ultimate consumer.
- (g) **Compliance plan.** For each facility, a transmix processor that produces 500 ppm LM diesel fuel must obtain approval from EPA for a compliance plan at least 60 days prior to producing 500 ppm LM diesel fuel. The compliance plan must detail how the transmix processor intends to meet all the following requirements:
 - (1) Demonstrate how the 500 ppm LM diesel fuel will be segregated by the producer through to the ultimate consumer from fuel having other designations in order to comply with the segregation requirement in paragraph (e) of this section.
 - (2) Demonstrate that the end users of 500 ppm LM diesel fuel will also have access to ULSD for use in those engines that require ULSD.

- (3) Identify the parties that will handle the 500 ppm LM diesel fuel through to the ultimate consumer.
- (4) Identify all ultimate consumers that will be supplied with the 500 ppm LM diesel fuel.
- (5) Demonstrate how misfueling of 500 ppm LM diesel fuel into vehicles, engines, or equipment that require the use of ULSD will be prevented.
- (6) Include an EPA registration number.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4347, Jan. 15, 2025]

§ 1090.520 Handling practices for pipeline interface that is not transmix.

- (a) Subject to the limitations in paragraph (b) of this section, a pipeline operator may cut pipeline interface from two batches of gasoline subject to EPA standards that are shipped adjacent to each other by pipeline into either or both these batches of gasoline provided that this action does not cause or contribute to a violation of the standards in this part.
- (b) During the summer season, a pipeline operator must not cut pipeline interface from two batches of gasoline subject to different RVP standards that are shipped adjacent to each other by pipeline into the batch of gasoline that is subject to the more stringent RVP standard. For example, during the summer season, a pipeline operator must not cut pipeline interface from a batch of RFG shipped adjacent to a batch of conventional gasoline into the batch of RFG.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4347, Jan. 15, 2025]

Subpart G—Exemptions

§ 1090.600 General provisions.

- (a) Gasoline, diesel fuel, or IMO marine fuel subject to an exemption under this subpart is exempt from the standards and provisions of this part as specified in this subpart.
- (b) Fuel that does not meet all the requirements and conditions specified in this subpart for an exemption is subject to all applicable standards and requirements of this part.

§ 1090.605 Exemptions for national security and military use.

- (a) Fuel, fuel additive, or regulated blendstock that is produced, imported, sold, offered for sale, supplied, offered for supply, stored, dispensed, or transported for use in the following tactical military vehicles, engines, or equipment, including locomotive or marine engines, is exempt from the standards specified in this part:
 - (1) Tactical military vehicles, engines, or equipment, including locomotive or marine engines, that have an EPA national security exemption from the emission standards in this chapter. See 40 CFR part 85, subpart R, and 40 CFR 1068.225.
 - (2) Tactical military vehicles, engines, or equipment, including locomotive or marine engines, that are not subject to a national security exemption from vehicle or engine emissions standards specified in paragraph (a)(1) of this section but, for national security purposes (e.g., for purposes of readiness, including training, for deployment overseas), need to be fueled on the same fuel as the vehicles, engines, or equipment that EPA has granted such a national security exemption.

- (b) The exempt fuel, fuel additive, or regulated blendstock must meet all the following requirements:
- (1) The fuel, fuel additive, or regulated blendstock must be accompanied by PTDs that meet the requirements of subpart L of this part.
 - (2) The fuel, fuel additive, or regulated blendstock must be segregated from non-exempt fuel, fuel additive, or regulated blendstock at all points in the distribution system.
 - (3) The fuel, fuel additive, or regulated blendstock must be dispensed from a fuel dispenser stand, fueling truck, or tank that is labeled with the appropriate designation of the exempt fuel, fuel additive, or regulated blendstock.
 - (4) The fuel, fuel additive, or regulated blendstock must not be used in any vehicles, engines, or equipment, including locomotive or marine engines, other than those specified in paragraph (a) of this section.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4347, Jan. 15, 2025]

§ 1090.610 Exemptions for temporary research, development, and testing.

- (a) **Requests for an exemption.**
- (1) Any person may receive an exemption from the standards specified in this part for fuel, fuel additive, or regulated blendstock used for research, development, or testing (“R&D”) purposes under paragraph (b) of this section by submitting the information specified in paragraph (c) of this section as specified in § 1090.10 and meeting the requirements of paragraph (d) of this section.
 - (2) Any person who performs emissions certification testing for a motor vehicle or motor vehicle engine under 42 U.S.C. 7525 or nonroad engine or nonroad vehicle under 42 U.S.C. 7546 is exempt from the standards specified in this part for the fuel, fuel additive, or regulated blendstock they use for emissions certification testing if they have an exemption under 40 CFR parts 85 and 86 to perform such testing.
 - (3) Any person who performs research, development, or testing of a fuel additive is exempt from the standards specified in this part for such fuel additive if the fuel additive is exempt under 40 CFR 79.4(b)(2).
- (b) **Criteria for an R&D exemption.** For an R&D exemption to be granted, the person requesting an exemption must do all the following:
- (1) Demonstrate that the exemption is for an appropriate R&D purpose.
 - (2) Demonstrate that an exemption is necessary.
 - (3) Design an R&D program that is reasonable in scope.
 - (4) Have a degree of control consistent with the purpose of the R&D program and EPA's monitoring requirements.
 - (5) Meet the requirements specified in paragraphs (c) and (d) of this section.
- (c) **Information required to be submitted.** To aid in demonstrating each of the elements in paragraph (b) of this section, the person requesting an exemption must include, at a minimum, all the following information:

- (1) A concise statement of the purpose of the R&D program demonstrating that the R&D program has an appropriate R&D purpose.
- (2) An explanation of why the stated purpose of the R&D program is unable to be achieved in a practicable manner without meeting the requirements of this part.
- (3) A demonstration of the reasonableness of the scope of the R&D program, including all the following:
 - (i) An estimate of the R&D program's duration in time (including beginning and ending dates).
 - (ii) An estimate of the maximum number of vehicles, engines, and equipment involved in the program, and the number of miles and engine hours that will be accumulated on each.
 - (iii) The manner in which the information on the vehicles, engines, or equipment used in the R&D program will be recorded and made available to EPA upon request.
 - (iv) An estimate of the volume of fuel, fuel additive, or regulated blendstock expected to be used in the R&D program that does not comply with the requirements of this part, as applicable.
 - (v) A list of how all applicable standards of this part would or would not apply to the fuel, fuel additive, or regulated blendstock expected to be used in the R&D program.
- (4) With regard to control, a demonstration that the R&D program affords EPA a monitoring capability, including all the following:
 - (i) A description of the technical and operational aspects of the R&D program.
 - (ii) The site of the R&D program (including facility name, street address, city, county, state, and ZIP code).
 - (iii) The manner in which information on the vehicles, engines, or equipment used in the R&D program will be recorded and made available to EPA upon request.
 - (iv) The manner in which information on the fuel, fuel additive, or regulated blendstock used in the R&D program (including quantity, properties, name, address, telephone number, and contact person of the supplier, and the date received from the supplier) will be recorded and made available to EPA upon request.
 - (v) The manner in which the person will ensure that fuel, fuel additive, or regulated blendstock used in the R&D program will be segregated from non-exempt fuel, fuel additive, or regulated blendstock and how fuel dispensers will be labeled to ensure that fuel, fuel additive, or regulated blendstock used in the R&D program is not dispensed for use in motor vehicles or nonroad engines, vehicles, or equipment, including locomotive or marine engines, that are not part of the R&D program.
 - (vi) The name, business address, telephone number, and title of the person in the organization requesting an exemption from whom further information on the application may be obtained.
 - (vii) The name, business address, telephone number, and title of the person in the organization requesting an exemption who is responsible for recording and making available the information specified in this paragraph (c), and the location where such information will be maintained.
 - (viii) Any other information requested by EPA to determine whether the R&D program satisfies the criteria in paragraph (b) of this section.

(d) *Additional requirements.*

- (1) Fuel, fuel additive, or regulated blendstock used in the R&D program must meet all the following requirements:
 - (i) The fuel, fuel additive, or regulated blendstock must be accompanied by PTDs that meet the requirements of subpart L of this part.
 - (ii) The fuel, fuel additive, or regulated blendstock must be designated as exempt fuel, fuel additive, or regulated blendstock by the fuel, fuel additive, or regulated blendstock manufacturer or supplier, as applicable.
 - (iii) The fuel, fuel additive, or regulated blendstock must be segregated from non-exempt fuel, fuel additive, or regulated blendstock at all points in the distribution system.
 - (iv) The fuel, fuel additive, or regulated blendstock must not be sold, distributed, offered for sale or distribution, dispensed, supplied, offered for supply, transported to or from, or stored by a retail outlet or WPC facility, unless the WPC facility is associated with the R&D program that uses the fuel, fuel additive, or regulated blendstock.
- (2) At the completion of the R&D program, any emission control systems or elements of design that are damaged or rendered inoperative must be replaced on vehicles, engines, or equipment remaining in service or the responsible person will be liable for a violation of 42 U.S.C. 7522(a)(3), unless sufficient evidence is supplied that the emission controls or elements of design were not damaged.
- (e) **Approval of exemption.** EPA may grant an R&D exemption upon a demonstration that the requirements of this section have been met. The R&D exemption approval may include such terms and conditions as EPA determines necessary to monitor the exemption and to carry out the purposes of this part, including restoration of emission control systems.
 - (1) The volume of fuel, fuel additive, or regulated blendstock used in the R&D program must not exceed the amount estimated in paragraph (c)(3)(iv) of this section, unless EPA grants an approval for a greater amount.
 - (2) Any R&D exemption granted under this section will expire at the completion of the R&D program or 1 year from the date of approval, whichever occurs first, and may only be extended upon re-application consistent with the requirements of this section.
 - (3) If any information required in paragraph (c) of this section changes after approval of the R&D exemption, the responsible person must notify EPA in writing immediately.
- (f) **Notification of completion.** Any person with an approved R&D exemption under this section must notify EPA in writing within 30 days after completion of the R&D program.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4347, Jan. 15, 2025]

§ 1090.615 Exemptions for racing and aviation.

Fuel, fuel additive, or regulated blendstock that is used in aircraft, or is used in racing vehicles or racing boats in sanctioned racing events, is exempt from the standards in subparts C and D of this part if all the following requirements are met:

- (a) The fuel, fuel additive, or regulated blendstock must be identified on PTDs and on any fuel dispenser from which the fuel, fuel additive, or regulated blendstock is dispensed as restricted for use either in aircraft or in racing motor vehicles or racing boats that are used only in sanctioned racing events.

- (b) The fuel, fuel additive, or regulated blendstock must be segregated from non-exempt fuel, fuel additive, or regulated blendstock at all points in the distribution system.
- (c) The fuel, fuel additive, or regulated blendstock must not made available for use as gasoline or diesel fuel subject to the standards in subpart C or D of this part, respectively, or dispensed for use in motor vehicles or nonroad engines, vehicles, or equipment, including locomotive or marine engines, except for those used only in aircraft or in sanctioned racing events.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4348, Jan. 15, 2025]

§ 1090.620 Exemptions for Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands.

Fuel that is produced, imported, sold, offered for sale, supplied, offered for supply, stored, dispensed, or transported for use in the territories of Guam, American Samoa, or the Commonwealth of the Northern Mariana Islands, is exempt from the standards in subparts C and D of this part if all the following requirements are met:

- (a) The fuel must be designated by the fuel manufacturer as gasoline, diesel fuel, or ECA marine fuel for use only in Guam, American Samoa, or the Commonwealth of the Northern Mariana Islands.
- (b) The fuel must be used only in Guam, American Samoa, or the Commonwealth of the Northern Mariana Islands.
- (c) The fuel must be accompanied by PTDs that meet the requirements of subpart L of this part.
- (d) The fuel must be segregated from non-exempt fuel at all points from the point the fuel is designated as exempt fuel for use only in Guam, American Samoa, or the Commonwealth of the Northern Mariana Islands, while the exempt fuel is in the United States (including an ECA or an ECA associated area under 40 CFR 1043.20) but outside these territories.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4348, Jan. 15, 2025]

§ 1090.625 Exemptions for California gasoline and diesel fuel.

- (a) **California gasoline and diesel fuel exemption.** California gasoline or diesel fuel that complies with all the requirements of this section is exempt from all other provisions of this part.
- (b) **California gasoline and diesel fuel requirements.**
 - (1) Each batch of California gasoline or diesel fuel must be designated as such by its fuel manufacturer.
 - (2) Designated California gasoline or diesel fuel must be segregated from fuel that is not California gasoline or diesel fuel at all points in the distribution system.
 - (3) Except for as specified in paragraph (d) or (e) of this section, designated California gasoline or diesel fuel must ultimately be used only in the state of California.
 - (4) Transferors and transferees of California gasoline or diesel fuel produced outside the state of California must meet the PTD requirements of subpart L of this part.
 - (5) Each transferor and transferee of California gasoline or diesel fuel produced outside the state of California must maintain copies of PTDs as specified in subpart M of this part.

- (6) California gasoline or diesel fuel must not be used in any part of the United States outside of the state of California unless the manufacturer or distributor recertifies or redesignates the batch of California gasoline or diesel fuel as specified in paragraph (d) or (e) of this section.
- (c) **Use of California test methods and offsite sampling procedures.** For any gasoline or diesel fuel that is not California gasoline or diesel fuel and that is either produced at a facility located in the state of California or is imported from outside the United States into the state of California, the manufacturer must do one of the following:
 - (1) Comply with the sampling and testing provisions specified in subpart N of this part, as applicable.
 - (2) Sample and test using methods approved in Title 13 of the California Code of Regulations.
 - (3) Sample and test per a current and valid protocol agreement between the fuel manufacturer and the California Air Resources Board or by Executive Order from the California Air Resources Board. Such protocols or Executive Orders must be provided to EPA upon request.
- (d) **California gasoline used outside of California.** California gasoline may be used in any part of the United States outside of the state of California if the manufacturer or distributor of the California gasoline does one of the following:
 - (1) Recertifies the California gasoline as gasoline under this part and includes the recertified gasoline in their average standard compliance calculations.
 - (2) Redesignates the California gasoline as gasoline under this part without recertification and does all the following:
 - (i) Demonstrates that the gasoline meets all applicable requirements for California reformulated gasoline under Title 13 of the California Code of Regulations.
 - (ii) Properly redesignates the gasoline under § 1090.1010(b)(2)(vi).
 - (iii) Generates PTDs under subpart L of this part.
 - (iv) Keeps records under subpart M of this part.
 - (v) Does not include the redesignated California gasoline in their average standard compliance calculations.
- (e) **California diesel fuel used outside of California.** California diesel fuel may be used in any part of the United States outside of the state of California without recertification if the manufacturer or distributor of the California diesel fuel redesignates the California diesel fuel as diesel fuel under this part and does all the following:
 - (1) Demonstrates that the diesel fuel meets all applicable requirements for California diesel fuel under Title 13 of the California Code of Regulations.
 - (2) Properly redesignates the diesel fuel under § 1090.1015(b)(3)(iii).
 - (3) Generates PTDs under subpart L of this part.
 - (4) Keeps records under subpart M of this part.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4349, Jan. 15, 2025]

§ 1090.630 Exemptions for Alaska, Hawaii, Puerto Rico, and the U.S. Virgin Islands summer gasoline.

Summer gasoline that is produced, imported, sold, offered for sale, supplied, offered for supply, stored, dispensed, or transported for use in Alaska, Hawaii, Puerto Rico, or the U.S. Virgin Islands is exempt from the RVP standards in § 1090.215 if all the following requirements are met:

- (a) The summer gasoline must be designated by the fuel manufacturer as summer gasoline for use only in Alaska, Hawaii, Puerto Rico, or the U.S. Virgin Islands.
- (b) The summer gasoline must be used only in Alaska, Hawaii, Puerto Rico, or the U.S. Virgin Islands.
- (c) The summer gasoline must be accompanied by PTDs that meet the requirements of subpart L of this part.
- (d) The summer gasoline must be segregated from non-exempt gasoline at all points from the point the summer gasoline is designated as exempt fuel for use only in Alaska, Hawaii, Puerto Rico, or the U.S. Virgin Islands, while the exempt summer gasoline is in the United States but outside these states or territories.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4349, Jan. 15, 2025]

§ 1090.635 Exemptions for refinery extreme, unusual, and unforeseen hardship.

- (a) In appropriate extreme, unusual, and unforeseen circumstances (e.g., circumstances like a natural disaster or refinery fire; not financial or supplier difficulties) that are clearly outside the control of the refiner and that could not have been avoided by the exercise of prudence, diligence, and due care, EPA may permit a refiner, for a brief period, to distribute fuel that is exempt from the standards in subparts C and D of this part if all the following requirements are met:
 - (1) It is in the public interest to do so (e.g., distribution of the nonconforming fuel will not damage vehicles or engines and is necessary to meet projected temporary shortfalls in the supply of the fuel in a state or region of the United States for which the shortfall is unable to otherwise be compensated for).
 - (2) The refiner exercised prudent planning and was not able to avoid the violation and has taken all reasonable steps to minimize the extent of the nonconformity.
 - (3) The refiner shows how compliance will be achieved as expeditiously as possible.
 - (4) The refiner agrees to make up any air quality detriment associated with the nonconforming fuel, where practicable.
 - (5) The refiner pays to the U.S. Treasury an amount equal to the economic benefit of the nonconformity minus the amount expended under paragraph (a)(4) of this section, in making up the air quality detriment.
- (b) Hardship applications under this section must be submitted to EPA as specified in § 1090.10 and must contain a letter signed by the RCO, or their delegate, stating that the information contained in the application is true and accurate to the best of their knowledge.

§ 1090.640 Exemptions for E85.

- (a) Gasoline that is used to produce E85 is exempt from the gasoline deposit control requirements in § 1090.260.
- (b) Any person who uses the exemption in paragraph (a) of this section must keep records to demonstrate that such exempt gasoline was used to produce E85 and was not distributed from a terminal for use as gasoline.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4349, Jan. 15, 2025]

§ 1090.645 Exemptions for exports of fuel, fuel additive, and regulated blendstock.

- (a) Fuel, fuel additive, or regulated blendstock that is exported for sale outside of the United States is exempt from the standards in subparts C and D of this part if all the following requirements are met:
 - (1) The fuel, fuel additive, or regulated blendstock must be designated for export by the fuel manufacturer, fuel additive manufacturer, or regulated blendstock producer.
 - (2) The fuel, fuel additive, or regulated blendstock designated for export must be accompanied by PTDs that meet the requirements of subpart L of this part.
 - (3) The fuel manufacturer, fuel additive manufacturer, or regulated blendstock producer must keep records that demonstrate that the fuel, fuel additive, or regulated blendstock was ultimately exported from the United States.
 - (4) The fuel, fuel additive, or regulated blendstock must be segregated from non-exempt fuel, fuel additive, or regulated blendstock at all points from the point the fuel, fuel additive, or regulated blendstock is designated for export to the point where it is ultimately exported from the United States.
- (b) Fuel, fuel additive, or regulated blendstock certified and designated for export may be certified for use in the United States if all the applicable requirements of this part are met.
- (c) Any fuel dispensed from a retail outlet within the geographic boundaries of the United States is not exempt under this section.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4349, Jan. 15, 2025]

§ 1090.650 Exemptions for distillate global marine fuel.

- (a) Distillate global marine fuel that is produced, imported, sold, offered for sale, supplied, offered for supply, stored, dispensed, or transported for use in steamships or Category 3 marine vessels is exempt from the standards in subpart D of this part when operating outside of ECA boundaries if all the following requirements are met:
 - (1) The fuel must not exceed 0.50 weight percent sulfur (5,000 ppm).
 - (2) The fuel must be accompanied by PTDs that meet the requirements of subpart L of this part.
 - (3) The fuel must be designated as distillate global marine fuel.
 - (4) The fuel must be segregated from non-exempt fuel at all points in the distribution system.

- (5) The fuel must not be used in vehicles, engines, or equipment other than in steamships or Category 3 marine vessels.

(b)

- (1) Fuel that does not meet the requirements specified in paragraph (a) of this section is subject to the standards, requirements, and prohibitions that apply for ULSD under this part.
- (2) Any person who produces, imports, sells, offers for sale, supplies, offers for supply, stores, dispenses, or transports distillate global marine fuel without meeting the applicable recordkeeping requirements of subpart M of this part must not claim the fuel is exempt from the standards, requirements, and prohibitions that apply for ULSD under this part.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4349, Jan. 15, 2025]

Subpart H—Averaging, Banking, and Trading Provisions

§ 1090.700 Compliance with average standards.

- (a) **Compliance with the sulfur average standard.** For each of their facilities, a gasoline manufacturer must demonstrate compliance with the sulfur average standard in § 1090.205(a) by using the equations in paragraphs (a)(1) and (2) of this section.
- (1) **Compliance sulfur value calculation.**
- (i) The compliance sulfur value is determined as follows:

Equation 1 to paragraph (a)(1)(i)

$$CSV_y = S_{tot,y} + D_{s,(y-1)} + D_{S_Oxy_Total,y} - C$$

Where:

CSV_y = Compliance sulfur value for compliance period y , in ppm-gallons.

$S_{tot,y}$ = Total amount of sulfur produced during compliance period y , per paragraph (a)(1)(ii) of this section, in ppm-gallons.

$D_{s,(y-1)}$ = Sulfur deficit from compliance period $y-1$, per § 1090.715(a)(1), in ppm-gallons.

$D_{S_Oxy_Total,y}$ = Total sulfur deficit from downstream BOB recertification during compliance period y , per § 1090.740(b)(1), in ppm-gallons.

C_s = Sulfur credits used by the gasoline manufacturer, per § 1090.720, in ppm-gallons.

- (ii) The total amount of sulfur produced is determined as follows:

Equation 2 to paragraph (a)(1)(ii)

$$S_{\text{tot},y} = \sum_{i=1}^n (V_i \cdot S_i)$$

Where:

$S_{\text{tot},y}$ = Total amount of sulfur produced during compliance period y, in ppm-gallons.

V_i = Volume of gasoline produced or imported in batch i, in gallons.

S_i = Sulfur content of batch i, in ppm.

i = Individual batch of gasoline produced or imported during the compliance period.

n = Number of batches of gasoline produced or imported during the compliance period.

If the calculation of $S_{\text{tot},y}$ results in a negative number, replace it with zero.

(2) **Sulfur compliance calculation.**

- (i) Compliance with the sulfur average standard in § 1090.205(a) is achieved if the following equation is true:

Equation 3 to paragraph (a)(2)(i)

$$CSV_y \leq V_{\text{tot}} \cdot S_{\text{std}}$$

Where:

CSV_y = Compliance sulfur value for compliance period y, per paragraph (a)(1)(i) of this section, in ppm-gallons.

V_{tot} = Total volume of gasoline produced or imported during the compliance period, in gallons.

S_{std} = Gasoline sulfur average standard, per § 1090.205(a), in ppm.

- (ii) Compliance with the sulfur average standard in § 1090.205(a) is not achieved if a deficit is incurred two or more consecutive years. A gasoline manufacturer incurs a deficit under § 1090.715 if the following equation is true:

Equation 4 to paragraph (a)(2)(ii)

$$CSV_y > V_{\text{tot}} \cdot S_{\text{std}}$$

Where:

CSV_y = Compliance sulfur value for compliance period y, per paragraph (a)(1)(i) of this section, in ppm-gallons.

V_{tot} = Total volume of gasoline produced or imported during the compliance period, in gallons.

S_{std} = Sulfur average standard, per § 1090.205(a), in ppm.

- (b) **Compliance with the benzene average standards.** For each of their facilities, a gasoline manufacturer must demonstrate compliance with the benzene average standard in § 1090.210(a) by using the equations in paragraphs (b)(1) and (2) of this section and with the maximum benzene average standard in § 1090.210(b) by using the equations in paragraphs (b)(3) and (4) of this section.

(1) **Compliance benzene value calculation.**

- (i) The compliance benzene value is determined as follows:

Equation 5 to paragraph (b)(1)(i)

$$CBV_y = BZ_{\text{tot},y} + D_{BZ,(y-1)} + D_{BZ_Oxy_Total,y} - C_{BZ}$$

Where:

CBV_y = Compliance benzene value for compliance period y, in benzene gallons.

$BZ_{\text{tot},y}$ = Total amount of benzene produced during compliance period y, per paragraph (b)(1)(ii) of this section, in benzene gallons.

$D_{BZ,(y-1)}$ = Benzene deficit from compliance period y-1, per § 1090.715(a)(2), in benzene gallons.

$D_{BZ_Oxy_Total,y}$ = Total benzene deficit from downstream BOB recertification during compliance period y, per § 1090.740(b)(3), in benzene gallons.

C_{BZ} = Benzene credits used by the gasoline manufacturer, per § 1090.720, in benzene gallons.

- (ii) The total amount of benzene produced is determined as follows:

Equation 6 to paragraph (b)(1)(ii)

$$BZ_{\text{tot},y} = \sum_{i=1}^n \left(\frac{V_i \cdot Bz_i}{100} \right)$$

Where:

$BZ_{\text{tot},y}$ = Total amount of benzene produced during compliance period y, in benzene gallons.

V_i = Volume of gasoline produced or imported in batch i, in gallons.

Bz_i = Benzene content of batch i, in volume percent.

i = Individual batch of gasoline produced or imported during the compliance period.

n = Number of batches of gasoline produced or imported during the compliance period.

If the calculation of $Bz_{tot,y}$ results in a negative number, replace it with zero.

(2) **Benzene average compliance calculation.**

- (i) Compliance with the benzene average standard in § 1090.210(a) is achieved if the following equation is true:

Equation 7 to paragraph (b)(2)(i)

$$CBV_y \leq V_{tot} \cdot \frac{Bz_{avg_std}}{100}$$

Where:

CBV_y = Compliance benzene value for compliance period y, per paragraph (b)(1)(i) of this section, in benzene gallons.

V_{tot} = Total volume of gasoline produced or imported during the compliance period, in gallons.

Bz_{avg_std} = Benzene average standard, per § 1090.210(a), in volume percent.

- (ii) Compliance with the benzene average standard in § 1090.210(a) is not achieved if a deficit is incurred two or more consecutive years. A gasoline manufacturer incurs a deficit under § 1090.715 if the following equation is true:

Equation 8 to paragraph (b)(2)(ii)

$$CBV_y > V_{tot} \cdot \frac{Bz_{avg_std}}{100}$$

Where:

CBV_y = Compliance benzene value for compliance period y, per paragraph (b)(1)(i) of this section, in benzene gallons.

V_{tot} = Total volume of gasoline produced or imported during the compliance period, in gallons.

Bz_{avg_std} = Benzene average standard, per § 1090.210(a), in volume percent.

- (3) **Average benzene concentration calculation.** The average benzene concentration is determined as follows:

Equation 9 to paragraph (b)(3)

$$BZ_{avg,y} = \frac{\sum_{i=1}^n (V_i \cdot BZ_i)}{V_{tot}}$$

Where:

$BZ_{avg,y}$ = Average benzene concentration for compliance period y, in volume percent.

V_i = Volume of gasoline produced or imported in batch i, in gallons.

BZ_i = Benzene content of batch i, in volume percent.

i = Individual batch of gasoline produced or imported during the compliance period.

n = Number of batches of gasoline produced or imported during the compliance period.

V_{tot} = Total volume of gasoline produced or imported during the compliance period, in gallons.

- (4) **Maximum benzene average compliance calculation.** Compliance with the maximum benzene average standard in § 1090.210(b) is achieved if the following equation is true:

Equation 10 to paragraph (b)(4)

$$BZ_{avg,y} \leq BZ_{max_std}$$

Where:

$BZ_{avg,y}$ = Average benzene concentration for compliance period y, per paragraph (b)(3) of this section, in volume percent.

BZ_{max_std} = Maximum benzene average standard, per § 1090.210(b), in volume percent.

- (5) **Rounding and reporting benzene values.**

(i) The total amount of benzene produced, as calculated in paragraph (b)(1)(ii) of this section, must be rounded to the nearest whole benzene gallon in accordance with § 1090.50.

(ii) The average benzene concentration, as calculated in paragraph (b)(3) of this section, must be rounded and reported to two decimal places in accordance with § 1090.50.

- (c) **Accounting for oxygenate added at a downstream location.** A gasoline manufacturer that complies with the requirements in § 1090.710 may include the volume of oxygenate added at a downstream location and the effects of such blending on sulfur content and benzene content in compliance calculations under this subpart.

- (d) **Inclusions.** A gasoline manufacturer must include the following products that they produced or imported during the compliance period in their compliance calculations:

- (1) CG.
- (2) RFG.
- (3) BOB.
- (4) Added gasoline volume resulting from the production of gasoline from PCG as follows:
 - (i) For PCG by subtraction under § 1090.1320(a)(1), include the PCG batch as a batch with a negative volume, positive sulfur content, and positive benzene content and include the new batch of gasoline as a batch with a positive volume, positive sulfur content, and positive benzene content in compliance calculations under this section. Any negative compliance sulfur value or compliance benzene value must be reported as zero and not as a negative result.
 - (ii) For PCG by addition under § 1090.1320(a)(2), include only the blendstock added to make the new batch of gasoline as a batch with a positive volume, positive sulfur content, and positive benzene content in compliance calculations under this section. Do not include any test results or volumes for the PCG or new batch of gasoline in these calculations.
- (5)
 - (i) Inclusion of a particular batch of gasoline for compliance calculations for a compliance period is based on the date the batch is produced, not shipped. For example, a batch produced on December 30, 2021, but shipped on January 2, 2022, would be included in the compliance calculations for the 2021 compliance period. The volume included in the 2021 compliance period for that batch would be the entire batch volume, even though the shipment of all or some of the batch did not occur until 2022.
 - (ii) For PCG by subtraction under § 1090.1320(a)(1), include PCG in the compliance period in which it was blended with blendstock. This may necessitate reporting a portion of the volume of PCG received in one compliance period as a separate PCG batch in the following compliance period.
- (e) **Exclusions.** A gasoline manufacturer must exclude the following products from their compliance calculations:
 - (1) Gasoline that was not produced by the gasoline manufacturer.
 - (2) Blendstock, unless the blendstock is added to PCG or TGP under § 1090.1320 or § 1090.1325, respectively.
 - (3) PCG, except as specified in paragraph (d)(4)(i) of this section.
 - (4) Certified butane and certified pentane blended under § 1090.1320(b).
 - (5) TGP.
 - (6) GTAB that meets the requirements in § 1090.1615(a).
 - (7) Gasoline imported by rail or truck using the provisions of § 1090.1610 to meet the alternative per-gallon standards of §§ 1090.205(d) and 1090.210(c).
 - (8) Gasoline exempt under subpart G of this part from the average standards in subpart C of this part (e.g., California gasoline, racing fuel, etc.).

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4350, Jan. 15, 2025]

§ 1090.705 Facility level compliance.

- (a) Except as specified in paragraph (b) of this section, a gasoline manufacturer must comply with average standards at the individual facility level.
- (b) A gasoline importer must comply with average standards at the company level, except that aggregation of all import facilities within a PADD as a single facility is required for compliance with the maximum benzene average standard in § 1090.210(b).

§ 1090.710 Downstream oxygenate accounting.

The requirements of this section apply to BOB for which a gasoline manufacturer accounts for the effects of the oxygenate blending that occurs downstream of the fuel manufacturing facility gate in the gasoline manufacturer's average standard compliance calculations under this subpart. This section also includes requirements for oxygenate blenders to ensure that oxygenate is added in accordance with the blending instructions specified by the gasoline manufacturer in order to ensure fuel quality standards are met.

- (a) **Provisions for gasoline manufacturers.** In order to account for the effects of oxygenate blending downstream, a gasoline manufacturer must meet all the following requirements:
 - (1) Produce or import BOB such that the gasoline continues to meet the applicable gasoline standards in subpart C of this part after the addition of the specified type and amount of oxygenate.
 - (2) For each batch of BOB produced or imported, create a hand blend in accordance with § 1090.1340 and determine the properties of the hand blend using the methods specified in subpart N of this part.
 - (3) Participate in the NSTOP specified in § 1090.1450 or have an approved in-line blending waiver under § 1090.1315.
 - (4) Transfer ownership of the BOB only to an oxygenate blender that is registered with EPA under subpart I of this part or to an intermediate owner with the restriction that it only be transferred to a registered oxygenate blender.
 - (5) Specify on the PTD for the BOB each oxygenate type and amount (or range of amounts) for which the hand blend was certified for compliance under § 1090.1340.
 - (6) Participate in the NFSP under subpart O of this part.
- (b) **Requirements for oxygenate blenders.** An oxygenate blender must add oxygenate of each type and amount (or within the range of amounts) as specified on the PTD for all BOB received, except as specified in paragraph (c)(2) of this section.
- (c) **Limitations.**
 - (1) Only the gasoline manufacturer that first certifies the BOB may account for the downstream addition of oxygenate under this section. On any occasion where any person downstream of the fuel manufacturing facility gate of the gasoline manufacturer that produced or imported gasoline or BOB adds oxygenate to such product, the person must not include the volume, sulfur content, and benzene content of the oxygenate in any compliance calculations for demonstrating compliance with the average standards specified in subpart C of this part or for credit generation under this subpart. All applicable per-gallon standards specified in subpart C of this part continue to apply.

- (2) A person downstream of the fuel manufacturing facility gate may recertify BOB for use as gasoline without the addition of the specified type and amount of oxygenate if the provisions of § 1090.740 are met. A person who recertifies BOB for use as gasoline without the addition of the specified type and amount of oxygenate is a gasoline manufacturer and must meet all applicable requirements for a gasoline manufacturer specified in this part.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4351, Jan. 15, 2025]

§ 1090.715 Deficit carryforward.

- (a) A gasoline manufacturer incurs a compliance deficit if they exceed the average standard specified in subpart C of this part for a given compliance period. The deficit incurred must be determined as specified in paragraph (a)(1) of this section for sulfur and paragraph (a)(2) of this section for benzene.
- (1) The sulfur deficit incurred is determined as follows:

Equation 1 to paragraph (a)(1)

$$D_{S,y} = CSV - V_{tot} \cdot S_{std}$$

Where:

$D_{S,y}$ = Sulfur deficit incurred for compliance period y, in ppm-gallons.

CSV_y = Compliance sulfur value for compliance period y, per § 1090.700(a)(1), in ppm-gallons.

V_{tot} = Total volume of gasoline produced or imported during the compliance period, in gallons.

S_{std} = Sulfur average standard, per § 1090.205(a), in ppm.

- (2) The benzene deficit incurred is determined as follows:

Equation 2 to paragraph (a)(2)

$$D_{Bz,y} = CBV_y - V_{tot} \cdot \frac{Bz_{avg_std}}{100}$$

Where:

$D_{Bz,y}$ = Benzene deficit incurred for compliance period y, in benzene gallons.

CBV_y = Compliance benzene value for compliance period y, per § 1090.700(b)(1)(i), in benzene gallons.

V_{tot} = Total volume of gasoline produced or imported during the compliance period, in gallons.

Bz_{avg_std} = Benzene average standard, per § 1090.210(a), in volume percent.

- (b) A gasoline manufacturer must use all sulfur or benzene credits previously generated or obtained at any of their facilities to achieve compliance with an average standard specified in subpart C of this part before carrying forward a sulfur or benzene deficit at any of their facilities.
- (c) A gasoline manufacturer that incurs a deficit under this section must satisfy that deficit and demonstrate compliance with the annual average standards during the next compliance period regardless of whether the gasoline manufacturer produces gasoline during next compliance period.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4351, Jan. 15, 2025]

§ 1090.720 Credit use.

- (a) **General credit use provisions.** Only a gasoline manufacturer may generate, use, transfer, or own credits generated under this subpart, as specified in § 1090.725(a)(1). Credits may be used by a gasoline manufacturer to comply with the average standards specified in subpart C of this part. A gasoline manufacturer may also bank credits for future use, transfer credits to another facility within the company (i.e., intracompany trading), or transfer credits to another gasoline manufacturer, if all applicable requirements of this subpart are met.
- (b) **Credit life.** Credits are valid for use for 5 years after the compliance period for which they are generated.
- (c) **Limitations on credit use.**
 - (1) Credits that have expired must not be used for demonstrating compliance with the average standards specified in subpart C of this part or be used to replace invalid credits under § 1090.735.
 - (2) A gasoline manufacturer possessing credits must use all credits prior to incurring a compliance deficit under § 1090.715.
 - (3) Credits must not be used to meet per-gallon standards.
 - (4) Credits must not be used to meet the maximum benzene average standard in § 1090.210(b).
 - (5) A gasoline manufacturer must only use credits that they own at the time of use.
- (d) **Credit reporting.** A gasoline manufacturer that generates, transacts, or uses credits under this subpart must submit reports to EPA that include all information regarding credits as specified in § 1090.905 using forms and procedures specified by EPA.
- (e) **Part 80 credit use.** Valid credits generated under 40 CFR 80.1615 and 80.1290 may be used by a gasoline manufacturer to comply with the average standards in subpart C of this part, subject to the provisions of this subpart.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4351, Jan. 15, 2025]

§ 1090.725 Credit generation.

- (a) **Parties that may generate credits.**
 - (1) No person other than a gasoline manufacturer may generate credits for use towards an average standard specified in subpart C of this part.
 - (2) No credits may be generated for gasoline produced by any of the following activities:

- (i) Transmix processing.
- (ii) Transmix blending.
- (iii) Oxygenate blending.
- (iv) Certified butane blending.
- (v) Certified pentane blending.
- (vi) Importation of gasoline by rail or truck using the alternative sampling and testing requirements in § 1090.1610.

- (3) No sulfur credits may be generated at a facility if that facility used sulfur credits in that same compliance period.
- (4) No benzene credits may be generated at a facility if that facility used benzene credits in that same compliance period.

(b) **Credit year.** Credits generated under this section must be identified by the compliance period of generation. For example, credits generated on gasoline produced in 2021 must be identified as 2021 credits.

(c) **Sulfur credit generation.**

- (1) The number of sulfur credits generated is determined as follows:

Equation 1 to paragraph (c)(1)

$$C_{S,y} = V_{\text{tot}} \cdot S_{\text{std}} - \text{CSV}_y$$

Where:

$C_{S,y}$ = Sulfur credits generated for compliance period y, in ppm-gallons.

V_{tot} = Total volume of gasoline produced or imported during the compliance period, in gallons.

S_{std} = Sulfur average standard, per § 1090.205(a), in ppm.

CSV_y = Compliance sulfur value for compliance period y, per § 1090.700(a)(1), in ppm-gallons.

- (2) The value of $C_{S,y}$ must be positive to generate credits.
- (3) Sulfur credits calculated under paragraph (c)(1) of this section must be expressed to the nearest ppm-gallon. Fractional values must be rounded in accordance with § 1090.50.

(d) **Benzene credit generation.**

- (1) The number of benzene credits generated is determined as follows:

Equation 2 to paragraph (d)(1)

$$C_{Bz,y} = V_{tot} \cdot \frac{Bz_{avg_std}}{100} - CBV_y$$

Where:

$C_{Bz,y}$ = Benzene credits generated for compliance period y, in benzene gallons.

V_{tot} = Total volume of gasoline produced or imported during the compliance period, in gallons.

Bz_{avg_std} = Benzene average standard, per § 1090.210(a), in volume percent.

CBV_y = Compliance benzene value for compliance period y, per § 1090.700(b)(1)(i), in benzene gallons.

- (2) The value of $C_{Bz,y}$ must be positive to generate credits.
- (3) Benzene credits calculated under paragraph (d)(1) of this section must be expressed to the nearest benzene gallon. Fractional values must be rounded in accordance with § 1090.50.
- (e) **Credit generation limitation.** A gasoline manufacturer may only generate credits after they have finished producing or importing gasoline for the compliance period.
- (f) **Credit generation reporting.** A gasoline manufacturer that generates credits under this section must submit reports to EPA that contain all information regarding credit generation as specified in § 1090.905 using forms and procedures specified by EPA.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4351, Jan. 15, 2025]

§ 1090.730 Credit transfers.

A gasoline manufacturer may only transfer or obtain credits from another gasoline manufacturer to meet an average standard specified in subpart C of this part if all applicable requirements of this section are met.

- (a) The credits are generated as specified in § 1090.725 and reported as specified in § 1090.905.
- (b) The credits are used for compliance in accordance with the limitations on credit use specified in § 1090.720(c).
- (c) Any credit transfer must take place no later than the deadline specified in § 1090.900(c) following the compliance period in which the credits are obtained.
- (d) The credit has not been transferred between EPA registered companies more than twice. The first transfer by the gasoline manufacturer that generated the credit ("transferor") must only be made to a gasoline manufacturer that intends to use the credit ("transferee"). If the transferee is unable to use the credit, it may make the second, and final, transfer only to a gasoline manufacturer that intends to use the credit. Intracompany credit transfers are unlimited.
- (e) The transferor must apply any credits necessary to meet the transferor's applicable average standard before transferring credits to any other gasoline manufacturer.
- (f) No person may transfer credits if the transfer would cause them to incur a compliance deficit under § 1090.715.

- (g) Unless the transferor and transferee are the same party (i.e., intracompany transfers), the transferor must supply to the transferee records as specified in § 1090.1210(g) indicating the year(s) the credits were generated, the identity of the gasoline manufacturer that generated the credits, and the identity of the transferring party.
- (h) The transferor and the transferee must submit reports to EPA that include all information regarding the transaction as specified in § 1090.905 using forms and procedures specified by EPA.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4352, Jan. 15, 2025]

§ 1090.735 Invalid credits and remedial actions.

For credits that have been calculated or generated improperly, or are otherwise determined to be invalid, all the following provisions apply:

- (a) Invalid credits must not be used to achieve compliance with an average standard specified in subpart C of this part, regardless of the good faith belief that the credits were validly generated.
- (b) Any validly generated credits existing in the transferring gasoline manufacturer's credit balance after correcting the credit balance, and after the transferor applies credits as needed to meet the average standard at the end of the compliance period, must first be applied to correct the invalid transfers before the transferring gasoline manufacturer trades or banks the credits.
- (c) The gasoline manufacturer that used the credits, and any transferor of the credits, must adjust their credit records, reports, and average standard compliance calculations as necessary to reflect the use of valid credits only. Updates to any reports must be done in accordance with subpart J of this part using forms and procedures specified by EPA.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4352, Jan. 15, 2025]

§ 1090.740 Downstream BOB recertification.

- (a)
 - (1) A gasoline manufacturer may recertify a BOB that another gasoline manufacturer has specified blending instructions for oxygenate(s) under § 1090.710(a)(5) for a different type or amount of oxygenate, including gasoline recertification to contain no oxygenate, if the recertifying gasoline manufacturer meets all the requirements of this section.
 - (2) A gasoline manufacturer must comply with applicable requirements of this part and incur deficits to be included in their compliance calculations under § 1090.700 for each facility at which the gasoline manufacturer recertifies BOB.
 - (3) Unless otherwise required under this part, a gasoline manufacturer that recertifies 1,000,000 or less gallons of BOB under this section at a facility does not need to obtain credits to satisfy deficits incurred under this section or arrange for an auditor to conduct audits under subpart S of this part for that facility. The gasoline manufacturer must still comply with all other applicable provisions of this part (e.g., register and submit reports under subparts I and J of this part, respectively).
 - (4) A party that only recertifies BOB that contains a greater amount of a specified oxygenate (e.g., a party adds 15 volume percent ethanol instead of 10 volume percent ethanol to an E10 BOB) or a different oxygenate at an equal or greater amount (e.g., a party adds 16 volume percent isobutanol

instead of 10 volume percent ethanol to an E10 BOB) does not incur deficits under this section, does not need to submit reports under subpart J of this part, and does not need to arrange for an auditor to conduct an audit under subpart S of this part. The party must still comply with all other applicable provisions of this part (e.g., register and keep records under subparts I and M of this part, respectively).

(b) A gasoline manufacturer that recertifies a BOB under this section must calculate sulfur and benzene deficits for each batch and the total deficits for sulfur and benzene as follows:

(1) **Total sulfur deficit from downstream BOB recertification.** Calculate the total sulfur deficit from downstream BOB recertification for each facility as follows:

Equation 1 to paragraph (b)(1)

$$D_{S_Oxy_Total,y} = \sum_{i=1}^n D_{S_Oxy_Batch,i}$$

Where:

$D_{S_Oxy_Total,y}$ = Total sulfur deficit from downstream BOB recertification during compliance period y, in ppm-gallons.

$D_{S_Oxy_Batch,i}$ = Sulfur deficit for batch i of recertified BOB, per paragraph (b)(2) of this section, in ppm-gallons.

i = Individual batch of BOB recertified during compliance period y.

n = Number of batches of BOB recertified during compliance period y.

(2) **Sulfur deficits from downstream BOB recertification.** Calculate the sulfur deficit from BOB recertification for each individual batch of BOB recertified as follows:

Equation 2 to paragraph (b)(2)

$$D_{S_Oxy_Batch,i} = V_{BOB} \cdot PSV \cdot \left(\frac{1}{1 - (PTD_{Oxy} - ACTUAL_{Oxy})} - 1 \right)$$

Where:

$D_{S_Oxy_Batch,i}$ = Sulfur deficit for batch i of recertified BOB, in ppm-gallons.

V_{BOB} = Volume of BOB in the batch being recertified, in gallons.

PSV = Presumed sulfur value of recertified BOB, in ppm. For purposes of this equation, PSV equals 11 ppm.

PTD_{Oxy} = Volume fraction of oxygenate that would have been added to the BOB as specified on PTDs.

ACTUAL_{Oxy} = Volume fraction of oxygenate that was actually added to the BOB. If no oxygenate was added to the BOB, then ACTUAL_{Oxy} equals 0.

- (3) **Total benzene deficit from downstream BOB recertification.** Calculate the total benzene deficit from downstream BOB recertification for each facility as follows:

Equation 3 to paragraph (b)(3)

$$D_{Bz_Oxy_Total,y} = \sum_{i=1}^n D_{Bz_Oxy_Batch,i}$$

Where:

$D_{Bz_Oxy_Total,y}$ = Total benzene deficit from downstream BOB recertification during compliance period y, in benzene gallons.

$D_{Bz_Oxy_Batch,i}$ = Benzene deficit for batch i of recertified BOB, per paragraph (b)(4) of this section, in benzene gallons.

i = Individual batch of BOB recertified during compliance period y.

n = Number of batches of BOB recertified during compliance period y.

- (4) **Benzene deficits from downstream BOB recertification.** Calculate the benzene deficit from BOB recertification for each individual batch of BOB recertified as follows:

Equation 4 to paragraph (b)(4)

$$D_{Bz_Oxy_Batch,i} = V_{BOB} \cdot \frac{PBV}{100} \cdot \left(\frac{1}{1 - (PTD_{Oxy} - ACTUAL_{Oxy})} - 1 \right)$$

Where:

$D_{Bz_Oxy_Batch,i}$ = Benzene deficit for batch i of recertified BOB, in benzene gallons.

V_{BOB} = Volume of BOB in the batch being recertified, in gallons.

PBV = Presumed benzene value of recertified BOB, in volume percent. For purposes of this equation, PBV equals 0.68 volume percent.

PTD_{Oxy} = Volume fraction of oxygenate that would have been added to the BOB as specified on PTDs.

ACTUAL_{Oxy} = Volume fraction of oxygenate that was actually added to the BOB. If no oxygenate was added to the BOB, then ACTUAL_{Oxy} equals 0.

- (5) **Deficit rounding.** The deficits calculated in paragraphs (b)(1) through (4) of this section must be rounded and reported to the nearest sulfur ppm-gallon or benzene gallon in accordance with § 1090.50, as applicable.
- (c) A gasoline manufacturer does not incur a deficit, nor may they generate credits, for negative values from the equations in paragraph (b) of this section.
- (d) Deficits incurred under this section must be fulfilled in the compliance period in which they occur and must not be carried forward under § 1090.715.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4352, Jan. 15, 2025]

§ 1090.745 Informational annual average calculations.

- (a) A gasoline manufacturer must calculate and report annual average sulfur and benzene concentrations for each of their facilities as specified in this section. The values calculated and reported under this section are not used to demonstrate compliance with average standards under this part.
- (b) A gasoline manufacturer must calculate and report their unadjusted average sulfur concentration as follows:

Equation 1 to paragraph (b)

$$S_{avg,y} = \frac{\sum_{i=1}^n (V_i \cdot S_i)}{V_{tot}}$$

Where:

$S_{avg,y}$ = Facility unadjusted average sulfur concentration for compliance period y, in ppm. Round and report $S_{avg,y}$ to two decimal places.

V_i = Volume of gasoline produced or imported in batch i, in gallons.

S_i = Sulfur content of batch i, in ppm.

i = Individual batch of gasoline produced or imported during the compliance period.

n = Number of batches of gasoline produced or imported during the compliance period.

V_{tot} = Total volume of gasoline produced or imported during the compliance period, in gallons.

- (c) A gasoline manufacturer must calculate and report their net average sulfur concentration as follows:

Equation 2 to paragraph (c)

$$S_{\text{net_avg},y} = \frac{CSV_y}{V_{\text{tot}}}$$

Where:

$S_{\text{net_avg},y}$ = Facility net average sulfur concentration for compliance period y , in ppm. Round and report $S_{\text{net_avg},y}$ to two decimal places.

CSV_y = Compliance sulfur value for compliance period y , per § 1090.700(a)(1), in ppm-gallons.

V_{tot} = Total volume of gasoline produced or imported during the compliance period, in gallons.

(d) A gasoline manufacturer must calculate and report their net average benzene concentration as follows:

Equation 3 to paragraph (d)

$$B_{\text{net_avg},y} = \frac{CBV}{V_{\text{tot}}}$$

Where:

$B_{\text{net_avg},y}$ = Facility net average benzene concentration for compliance period y , in volume percent. Round and report $B_{\text{net_avg},y}$ to two decimal places.

CBV_y = Compliance benzene value for compliance period y , per § 1090.700(b)(1)(i), in benzene gallons.

V_{tot} = Total volume of gasoline produced or imported during the compliance period, in gallons.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4353, Jan. 15, 2025]

Subpart I—Registration

§ 1090.800 General provisions.

(a) **Who must register.** The following parties must register with EPA prior to engaging in any activity under this part:

(1) Fuel manufacturers, including:

- (i) Gasoline manufacturers.
- (ii) Diesel fuel manufacturers.
- (iii) ECA marine fuel manufacturers.
- (iv) Certified butane blenders.
- (v) Certified pentane blenders.
- (vi) Transmix processors.

- (2) Oxygenate blenders.
- (3) Oxygenate producers, including DFE producers.
- (4) Certified pentane producers.
- (5) Certified ethanol denaturant producers.
- (6) Distributors, carriers, and pipeline operators that are part of the 500 ppm LM fuel distribution chain under a compliance plan submitted under § 1090.515(g).
- (7) Independent surveyors.
- (8) Auditors.
- (9) Third parties that submit reports on behalf of any regulated party under this part. Such parties must register and associate their registration with the regulated party for whom they are reporting.

(b) **Dates for registration.** The deadlines for registration are as follows:

- (1) **New registrants.** Except as specified in paragraph (b)(2) of this section, a party not currently registered with EPA must register with EPA no later than 60 days in advance of the first date that such party engages in any activity under this part requiring registration under paragraph (a) of this section.
- (2) **Existing registrants.** Any party that is already registered with EPA under 40 CFR part 80 as of January 1, 2021, is deemed to be registered for purposes of this part, except that such party is responsible for reviewing and updating their registration information consistent with the requirements of this part, as specified in paragraph (c) of this section.

(c) **Updates to registration.** A registered party must submit updated registration information to EPA within 30 days of any occasion when the registration information previously supplied becomes incomplete or inaccurate.

(d) **RCO submission.** Registration information must be submitted by the RCO. The RCO may delegate responsibility to a person who is familiar with the requirements of this part and who is no lower in the organization than a fuel manufacturing facility manager, or equivalent.

(e) **Forms and procedures for registration.** All registrants must use forms and procedures specified by EPA.

(f) **Company and facility identification.** EPA will provide registrants with company and facility identifiers to be used for recordkeeping and reporting under this part.

(g) **English language.** Registration information submitted to EPA must be in English.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4353, Jan. 15, 2025]

§ 1090.805 Contents of registration.

(a) **General information required for all registrants.** A party required to register under this part must submit all the following general information to EPA:

(1) **Company information.** For the company of the party, all the following information:

- (i) The company name.

- (ii) Company address, which must be the physical address of the business (i.e., not a post office box).
- (iii) Mailing address, if different from company address.
- (iv) Name(s), title(s), telephone number(s), and email address(es) of an RCO and their delegate, if applicable.

(2) **Facility information.** For each separate facility, all the following information:

- (i) The facility name.
- (ii) The physical location of the facility.
- (iii) A contact name, email address, and telephone number for the facility.
- (iv) The type of facility.

(3) **Location of records.** For each separate facility, or for each importer's operations in a single PADD, all the following information:

- (i) Whether records are kept on-site or off-site of the facility, or for an importer, the registered address.
- (ii) If records are kept off-site, the primary off-site storage name, physical location, contact name, and telephone number.

(4) **Activities.** A description of the activities that are engaged in by the company and its facilities (e.g., refining, importing, etc.).

(b) **Additional information required for certified pentane producers.** In addition to the information in paragraph (a) of this section, a certified pentane producer must also submit the following information:

- (1) A description of the certified pentane production facility that demonstrates that the facility is capable of producing certified pentane that is compliant with the requirements of this part without significant modifications to the existing facility.
- (2) A description of how certified pentane will be shipped from the certified pentane production facility to the certified pentane blender(s) and the associated quality assurance practices that demonstrate that contamination during distribution can be adequately controlled so as not to cause certified pentane to be in violation of the standards in this part.

[85 FR 78469, Dec. 4, 2020, as amended at 88 FR 44593, July 12, 2023; 90 FR 4353, Jan. 15, 2025]

§ 1090.810 Voluntary cancellation of company or facility registration.

- (a) **Criteria for voluntary cancellation.** A party may request cancellation of the registration of the company or any of its facilities at any time. Such request must use forms and procedures specified by EPA.
- (b) **Effect of voluntary cancellation.** A party whose registration is canceled:
 - (1) Will still be liable for violation of any requirements under this part.
 - (2) Will not be listed on any public list of actively registered companies that is maintained by EPA.
 - (3) Will not have access to any of the electronic reporting systems associated with this part.

- (4) Will still be required to meet any applicable requirements under this part (e.g., the recordkeeping provisions under subpart M of this part).
- (c) **Re-registration.** If a party whose registration has been voluntarily cancelled wants to re-register, they must do all the following:
 - (1) Notify EPA of their intent to re-register.
 - (2) Provide any required information and correct any identified deficiencies.
 - (3) Refrain from initiating a new registration unless directed to do so by EPA.
 - (4) Submit updated information as needed.

§ 1090.815 Deactivation (involuntary cancellation) of registration.

- (a) **Criteria for deactivation.** EPA may deactivate the registration of any party, or any of a party's facilities, required to register under this part, using the process specified in paragraph (b) of this section, if any of the following criteria are met:
 - (1) The party has not accessed their account or engaged in any registration or reporting activity within the most recent 24 months.
 - (2) The party has failed to comply with the registration requirements of this subpart.
 - (3) The party has failed to submit any required notification or report within 30 days of the required submission date.
 - (4) Any required attestation engagement report has not been received within 30 days of the required submission date.
 - (5) The party fails to pay a penalty or to perform any requirement under the terms of a court order, administrative order, consent decree, or administrative settlement between the party and EPA.
 - (6) The party submits false or incomplete information.
 - (7) The party denies EPA access or prevents EPA from completing authorized activities under section 114 or 208 of the Clean Air Act (42 U.S.C. 7414 or 7542) despite presenting a warrant or court order. This includes a failure to provide reasonable assistance.
 - (8) The party fails to keep or provide the records required under subpart M of this part.
 - (9) The party otherwise circumvents the intent of the Clean Air Act or of this part.
- (b) **Process for deactivation.** Except as specified in paragraph (c) of this section, EPA will use the following process whenever it decides to deactivate the registration of a party:
 - (1) EPA will provide written notification to the RCO identifying the reasons or deficiencies for which EPA intends to deactivate the party's registration. The party will have 30 calendar days from the date of the notification to correct the deficiencies identified or explain why there is no need for corrective action.
 - (2) If the basis for EPA's notice of intent to deactivate registration is the absence of activity under paragraph (a)(1) of this section, a stated intent to engage in activity will be sufficient to avoid deactivation of registration.

- (3) If the party does not correct identified deficiencies under paragraphs (a)(2) through (9) of this section, EPA may deactivate the party's registration without further notice to the party.
- (c) **Immediate deactivation.** In instances in which public health, public interest, or safety requires, EPA may deactivate the registration of the party without any notice to the party. EPA will provide written notification to the RCO identifying the reason(s) EPA deactivated the registration of the party.
- (d) **Effect of deactivation.** A party whose registration is deactivated:
 - (1) Will still be liable for violation of any requirement under this part.
 - (2) Will not be listed on any public list of actively registered companies that is maintained by EPA.
 - (3) Will not have access to any of the electronic reporting systems associated with this part.
 - (4) Will still be required to meet any applicable requirements under this part (e.g., the recordkeeping provisions under subpart M of this part).
- (e) **Re-registration.** If a party whose registration has been deactivated wishes to re-register, they must do all the following:
 - (1) Notify EPA of their intent to re-register.
 - (2) Provide any required information and correct any identified deficiencies.
 - (3) Refrain from initiating a new registration unless directed to do so by EPA.
 - (4) Remedy the circumstances that caused the party to be deactivated in the first place.
 - (5) Submit updated information as needed.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4353, Jan. 15, 2025]

§ 1090.820 Changes of ownership.

- (a) When a company or any of its facilities will change ownership, the company must notify EPA within 30 days after the date of the change in ownership.
- (b) The notification required under paragraph (a) of this section must include all the following:
 - (1) The effective date of the transfer of ownership of the company or facility and a summary of any changes to the registration information for the affected companies and facilities.
 - (2) Documents that demonstrate the sale or change in ownership of the company or facility.
 - (3) A letter, signed by the RCO from the company that currently owns or will own the company or facility and, if possible, documentation from the company that previously registered the company or facility that details the effective date of the transfer of ownership of the company or facility and summarizes any changes to the registration information.
 - (4) Any additional information requested by EPA to complete the change in registration.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4353, Jan. 15, 2025]

Subpart J—Reporting

§ 1090.900 General provisions.

(a) **Forms and procedures for reporting.**

- (1) All reporting, including all transacting of credits under this part, must be submitted electronically using forms and procedures specified by EPA.
- (2) Values must be reported in the units (e.g., gallons, ppm, etc.) and to the number of decimal places specified in this part or in reporting formats and procedures, whichever is more precise.
- (3) Reported volumes must be temperature-corrected in accordance with § 1090.1350(d).
- (4) Report values as specified in § 1090.1335(e).

(b) **English language.** All reports submitted under this subpart must be submitted in English.

(c) **Report deadlines.** All annual, batch, and credit transaction reports required under this subpart, except attestation engagement reports, must be submitted by March 31 for the preceding compliance period (e.g., reports covering the calendar year 2021 must be submitted to EPA by no later than March 31, 2022). Attestation engagement reports must be submitted by June 1 for the preceding compliance period (e.g., attestation engagement reports covering calendar year 2021 must be submitted to EPA by no later than June 1, 2022). Independent survey quarterly reports must be submitted by the deadlines in table 1 to paragraph (a)(4) in § 1090.925.

(d) **RCO submission.** Reports must be signed and submitted by the RCO or their delegate.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4353, Jan. 15, 2025]

§ 1090.905 Reports by gasoline manufacturers.

(a) **Annual compliance demonstration for sulfur.** For each compliance period, a gasoline manufacturer must submit a report for each of their facilities that includes all the following information:

(1) **Company-level reporting.** For the company, as applicable:

- (i) The EPA-issued company and facility identifiers.
- (ii) Provide information for sulfur credits, and separately by compliance period of creation, as follows:
 - (A) The number of sulfur credits owned at the beginning of the compliance period.
 - (B) The number of sulfur credits that expired at the end of the compliance period.
 - (C) The number of sulfur credits that will be carried over into the next compliance period.
 - (D) Any other information as EPA may require in order to administer reporting systems.

(2) **Facility-level reporting.** For each refinery or importer, as applicable:

- (i) The EPA-issued company and facility identifiers.
- (ii) The compliance sulfur value, per § 1090.700(a)(1), in ppm-gallons.
- (iii) The total volume of gasoline produced or imported, in gallons.

- (iv) Provide information for sulfur credits, and separately by compliance period of creation, as follows:
 - (A) The number of sulfur credits generated during the compliance period.
 - (B) The number of sulfur credits retired during the compliance period.
 - (C) The sulfur credit deficit that was carried over from the previous compliance period.
 - (D) The sulfur credit deficit that will be carried over into the next compliance period.
 - (E) The total sulfur deficit from downstream BOB recertification, per § 1090.740(b)(1).
 - (v) The unadjusted average sulfur concentration, per § 1090.745(b), in ppm.
 - (vi) The net average sulfur concentration, per § 1090.745(c), in ppm.
 - (vii) Any other information as EPA may require in order to administer reporting systems.
- (b) **Annual compliance demonstration for benzene.** For each compliance period, a gasoline manufacturer must submit a report for each of their facilities that includes all the following information:
- (1) **Company-level reporting.** For the company, as applicable:
 - (i) The EPA-issued company and facility identifiers and compliance level.
 - (ii) Provide information for benzene credits, and separately by compliance period of creation, as follows:
 - (A) The number of benzene credits owned at the beginning of the compliance period.
 - (B) The number of benzene credits that expired at the end of the compliance period.
 - (C) The number of benzene credits that will be carried over into the next compliance period.
 - (D) Any other information as EPA may require in order to administer reporting systems.
 - (2) **Facility-level reporting.** For each fuel manufacturing facility or importer, as applicable:
 - (i) The EPA-issued company and facility identifiers.
 - (ii) The compliance benzene value, per § 1090.700(b)(1)(i), in benzene gallons.
 - (iii) The total volume of gasoline produced or imported, in gallons.
 - (iv) The average benzene concentration, per § 1090.700(b)(3), in percent volume. For an importer, report the average benzene concentration for each aggregated import facility.
 - (v) The net average benzene concentration, per § 1090.745(d), in percent volume.
 - (vi) Provide information for benzene credits, and separately by compliance period of creation, as follows:
 - (A) The number of benzene credits generated during the compliance period.
 - (B) The number of benzene credits retired during the compliance period.
 - (C) The benzene credit deficit that was carried over from the previous compliance period
 - (D) The benzene credit deficit that will be carried over into the next compliance period.

- (E) The total benzene deficit from downstream BOB recertification, per § 1090.740(b)(3).
- (vii) Any other information as EPA may require in order to administer reporting systems.
- (c) **Batch reporting.** A gasoline manufacturer must report the following information for each of their facilities on a per-batch basis for gasoline and gasoline regulated blendstocks:
 - (1) For all gasoline for which the gasoline manufacturer has not accounted for oxygenate added downstream under § 1090.710:
 - (i) The EPA-issued company and facility identifiers.
 - (ii) The batch number.
 - (iii) The date the batch was produced or imported.
 - (iv) The batch volume, in gallons.
 - (v) The designation of the gasoline as RFG, CG, RFG “Intended for Oxygenate Blending”, or CG “Intended for Oxygenate Blending”.
 - (vi) The tested sulfur content of the batch separately for per-gallon and average compliance, in ppm, and the test method used to measure the sulfur content.
 - (vii) The tested benzene content of the batch, as a volume percentage, and the test method used to measure the benzene content.
 - (viii) For all batches of summer gasoline:
 - (A)
 - (1) The applicable RVP standard, as specified in § 1090.215.
 - (2) Whether the ethanol 1.0 psi waiver under § 1090.215(b) applies.
 - (B) The tested RVP of the batch, in psi, and the test method used to measure the RVP. If the gasoline is Summer RFG that is designated as “Intended for Oxygenate Blending” under § 1090.1010(a)(4), report the tested RVP of the hand blend.
 - (ix) If the gasoline contains oxygenate, the type and tested content of each oxygenate, as a volume percentage, and the test method used to measure the content of each oxygenate.
 - (2) For BOB for which the gasoline manufacturer has accounted for oxygenate added downstream under § 1090.710:
 - (i) The EPA-issued company and facility identifiers.
 - (ii) The batch number.
 - (iii) The date the batch was produced or imported.
 - (iv) The batch volume, in gallons. This volume is the sum of the produced or imported BOB volume plus the anticipated volume from the addition of oxygenate downstream that the gasoline manufacturer specified to be blended with the BOB.
 - (v) The designation of the BOB (CBOB or RBOB) used to prepare the hand blend of BOB and oxygenate under § 1090.1340.

- (vi) The tested sulfur content for both the BOB and the hand blend of BOB and oxygenate prepared under § 1090.1340, and the test method used to measure the sulfur content.
- (vii) The tested benzene content for the hand blend of BOB and oxygenate prepared under § 1090.1340, and the test method used to measure the benzene content.
- (viii) For all batches of summer BOB:
 - (A)
 - (1) The applicable RVP standard, as specified in § 1090.215, for the neat CBOB or hand blend of RBOB and oxygenate prepared under § 1090.1340.
 - (2) Whether the ethanol 1.0 psi waiver under § 1090.215(b) applies for the neat CBOB or hand blend of RBOB and oxygenate prepared under § 1090.1340.
 - (B) The tested RVP of the neat CBOB or hand blend of RBOB and oxygenate prepared under § 1090.1340, in psi, and the test method used to measure the RVP.
- (ix) The type and content of each oxygenate, as a volume percentage, in the hand blend of BOB and oxygenate prepared under § 1090.1340, and, if measured, the test method used for each oxygenate.
- (3) For blendstock added to PCG by a gasoline manufacturer complying by subtraction under § 1090.1320(a)(1):
 - (i) For the PCG prior to the addition of blendstock:
 - (A) The EPA-issued company and facility identifiers for the facility at which the PCG is blended to produce a new batch.
 - (B) The batch number assigned by the facility at which the PCG is blended to produce a new batch.
 - (C) The date the batch was received or, for PCG that was not received from another company, the date the PCG was designated to be used to produce a new batch of gasoline.
 - (D) The batch volume, including the volume of any oxygenate that would have been added to the PCG, as a negative number in gallons.
 - (E) The designation of the PCG.
 - (F) The tested sulfur content of the batch, in ppm, and the test method used to measure the sulfur content. If the PCG is a BOB and the blending manufacturer is accounting for downstream oxygenate under § 1090.710, report the tested sulfur content of the hand blend prepared under § 1090.1340.
 - (G) The tested benzene content of the batch, as a volume percentage, and the test method used to measure the benzene content. If the PCG is a BOB and the blending manufacturer is accounting for downstream oxygenate under § 1090.710, report the tested benzene content of the hand blend prepared under § 1090.1340.
 - (H) If the PCG contains oxygenate, the type and tested content of each oxygenate, as a volume percentage, and the test method used to measure the content of each oxygenate.
 - (I) Identification of the batch as PCG.

- (ii) For the batch of gasoline or BOB produced using PCG and blendstock:
 - (A) For batches of finished gasoline or neat BOB, all the information specified in paragraph (c)(1) of this section.
 - (B) For batches of BOB in which the oxygenate to be blended with the BOB is included in the gasoline manufacturer's compliance calculations, all the information specified in paragraph (c)(2) of this section.
- (4) For blendstock(s) added to PCG by a gasoline manufacturer complying by addition under § 1090.1320(a)(2), report each blendstock as a separate batch and all the following information:
 - (i) For the blendstock, the sulfur content and benzene content of the batch.
 - (ii) For batches produced by adding blendstock to PCG, the sulfur content, oxygenate type and amount (unless not required under § 1090.1310(e)), and for summer gasoline, RVP, of the batch.
- (5) For certified butane blended by a certified butane blender or certified pentane blended by a certified pentane blender:
 - (i) For the certified butane or certified pentane batch:
 - (A) The batch number.
 - (B) The date the batch was received by the blender.
 - (C) The volume of certified butane or certified pentane blended, in gallons.
 - (D) The designation of the batch (certified butane or certified pentane).
 - (E) The volume percentage of butane in batches of butane, or pentane in batches of pentane, provided by the certified butane or certified pentane supplier.
 - (F) The sulfur content of the batch, in ppm, provided by the certified butane or certified pentane supplier.
 - (G) The benzene content of the batch, in volume percent, provided by the certified butane or certified pentane supplier.
 - (ii) For the batch of blended product (i.e., PCG plus butane or PCG plus pentane):
 - (A) The batch number.
 - (B) The date the batch was produced.
 - (C) The batch volume, in gallons.
 - (D) The designation of the blended product.
 - (E) For a new batch of gasoline (e.g., a blended gasoline containing certified butane and PCG) that is summer gasoline or summer BOB, the tested RVP of the batch, in psi, and the test method used to measure the RVP.
- (6) For gasoline produced by adding any blendstocks to TGP:
 - (i) For each batch of gasoline produced with TGP, the sulfur content and for summer gasoline, RVP, of the batch.

- (ii) For blendstocks added to TGP, a transmix processor or blending manufacturer must treat the TGP like PCG and report one of the following:
 - (A) The information specified in paragraph (c)(3) of this section.
 - (B) The information specified in paragraph (c)(4) of this section.
- (7) For GTAB:
 - (i) The EPA-issued company and facility identifiers.
 - (ii) The batch number.
 - (iii) The date the batch was imported.
 - (iv) The batch volume, in gallons.
 - (v) The designation of the product as GTAB.
- (8) For each batch of gasoline produced by a transmix processor or blending manufacturer from only TGP or both TGP and PCG under § 1090.505:
 - (i) The EPA-issued company and facility identifiers.
 - (ii) The batch number.
 - (iii) The date the batch was produced.
 - (iv) The batch volume, in gallons.
 - (v) The designation of the gasoline.
 - (vi) The tested sulfur content of the batch, in ppm, and the test method used to measure the sulfur content.
 - (vii) For summer gasoline:
 - (A)
 - (1) The applicable RVP standard, as specified in § 1090.215.
 - (2) Whether the ethanol 1.0 psi waiver under § 1090.215(b) applies.
 - (B) The tested RVP of the batch, in psi, and the test method used to measure the RVP.
- (9) Any other information as EPA may require in order to administer reporting systems.
- (d) **Credit transactions.** Any party that is required to demonstrate annual compliance under paragraph (a) or (b) of this section must submit information related to individual transactions involving sulfur and benzene credits, including all the following:
 - (1) The generation, purchase, sale, or retirement of such credits.
 - (2) If any credits were obtained from or transferred to other fuel manufacturers, and for each other party, their name and EPA-issued company identifier, the number of credits obtained from or transferred to the other party, and the year the credits were generated.
 - (3) Any other information as EPA may require in order to administer reporting systems.

§ 1090.910 Reports by gasoline manufacturers that recertify BOB to gasoline.

A gasoline manufacturer that recertifies BOB under § 1090.740 must report the information of this section, as applicable

(a) **Batch reporting.**

- (1) A party that recertifies a BOB under § 1090.740 with less oxygenate than specified by the BOB manufacturer must report the following for each batch:
 - (i) The EPA-issued company and facility identifiers for the recertifying party.
 - (ii) The batch number assigned by the recertifying party.
 - (iii) The date the batch was recertified.
 - (iv) The batch volume, as a negative number in gallons. The volume is the amount of oxygenate that the recertifying gasoline manufacturer did not blend with the BOB.
 - (v) The designation of the batch.
 - (vi) A sulfur content of 11 ppm.
 - (vii) A benzene content of 0.68 volume percent.
 - (viii) The type and content of each oxygenate, as a volume percentage.
 - (ix) The sulfur deficit for the batch calculated under § 1090.740(b)(2).
 - (x) The benzene deficit for the batch calculated under § 1090.740(b)(4).
- (2) A party that recertifies a BOB under § 1090.740 with more oxygenate than specified by the BOB manufacturer does not need to report the batch.

(b) **Annual sulfur and benzene compliance reporting.** A party that recertifies a BOB under § 1090.740 must include any deficits incurred from recertification in reports under § 1090.905(a) and (b).

(c) **Credit transactions.** A party that recertifies a BOB under § 1090.740 must report any credit transactions under § 1090.905(d).

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4354, Jan. 15, 2025]

§ 1090.915 Reports by oxygenate producers and importers.

An oxygenate producer, for each of their production facilities, or an importer for the oxygenate they import, must submit a report for each compliance period that includes all the following information:

- (a) The EPA-issued company and facility identifiers.
- (b) The total volume of oxygenate produced or imported.
- (c) For each batch of oxygenate produced or imported during the compliance period, all the following:
 - (1) The batch number.
 - (2) The date the batch was produced or imported.

- (3) One of the following product types:
 - (i) Denatured ethanol using certified ethanol denaturant complying with § 1090.275.
 - (ii) Denatured ethanol from non-certified ethanol denaturant.
 - (iii) A specified oxygenate other than ethanol (e.g., isobutanol).
- (4) The volume of the batch, in gallons.
- (5) The sulfur content of the batch, in ppm, and the method used to determine the sulfur content.
- (d) Any other information as EPA may require in order to administer reporting systems.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4354, Jan. 15, 2025]

§ 1090.920 Reports by certified pentane producers.

A certified pentane producer must submit a report for each facility at which certified pentane was produced or imported that contains all the following information:

- (a) The EPA-issued company and facility identifiers.
- (b) For each batch of certified pentane produced or imported during the compliance period, all the following:
 - (1) The batch number.
 - (2) The date the batch was produced or imported.
 - (3) The batch volume, in gallons.
 - (4) The tested pentane content of the batch, as a volume percentage, and the test method used to measure the pentane content.
 - (5) The tested sulfur content of the batch, in ppm, and the test method used to measure the sulfur content.
 - (6) The tested benzene of the batch, as a volume percentage, and the test method used to measure the benzene content.
 - (7) The tested RVP of the batch, in psi, and the test method used to measure the RVP.
- (c) Any other information as EPA may require in order to administer reporting systems.

§ 1090.925 Reports by independent surveyors.

- (a) **General procedures.** An independent surveyor must meet the following requirements:
 - (1) Electronically submit any plans, notifications, or reports required under this part using forms and procedures specified by EPA.
 - (2) For each report required under this section, affirm that the survey was conducted in accordance with an EPA-approved survey plan and that the survey results are accurate.
 - (3) Include EPA-issued company identifiers on each report required under this section.

- (4) Submit quarterly reports required under paragraphs (b) and (d) of this section by the following deadlines:

TABLE 1 TO PARAGRAPH (a)(4)—QUARTERLY REPORTING DEADLINES

Calendar quarter	Time period covered	Quarterly report deadline
Quarter 1	January 1-March 31	June 1.
Quarter 2	April 1-June 30	September 1.
Quarter 3	July 1-September 30	December 1.
Quarter 4	October 1-December 31	March 31.

- (b) **NFSP quarterly reporting.** An independent surveyor conducting the NFSP under § 1090.1405 must submit the following information quarterly, as applicable:

- (1) For each retail outlet sampled by the independent surveyor:

- (i) The identification information for the retail outlet, as assigned by the surveyor in a consistent manner and as specified in the survey plan.
- (ii) The displayed fuel manufacturer brand name at the retail outlet, if any.
- (iii) The physical location (*i.e.*, address) of the retail outlet.

- (2) For each gasoline sample collected by the independent surveyor:

- (i) A description of the labeling of the fuel dispenser(s) (*e.g.*, “E0”, “E10”, “E15”, etc.) from which the independent surveyor collected the sample.
- (ii) The date and time the independent surveyor collected the sample.
- (iii) The test results for the sample, and the test methods used, as determined by the independent surveyor, including the following parameters:
 - (A) The oxygen content, in weight percent.
 - (B) The type and amount of each oxygenate, by weight and volume percent.
 - (C) The sulfur content, in ppm.
 - (D) The benzene content, in volume percent.
 - (E) The specific gravity.
 - (F) The RVP in psi, if tested.
 - (G) The aromatic content in volume percent, if tested.
 - (H) The olefin content in volume percent, if tested.
 - (I) The distillation parameters, if tested.

- (3) For each diesel fuel sample collected at a retail outlet by the independent surveyor:
 - (i) A description of the labeling of the fuel dispenser(s) (e.g., "ULSD") from which the independent surveyor collected the sample.
 - (ii) The date and time the independent surveyor collected the sample.
 - (iii) The tested sulfur content of the sample, and the test method used, as determined by the independent surveyor, in ppm.
- (4) Any other information as EPA may require in order to administer reporting systems.
- (c) **NFSP annual reporting.** An independent surveyor conducting the NFSP under § 1090.1405 must submit the following information annually by March 31.
 - (1) An identification of the parties that participated in the survey during the compliance period.
 - (2) An identification of each geographic area included in a survey.
 - (3) Summary statistics for each identified geographic area, including the following:
 - (i) The number of samples collected and tested.
 - (ii) The mean, median, and range expressed in appropriate units for each measured fuel parameter.
 - (iii) The standard deviation for each measured fuel parameter.
 - (iv) The estimated compliance rate for each measured fuel parameter subject to a per-gallon standard in subpart C or D of this part.
 - (v) A summary of potential noncompliance issues.
 - (4) Any other information as EPA may require in order to administer reporting systems.
- (d) **NSTOP quarterly reporting.** An independent surveyor conducting the NSTOP under § 1090.1450 must submit the following information quarterly, as applicable:
 - (1) For each gasoline manufacturing facility sampled by the independent surveyor:
 - (i) The EPA-issued company and facility identifiers for the gasoline manufacturer and the gasoline manufacturing facility.
 - (ii) [Reserved]
 - (2) For each gasoline sample collected by the independent surveyor:
 - (i) The designation of the gasoline.
 - (ii) The date and time the independent surveyor collected the sample.
 - (iii) The batch number or the sample identification number as assigned by the independent surveyor in a consistent manner and as specified in the survey plan.
 - (iv) A description of any instance in which the gasoline manufacturer did not follow the applicable sampling procedures.
 - (v) The test results for the sample, and the test methods used, as determined by the independent surveyor, including the following parameters:
 - (A) The sulfur content, in ppm.

- (B) The benzene content, in volume percent.
- (C) The RVP in psi, if tested.
- (vi) The test results for the sample, and the test methods used, as determined by the gasoline manufacturer, including the following parameters:
 - (A) The sulfur content, in ppm.
 - (B) The benzene content, in volume percent.
 - (C) The RVP in psi, if tested.
- (vii) If available, the test results for the sample, and the test methods used, as determined by EPA's National Vehicle and Fuel Emissions Laboratory, including the following parameters:
 - (A) The sulfur content, in ppm.
 - (B) The benzene content, in volume percent.
 - (C) The RVP in psi, if tested.
- (viii) The determined site precision under § 1090.1450(c)(10)(i) and the test performance index under § 1090.1450(c)(10)(ii) for each method and instrument that the gasoline manufacturer used to test the sample.
- (ix) The reproducibility of each method that the gasoline manufacturer used to test the sample.
- (x) Any applicable correlation equations used to compare the gasoline manufacturer's test results to the independent surveyor's test results.
- (3) Any other information as EPA may require in order to administer reporting systems.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4354, Jan. 15, 2025]

§ 1090.930 Reports by auditors.

- (a) Attestation engagement reports required under subpart S of this part must be submitted by an independent auditor registered with EPA and associated with a company, or companies, through registration under subpart I of this part. Each attestation engagement report must clearly identify the company and compliance level (e.g., facility), time period, and scope covered by the report. Attestation engagement reports covered by this section include those required under this part and those required under 40 CFR part 80, subpart M, beginning with the report due June 1, 2022.
- (b) An attestation engagement report must be submitted to EPA covering each compliance period by June 1 of the following calendar year. The auditor must make the attestation engagement report available to the company for which it was performed.
- (c) The attestation engagement must comply with subpart S of this part and the attestation engagement report must clearly identify the methodologies followed and any findings, exceptions, and variances.
- (d) A single attestation engagement report submission by the auditor may include procedures performed under this part and under 40 CFR part 80, subpart M. If a single submission method is used, the auditor must clearly and separately describe the procedures and findings for each program.

- (e) The auditor must submit written acknowledgement from the RCO that the gasoline manufacturer has reviewed the attestation engagement report.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4354, Jan. 15, 2025]

§ 1090.935 Reports by diesel fuel manufacturers.

(a) Batch reporting.

- (1) For each compliance period, a diesel fuel manufacturer that produces ULSD must submit the following information:
 - (i) The EPA-issued company and facility identifiers for the diesel fuel manufacturer.
 - (ii) The highest sulfur content observed for a batch of ULSD produced during the compliance period on a company level, in ppm.
 - (iii) The average sulfur concentration of all batches produced during the compliance period on a company level, in ppm.
 - (iv) A list of all batches of ULSD that exceeded the sulfur standard in § 1090.305(b) by facility. For each such batch, report the following:
 - (A) The batch number.
 - (B) The date the batch was produced.
 - (C) The volume of the batch, in gallons.
 - (D) The sulfur content of the batch, in ppm.
 - (E) The corrective action taken, if any.

(b) [Reserved]

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4355, Jan. 15, 2025]

Subpart K—Batch Certification and Designation

§ 1090.1000 Batch certification requirements.

(a) General provisions.

- (1) A fuel manufacturer, fuel additive manufacturer, or regulated blendstock producer must certify batches of fuel, fuel additive, or regulated blendstock as specified in this section.
- (2) A fuel manufacturer, fuel additive manufacturer, or regulated blendstock producer does not need to certify fuel, fuel additive, or regulated blendstock that is exempt under subpart G of this part.
- (3)
 - (i) For purposes of this part, the volume of a batch is one of the following:
 - (A) The sum of all shipments or transfers of fuel, fuel additive, or regulated blendstock out of the tank or vessel in which the fuel, fuel additive, or regulated blendstock was certified.

- (B) The entire volume of a tank or vessel may be certified as a single batch. In such cases, any heel left in the tank or vessel after shipments of the batch becomes PCG.
- (ii) If a volume of fuel, fuel additive, or regulated blendstock is placed in a tank, certified (if not previously certified), and is not altered in any manner, then it is considered to be the same batch even if several shipments or transfers are made out of that tank.
- (iii) Batch volumes must be temperature-corrected in accordance with § 1090.1350(d).
- (4) For fuel produced at a facility that has an in-line blending waiver under § 1090.1315, the volume of the batch is the volume of product that is homogeneous under the requirements in § 1090.1337 and is produced during a period not to exceed 10 days.
- (5) A fuel manufacturer must certify each batch of fuel at the facility where the fuel is produced or at a facility that is under the complete control of the fuel manufacturer before they transfer custody or title of the fuel to any other person.
- (6) No person may sell, offer for sale, distribute, offer to distribute, supply, offer for supply, dispense, store, transport, or introduce into commerce gasoline, diesel fuel, or ECA marine fuel that is not certified under this section.

(b) **Gasoline.**

- (1) A gasoline manufacturer must certify gasoline as specified in paragraph (b)(2) of this section prior to introduction into commerce.
- (2) To certify batches of gasoline, a gasoline manufacturer must comply with all the following:
 - (i) Register with EPA as a refiner, blending manufacturer, importer, transmix processor, certified butane blender, or certified pentane blender under subpart I of this part, as applicable, prior to producing gasoline.
 - (ii) Ensure that each batch of gasoline meets the applicable requirements of subpart C of this part using the applicable procedures specified in subpart N of this part. A transmix processor must also meet all applicable requirements of subpart F of this part to ensure that each batch of gasoline meets the applicable requirements of subpart C of this part.
 - (iii) Assign batch numbers as specified in § 1090.1020.
 - (iv) Designate batches of gasoline as specified in § 1090.1010.
- (3) PCG may be mixed with other PCG without re-certification if the resultant mixture complies with the applicable standards in subpart C of this part and is accurately and clearly designated under § 1090.1010. Resultant mixtures of PCG are not new batches and should not be assigned new batch numbers.
- (4) Any person who mixes summer gasoline with summer or winter gasoline that has a different designation must comply with one of the following:
 - (i) Designate the resultant mixture as meeting the least stringent RVP designation of any batch that is mixed. For example, a distributor that mixes Summer RFG with 7.8 psi Summer CG must designate the mixture as 7.8 psi Summer CG.
 - (ii) Determine the RVP of the mixture using the procedures specified in subpart N of this part and designate the new batch under § 1090.1010 to reflect the RVP of the resultant mixture.

- (5) Any person who mixes summer gasoline with winter gasoline to transition any storage tank from winter to summer gasoline is exempt from the requirement in paragraph (b)(4)(ii) of this section but must ensure that the gasoline meets the applicable RVP standard in § 1090.215.

(c) **Diesel fuel and ECA marine fuel.**

- (1) A diesel fuel or ECA marine fuel manufacturer must certify diesel fuel or ECA marine fuel as specified in paragraph (c)(2) of this section prior to introducing the fuel into commerce.
- (2) To certify batches of diesel fuel or ECA marine fuel, a diesel fuel or ECA marine fuel manufacturer must comply with all the following:
 - (i) Register with EPA as a refiner, blending manufacturer, importer, or transmix processor under subpart I of this part, as applicable, prior to producing diesel fuel or ECA marine fuel.
 - (ii) Ensure that each batch of diesel fuel or ECA marine fuel meets the applicable requirements of subpart D of this part using the applicable procedures specified in subpart N of this part. A transmix processor must also meet all applicable requirements specified in subpart F of this part to ensure that each batch of diesel fuel or ECA marine fuel meets the applicable requirements of subpart D of this part.
 - (iii) Assign batch numbers as specified in § 1090.1020.
 - (iv) Designate batches of diesel fuel as specified in § 1090.1015.

(d) **Oxygenates.**

- (1) An oxygenate producer must certify oxygenates intended to be blended into gasoline as specified in paragraph (d)(2) of this section.
- (2) To certify batches of oxygenates, an oxygenate producer must comply with all the following:
 - (i) Register with EPA as an oxygenate producer under subpart I of this part prior to producing or importing oxygenate intended for blending into gasoline.
 - (ii) Ensure that each batch of oxygenate meets the requirements in § 1090.270 by using the applicable procedures specified in subpart N of this part.
 - (iii) Assign batch numbers as specified in § 1090.1020.
 - (iv) Designate batches of oxygenate as intended for blending with gasoline as specified in § 1090.1010(c).

(e) **Certified butane.**

- (1) A certified butane producer must certify butane intended to be blended by a blending manufacturer under § 1090.1320 as specified in paragraph (e)(2) of this section.
- (2) To certify batches of certified butane, a certified butane producer must comply with all the following:
 - (i) Ensure that each batch of certified butane meets the requirements in § 1090.250 by using the applicable procedures specified in subpart N of this part.
 - (A) Testing must occur after the most recent delivery into the certified butane producer's storage tank, before transferring the certified butane batch for delivery.

(B) The certified butane producer must provide documentation of the test results for each batch of certified butane to the certified butane blender.

(ii) Designate batches of certified butane as intended for blending with gasoline as specified in § 1090.1010(d).

(f) **Certified pentane.**

(1) A certified pentane producer must certify pentane intended to be blended by a blending manufacturer under § 1090.1320 as specified in paragraph (f)(2) of this section.

(2) To certify batches of certified pentane, a certified pentane producer must comply with all the following:

(i) Register with EPA as a certified pentane producer under subpart I of this part prior to producing certified pentane.

(ii) Ensure that each batch of certified pentane meets the requirements in § 1090.255 by using the applicable procedures specified in subpart N of this part.

(A) Testing must occur after the most recent delivery into the certified pentane producer's storage tank, before transferring the certified pentane batch for delivery.

(B) The certified pentane producer must provide documentation of the test results for each batch of certified pentane to the certified pentane blender.

(iii) Assign batch numbers as specified in § 1090.1020.

(iv) Designate batches of certified pentane as intended for blending with gasoline as specified in § 1090.1010(d).

(g) **Certified ethanol denaturant.**

(1) A certified ethanol denaturant producer must certify certified ethanol denaturant intended to be used to make DFE that meets the requirements in § 1090.275 as specified in paragraph (g)(2) of this section.

(2) To certify batches of certified ethanol denaturant, a certified ethanol denaturant producer must comply with all the following:

(i) Register with EPA as a certified ethanol denaturant producer under subpart I of this part prior to producing certified ethanol denaturant.

(ii) Ensure that each batch of certified ethanol denaturant meets the requirements in § 1090.275 by using the applicable procedures specified in subpart N of this part.

(iii) Assign batch numbers as specified in § 1090.1020.

(iv) Designate batches of certified ethanol denaturant as intended for blending with gasoline as specified in § 1090.1010(e).

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4355, Jan. 15, 2025]

§ 1090.1005 Designation of batches of fuel, fuel additive, and regulated blendstock.

- (a) A fuel manufacturer, fuel additive manufacturer, or regulated blendstock producer must designate batches of fuel, fuel additive, or regulated blendstock as specified in this subpart.
- (b) A fuel manufacturer, fuel additive manufacturer, or regulated blendstock producer must designate the fuel, fuel additive, or regulated blendstock prior to the fuel, fuel additive, or regulated blendstock leaving the facility where it was produced and must include the designations on PTDs as specified in this subpart.
- (c) By designating a batch of fuel, fuel additive, or regulated blendstock under this subpart, the designating party is acknowledging that the batch is subject to all applicable standards under this part.
- (d) A person must comply with all provisions of this part even if they fail to designate or improperly designate a batch of fuel, fuel additive, or regulated blendstock.
- (e) No person may use the designation provisions of this subpart to circumvent any standard or requirement in this part.

§ 1090.1010 Designation requirements for gasoline and regulated blendstocks.

- (a) **Designation requirements for gasoline manufacturers.** A gasoline manufacturer must accurately and clearly designate each batch of gasoline as follows:
 - (1) A gasoline manufacturer must designate each batch of gasoline as one of the following fuel types:
 - (i) Winter RFG.
 - (ii) Summer RFG.
 - (iii) Winter RBOB.
 - (iv) Summer RBOB.
 - (v) Winter CG.
 - (vi) Summer CG.
 - (vii) Winter CBOB.
 - (viii) Summer CBOB.
 - (ix) Exempt gasoline under subpart G of this part (including additional identifying information).
 - (x) California gasoline.
 - (2) A gasoline manufacturer must further designate gasoline designated as Summer CG or Summer CBOB as follows:
 - (i) 7.8 psi Summer CG or Summer CBOB, respectively.
 - (ii) 9.0 psi Summer CG or Summer CBOB, respectively.
 - (iii) If the CBOB is excluded from the special regulatory treatment for ethanol under § 1090.215(b)(3)(ii), Low-RVP Summer CBOB.
 - (iv) SIP-controlled Summer CG or Summer CBOB, respectively.

- (3) A CBOB or RBOB manufacturer must further designate the CBOB or RBOB with the type(s) and amount(s) of oxygenate specified to be blended with the CBOB or RBOB as specified in § 1090.710(a)(5).
- (4) In addition to any other applicable designation in this paragraph (a), gasoline designed for downstream oxygenate blending for which the gasoline manufacturer has not accounted for oxygenate added downstream under § 1090.710 must be designated as “Intended for Oxygenate Blending”, along with a designation indicating the type(s) and amount(s) of oxygenate to be blended with the gasoline.
- (b) **Designation requirements for gasoline distributors and certain gasoline blending manufacturers.** A gasoline distributor, certified butane blender, certified pentane blender, or party that recertifies BOB under § 1090.740 must accurately and clearly designate each batch or portion of a batch of gasoline for which they transfer custody to another facility as follows:
 - (1) A distributor must accurately and clearly classify each batch or portion of a batch of gasoline as specified by the gasoline manufacturer in paragraph (a) of this section.
 - (2) Except as specified in paragraph (b)(2)(vii) of this section, a distributor, certified butane blender, certified pentane blender, or party that recertifies BOB under § 1090.740 may redesignate a batch or portion of a batch of gasoline without recertifying the batch or portion of a batch as follows:
 - (i) Winter RFG or Winter RBOB may be redesignated as either Winter CG or Winter CBOB.
 - (ii) Winter CG or Winter CBOB may be redesignated as either Winter RFG or Winter RBOB.
 - (iii) Summer RFG, Summer RBOB, Summer CG, or Summer CBOB may be redesignated without recertification to a less stringent RVP designation. For example, a distributor could redesignate without recertification a portion of a batch of Summer RFG to 7.8 psi Summer CG or 9.0 psi Summer CG.
 - (iv) Summer RFG, Summer RBOB, Summer CG, or Summer CBOB may be redesignated without recertification as either Winter RFG, Winter RBOB, Winter CG, or Winter CBOB.
 - (v) Summer CG, Summer CBOB, or any winter gasoline may be redesignated to either Summer RFG or Summer RBOB, provided the RVP is determined using the applicable procedures specified in subpart N of this part and the new batch meets the RFG RVP standard specified in § 1090.215(a)(3).
 - (vi)
 - (A) California gasoline may be redesignated as RFG or CG, with appropriate season designation and RVP designation under paragraph (a) of this section, if the requirements specified in § 1090.625(d) are met.
 - (B) California gasoline that is not redesignated under paragraph (b)(2)(vi)(A) of this section may instead be recertified as gasoline under § 1090.1000(b).
 - (vii) CG or RFG must not be redesignated as BOB.
 - (3) A distributor, certified butane blender, certified pentane blender, or party that recertifies BOB under § 1090.740 that redesignates a batch or portion of a batch of gasoline under paragraph (b)(2) of this section must accurately and clearly designate the batch or portion of the batch of gasoline as specified in paragraph (a) of this section.

- (c) **Designation requirements for oxygenate producers.** An oxygenate producer must accurately and clearly designate each batch of oxygenate intended for blending with gasoline as one of the following oxygenate types:
 - (1) DFE.
 - (2) The name of the specific oxygenate (e.g., isobutanol).
- (d) **Designation requirements for certified butane and certified pentane.** A certified butane or certified pentane producer must accurately and clearly designate each batch of certified butane or certified pentane as one of the following types:
 - (1) Certified butane.
 - (2) Certified pentane.
- (e) **Designation requirements for certified ethanol denaturant.** A certified ethanol denaturant producer must accurately and clearly designate batches of certified ethanol denaturant as “certified ethanol denaturant”.
- (f) **Designation requirements for TGP.** A transmix processor must accurately and clearly designate any TGP that they transfer to any other person as “TGP”.

[85 FR 78469, Dec. 4, 2020, as amended at 89 FR 14775, Feb. 29, 2024; 90 FR 4355, Jan. 15, 2025]

§ 1090.1015 Designation requirements for diesel fuel and distillate fuel.

- (a) **Designation requirements for diesel fuel and distillate fuel manufacturers.**
 - (1) Except as specified in paragraph (a)(3) of this section, a diesel fuel or distillate fuel manufacturer must accurately and clearly designate each batch of diesel fuel or distillate fuel as at least one of the following fuel types:
 - (i) ULSD. A diesel fuel manufacturer may also designate ULSD as 15 ppm MVNRLM diesel fuel.
 - (ii) 500 ppm LM diesel fuel.
 - (iii) Heating oil.
 - (iv) Jet fuel.
 - (v) Kerosene.
 - (vi) ECA marine fuel.
 - (vii) Distillate global marine fuel.
 - (viii) Certified NTDF.
 - (ix) Exempt diesel fuel or distillate fuel under subpart G of this part (including additional identifying information).
 - (2) Only a fuel manufacturer that complies with the requirements in § 1090.515 may designate fuel as 500 ppm LM diesel fuel.
 - (3) Any batch of diesel fuel or distillate fuel that is certified and designated as ULSD may also be designated as heating oil, kerosene, ECA marine fuel, jet fuel, or distillate global marine fuel if it is also suitable for such use.

- (b) **Designation requirements for distributors of diesel fuel and distillate fuel.** A distributor of diesel fuel or distillate fuel must accurately and clearly designate each batch of diesel fuel or distillate fuel for which they transfer custody as follows:
- (1) A distributor must accurately and clearly designate such diesel fuel or distillate fuel by sulfur content while it is in their custody (e.g., as 15 ppm or 500 ppm).
 - (2) A distributor must accurately and clearly designate such diesel fuel or distillate fuel as specified by the diesel fuel or distillate fuel manufacturer under paragraph (a) of this section.
 - (3) A distributor may redesignate batches or portions of batches of diesel fuel or distillate fuel for which they transfer custody to another facility without recertifying the batch or portion of the batch as follows:
 - (i) ULSD that is also suitable for use as kerosene or jet fuel (commonly referred to as dual use kerosene) may be designated as ULSD, kerosene, or jet fuel (as applicable).
 - (ii) ULSD may be redesignated as 500 ppm LM diesel fuel, heating oil, kerosene, ECA marine fuel, jet fuel, or distillate global marine fuel without recertification if all applicable requirements under this part are met for the new fuel designation.
 - (iii) California diesel fuel may be redesignated as ULSD if the requirements specified in § 1090.625(e) are met.
 - (iv) Heating oil, kerosene, ECA marine fuel, or jet fuel may be redesignated as ULSD if it meets the ULSD standards in § 1090.305 and was designated as ULSD under paragraph (a) of this section.
 - (v) 500 ppm LM diesel fuel may be redesignated as ECA marine fuel, distillate global marine fuel, or heating oil. Any person who redesignates 500 ppm LM diesel fuel to ECA marine fuel or distillate global marine fuel must maintain records from the producer of the 500 ppm LM diesel fuel (i.e., PTDs accompanying the fuel under § 1090.1115) to demonstrate compliance with the 500 ppm sulfur standard in § 1090.320(b).
 - (vi) Fuel designated as certified NTFD may be redesignated as ULSD without recertification if the applicable requirements of 40 CFR 80.1408 are met.
- (c) **ULSD designation limitation.** No person may designate distillate fuel with a sulfur content greater than the sulfur standard in § 1090.305(b) as ULSD.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4355, Jan. 15, 2025]

§ 1090.1020 Batch numbering.

- (a) A fuel manufacturer, fuel additive manufacturer, or regulated blendstock producer must assign a number (the "batch number") to each batch of gasoline, diesel fuel, oxygenate, certified pentane, or certified ethanol denaturant either produced or imported. The batch number must, if available, consist of the EPA-assigned company registration number of the party that either produced or imported the fuel, fuel additive, or regulated blendstock, the EPA-assigned facility registration number where the fuel, fuel additive, or regulated blendstock was produced or imported, the last two digits of the year that the batch was either produced or imported, and a unique number for the batch, beginning with the number one (1)

for the first batch produced or imported each calendar year and each subsequent batch during the calendar year being assigned the next sequential number (e.g., 4321-54321-20-000001, 4321-54321-20-000002, etc.). EPA assigns company and facility registration numbers as specified in subpart I of this part.

- (b) Certified butane or certified pentane blended with PCG during a period of up to one month may be included in a single batch for purposes of reporting to EPA.
- (c) A gasoline manufacturer that recertifies BOBs under § 1090.740 may include up to a single month's volume as a single batch for purposes of reporting to EPA.

Subpart L—Product Transfer Documents

§ 1090.1100 General requirements.

- (a) **General provisions.**
 - (1) On each occasion when any person transfers custody or title to any product covered under this part, other than when fuel is sold or dispensed to the ultimate end user at a retail outlet or WPC facility, the transferor must provide the transferee PTDs that include the following information:
 - (i) The name and address of the transferor.
 - (ii) The name and address of the transferee.
 - (iii) The volume of the product being transferred.
 - (iv) The location of the product at the time of the transfer.
 - (v) The date of the transfer.
 - (2) The specific designations required for gasoline-related products specified in § 1090.1010 or distillate-related products specified in § 1090.1015.
- (b) **Use of codes.** Except for transfers to a truck carrier, retailer, or WPC, product codes may be used to convey the information required under this subpart, if such codes are clearly understood by each transferee.
- (c) **Part 80 PTD requirements.** For any product subject to 40 CFR part 80, subpart M, a party must also include the applicable PTD information required under 40 CFR 80.1453.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4355, Jan. 15, 2025]

§ 1090.1105 PTD requirements for exempt fuel, fuel additive, and regulated blendstock.

- (a) In addition to the information required under § 1090.1100, on each occasion when any person transfers custody or title to any exempt fuel, fuel additive, or regulated blendstock under subpart G of this part, other than when the exempt fuel, fuel additive, or regulated blendstock is sold or dispensed to the ultimate end user at a retail outlet or WPC facility, the transferor must provide the transferee PTDs that include the following statements, as applicable:
 - (1) **National security exemption language.** For fuel, fuel additive, or regulated blendstock with a national security exemption specified in § 1090.605: "This fuel is for use in vehicles, engines, or equipment under an EPA-approved national security exemption only."

- (2) **R&D exemption language.** For fuel, fuel additive, or regulated blendstock used for an R&D program specified in § 1090.610: “This fuel is for use in research, development, and test programs only.”
- (3) **Racing fuel language.** For fuel, fuel additive, or regulated blendstock used for racing purposes specified in § 1090.615: “This fuel is for racing purposes only.”
- (4) **Aviation fuel language.** For fuel, fuel additive, or regulated blendstock used in aircraft specified in § 1090.615: “This fuel is for aviation use only.”
- (5) **Territory fuel exemption language.** For fuel for use in American Samoa, Guam, or the Commonwealth of the Northern Mariana Islands specified in § 1090.620: “This fuel is for use only in Guam, American Samoa, or the Northern Mariana Islands.”
- (6) **California gasoline language.** For California gasoline specified in § 1090.625: “California gasoline”.
- (7) **California diesel fuel language.** For California diesel fuel specified in § 1090.625: “California diesel fuel”.
- (8) **Alaska, Hawaii, Puerto Rico, and U.S. Virgin Islands summer gasoline language.** For summer gasoline for use in Alaska, Hawaii, Puerto Rico, or the U.S. Virgin Islands specified in § 1090.630: “This summer gasoline is for use only in Alaska, Hawaii, Puerto Rico, or the U.S. Virgin Islands.”
- (9) **Exported fuel language.** For exported fuel, fuel additive, or regulated blendstock specified in § 1090.645: “This fuel is for export from the United States only.”
- (b) In statements required by paragraph (a) of this section, where “fuel” is designated in a statement, the specific fuel, fuel additive, or regulated blendstock type (e.g., “diesel fuel” or “gasoline”) may be used in place of the word “fuel”.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4355, Jan. 15, 2025]

§ 1090.1110 PTD requirements for gasoline, gasoline additives, and gasoline regulated blendstocks.

- (a) **General requirements.** On each occasion when any person transfers custody or title of any gasoline, gasoline additive, or gasoline regulated blendstock, other than when fuel is sold or dispensed to the ultimate end user at a retail outlet or WPC facility, the transferor must provide the transferee PTDs that include the following information:
 - (1) All applicable information required under § 1090.1100 and this section.
 - (2) An accurate and clear statement of the applicable designation of the gasoline, gasoline additive, or gasoline regulated blendstock under § 1090.1010.
- (b) **BOB language requirements.** For batches of BOB, in addition to the information required under paragraph (a) of this section, the following information must be included on the PTD:
 - (1) **Oxygenate type(s) and amount(s).** Statements specifying each oxygenate type and amount (or range of amounts) for which the BOB was certified under § 1090.710(a)(5).
 - (2) **Summer BOB language requirements.**
 - (i) Except as specified in paragraph (b)(2)(ii) of this section, for batches of summer BOB, identification of the product with one of the following statements indicating the applicable RVP standard, as specified in § 1090.215:

- (A) "9.0 psi CBOB. This product does not meet the requirements for summer reformulated gasoline."
 - (B) "7.8 psi CBOB. This product does not meet the requirements for summer reformulated gasoline."
 - (C) "Low-RVP CBOB. This product does not meet the requirements for summer reformulated gasoline."
 - (D) "RBOB. This product meets the requirements for summer reformulated or conventional gasoline."
 - (ii) For BOBs designed to produce a finished gasoline that must meet an RVP standard required by any SIP approved or promulgated under 42 U.S.C. 7410 or 7502, additional or substitute language to satisfy the state program may be used as necessary but must include at a minimum the applicable RVP standard established under the SIP.
- (c) **RFG and CG requirements.** For batches of RFG and CG, in addition to the information required under paragraph (a) of this section, the following information must be included on the PTD:
- (1) **Summer gasoline language requirements.**
 - (i) Except as specified in paragraph (c)(1)(ii) of this section, for summer gasoline, identification of the product with one of the following statements indicating the applicable RVP standard, as specified in § 1090.215:
 - (A) For gasoline that meets the 9.0 psi RVP standard in § 1090.215(a)(1): "9.0 psi Gasoline."
 - (B) For gasoline that meets the 7.8 psi RVP standard in § 1090.215(a)(2): "7.8 psi Gasoline."
 - (C) For gasoline that meets the RFG 7.4 psi RVP standard in § 1090.215(a)(3): "Reformulated Gasoline."
 - (ii) For finished gasoline that meets an RVP standard required by any SIP approved or promulgated under 42 U.S.C. 7410 or 7502, additional or substitute language to satisfy the state program may be used as necessary.
 - (2) **Ethanol content language requirements.**
 - (i) For gasoline-ethanol blends, one of the following statements that accurately describes the gasoline:
 - (A) For gasoline containing no ethanol ("E0"), the following statement: "E0: Contains no ethanol."
 - (B) For finished gasoline containing less than 9 volume percent ethanol, the following statement: "EX—Contains up to X% ethanol." The term X refers to the maximum volume percent ethanol present in the gasoline-ethanol blend.
 - (C) For E10, the following statement: "E10: Contains between 9 and 10 vol % ethanol."
 - (D) For E15, the following statement: "E15: Contains between 10 and 15 vol % ethanol."
 - (E) For gasoline-ethanol blends containing more than 15 volume percent ethanol, the following statement: "EXX: Contains up to XX vol % ethanol." The term XX refers to the maximum volume percent ethanol present in the gasoline-ethanol blend.

- (ii) No person may designate a fuel as E10 if the fuel is produced by blending ethanol and gasoline in a manner designed to contain less than 9.0 or more than 10.0 volume percent ethanol.
- (iii) No person may designate a fuel as E15 if the fuel is produced by blending ethanol and gasoline in a manner designed to contain less than 10.0 or more than 15.0 volume percent ethanol.

(d) ***Oxygenate language requirements.*** In addition to any other PTD requirements of this subpart, on each occasion when any person transfers custody or title to any oxygenate upstream of any oxygenate blending facility, the transferor must provide to the transferee PTDs that include the following information, as applicable:

- (1) For DFE: "Denatured fuel ethanol, maximum 10 ppm sulfur."
- (2) For other oxygenates, the name of the specific oxygenate must be identified on the PTD, followed by "maximum 10 ppm sulfur." For example, for isobutanol, the following statement on the PTD would be required, "Isobutanol, maximum 10 ppm sulfur."

(e) ***Gasoline detergent language requirements.***

- (1) In addition to any other PTD requirements of this subpart, on each occasion when any person transfers custody or title to any gasoline detergent, the transferor must provide to the transferee PTDs that include the following information:
 - (i) The identity of the product being transferred as detergent.
 - (ii) The name of the registered detergent must be used to identify the detergent additive package on its PTD and the LAC on the PTD must be consistent with the requirements in § 1090.260.
- (2) In addition to any other PTD requirements of this subpart, on each occasion when any person transfers custody or title to any gasoline, the transferor must provide to the transferee PTDs that include the following information:
 - (i) The identify of the gasoline being transferred as detergent-additized gasoline or non-detergent-additized gasoline.
 - (ii) [Reserved]

(f) ***Gasoline additives language requirements.*** In addition to any other PTD requirements of this subpart, on each occasion when any person transfers custody or title to any gasoline additive that meets the requirements in § 1090.265(a), the transferor must provide to the transferee PTDs that include the following information:

- (1) The maximum allowed treatment rate of the additive so that the additive will contribute no more than 3 ppm sulfur to the finished gasoline.
- (2) [Reserved]

(g) ***Certified ethanol denaturant language requirements.*** In addition to any other PTD requirements of this subpart, on each occasion when any person transfers custody or title to any certified ethanol denaturant that meets the requirements in § 1090.275, the transferor must provide to the transferee PTDs that include the following information:

- (1) The following statement: "Certified Ethanol Denaturant suitable for use in the manufacture of denatured fuel ethanol meeting EPA standards."

- (2) The PTD must state that the sulfur content is 330 ppm or less. If the certified ethanol denaturant manufacturer represents a batch of denaturant as having a maximum sulfur content lower than 330 ppm, the PTD must instead state that lower sulfur maximum (e.g., has a sulfur content of 120 ppm or less).

(h) ***Butane and pentane language requirements.***

- (1) In addition to any other PTD requirements of this subpart, on each occasion when any person transfers custody or title to any certified butane or certified pentane, the transferor must provide to the transferee PTDs that include the following information:
 - (i) The certified butane or certified pentane producer company name and, for the certified pentane producer, the facility registration number issued by EPA.
 - (ii) One of the following statements, as applicable:
 - (A) “Certified pentane for use by certified pentane blenders.”
 - (B) “Certified butane for use by certified butane blenders.”
- (2) PTDs must be transferred from each party transferring certified butane or certified pentane for use by a certified butane or certified pentane blender to each party that receives the certified butane or certified pentane through to the certified butane or certified pentane blender, respectively.

(i) ***TGP language requirements.*** In addition to any other PTD requirements of this subpart, on each occasion when any person transfers custody or title to any TGP, the transferor must provide to the transferee PTDs that include the following information:

- (1) The following statement: “Transmix Gasoline Product—not for use as gasoline.”
- (2) [Reserved]

[85 FR 78469, Dec. 4, 2020, as amended at 89 FR 14775, Feb. 29, 2024; 90 FR 4356, Jan. 15, 2025]

§ 1090.1115 PTD requirements for distillate fuel and residual fuel.

- (a) ***General requirements.*** On each occasion when any person transfers custody or title of any distillate fuel or residual fuel, other than when fuel is sold or dispensed to the ultimate end user at a retail outlet or WPC facility, the transferor must provide the transferee PTDs that include the following information:
 - (1) The sulfur per-gallon standard that the transferor represents the distillate fuel or residual fuel to meet under subpart D of this part (e.g., 15 ppm sulfur for ULSD or 1,000 ppm sulfur for ECA marine fuel).
 - (2) An accurate and clear statement of the applicable designation(s) of the distillate fuel or residual fuel under § 1090.1015 (e.g., “ULSD”, “500 ppm LM diesel fuel”, or “ECA marine fuel”).
 - (3) If the distillate fuel or residual fuel does not meet the sulfur standard in § 1090.305(b) for ULSD, the following statement: “Not for use in highway vehicles or engines or nonroad, locomotive, or marine engines.”
- (b) ***500 ppm LM diesel fuel language requirements.*** For batches of 500 ppm LM diesel fuel, in addition to the information required under paragraph (a) of this section, PTDs must include the following information:

(1) The following statement: "500 ppm sulfur (maximum) LM diesel fuel. For use only in accordance with a compliance plan under 40 CFR 1090.515(g). Not for use in highway vehicles or other nonroad vehicles and engines."

(2) [Reserved]

(c) **ECA marine fuel language requirements.** For batches of ECA marine fuel, in addition to the information required under paragraph (a) of this section, PTDs must include the following information:

(1) The following statement: "1,000 ppm sulfur (maximum) ECA marine fuel. For use in Category 3 marine vessels only. Not for use in Category 1 or Category 2 marine vessels."

(2) A party may replace the required statement in paragraph (c)(1) of this section with the following statement for qualifying vessels under 40 CFR part 1043: "High sulfur fuel. For use only in ships as allowed by MARPOL Annex VI, Regulation 3 or Regulation 4."

(3) Under 40 CFR 1043.80, a fuel supplier (i.e., the person who transfers custody or title of marine fuel onto a vessel) must provide bunker delivery notes to vessel operators.

(d) **Distillate global marine fuel language requirements.** For batches of distillate global marine fuel, in addition to the information required under paragraph (a) of this section, PTDs must include the following information:

(1) The following statement: "5,000 ppm sulfur (maximum) Distillate Global Marine Fuel. For use only in steamships or Category 3 marine vessels outside of an Emission Control Area (ECA), consistent with MARPOL Annex VI."

(2) [Reserved]

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4356, Jan. 15, 2025]

§ 1090.1120 PTD requirements for diesel fuel additives.

In addition to any other PTD requirements in this subpart, on each occasion when any person transfers custody or title to a diesel fuel additive that is subject to the provisions of § 1090.310 to a party in the additive distribution system or in the diesel fuel distribution system for use downstream of the diesel fuel manufacturing facility, the transferor must provide to the transferee PTDs that include the following information:

(a) For diesel fuel additives that comply with the sulfur standard in § 1090.310(a), the following statement: "The sulfur content of this diesel fuel additive does not exceed 15 ppm."

(b) For diesel fuel additives that meet the requirements in § 1090.310(b), the transferor must provide to the transferee PTDs that identify the additive as such, and comply with all the following:

(1) Indicate the high sulfur potential of the diesel fuel additive by including the following statement: "This diesel fuel additive may exceed the federal 15 ppm sulfur standard. Improper use of this additive may result in non-compliant diesel fuel."

(2) If the diesel fuel additive package contains a static dissipater additive or red dye having a sulfur content greater than 15 ppm, one of the following statements must be included that accurately describes the contents of the additive package:

(i) "This diesel fuel additive contains a static dissipater additive having a sulfur content greater than 15 ppm."

- (ii) "This diesel fuel additive contains red dye having a sulfur content greater than 15 ppm."
- (iii) "This diesel fuel additive contains a static dissipater additive and red dye having a sulfur content greater than 15 ppm."
- (3) Include the following information:
 - (i) The diesel fuel additive package's maximum sulfur concentration.
 - (ii) The maximum recommended concentration for use of the diesel fuel additive package in diesel fuel, in volume percent.
 - (iii) The contribution to the sulfur content of the diesel fuel, in ppm, that would result if the diesel fuel additive package is used at the maximum recommended concentration.
- (c) For diesel fuel additives that are sold in containers for use by the ultimate consumer of diesel fuel, each transferor must display on the additive container, in a legible and conspicuous manner, one of the following statements, as applicable:
 - (1) For diesel fuel additives that comply with the sulfur standard in § 1090.310(a): "This diesel fuel additive complies with the federal low sulfur content requirements for use in diesel motor vehicles and nonroad engines."
 - (2) For diesel fuel additives that do not comply with the sulfur standard in § 1090.310(a), the following statement: "This diesel fuel additive does not comply with federal ultra-low sulfur content requirements."

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4356, Jan. 15, 2025]

§ 1090.1125 Alternative PTD language.

- (a) Alternative PTD language to the language specified in this subpart may be used if approved by EPA in advance. Such language must contain all the applicable informational elements specified in this subpart.
- (b) Requests for alternative PTD language must be submitted as specified in § 1090.10.

Subpart M—Recordkeeping

§ 1090.1200 General recordkeeping requirements.

- (a) **Length of time records must be kept.** Records required under this part must be kept for 5 years from the date they were created, except that records relating to credit transfers must be kept by the transferor for 5 years from the date the credits were transferred and must be kept by the transferee for 5 years from the date the credits were transferred, used, or terminated, whichever is later.
- (b) **Make records available to EPA.** On request by EPA, the records specified in this part must be provided to EPA. For records that are electronically generated or maintained, the equipment and software necessary to read the records must be made available or, upon approval by EPA, electronic records must be converted to paper documents that must be provided to EPA.

§ 1090.1205 Recordkeeping requirements for all regulated parties.

- (a) **Overview.** Any party subject to the requirements and provisions of this part must keep records containing the information specified in this section.

- (b) **PTDs.** Any party that transfers custody or title of any fuel, fuel additive, or regulated blendstock must maintain the PTDs for which the party is the transferor or transferee.
- (c) **Sampling and testing.** Any party that performs any sampling and testing on any fuel, fuel additive, or regulated blendstock must keep records of the following information for each sample collected:
 - (1) The date, time, location, and identification of the storage tank, railcar, truck, or vessel from which the sample was collected.
 - (2) The name of the person who collected the sample and the person who performed the test.
 - (3) The results of all tests, including where more than one test is performed, as originally printed by the testing apparatus, or where no printed result is produced, the results as originally recorded by the person that performed the test.
 - (4) The test methodology used.
 - (5) Records related to performance-based measurement and statistical quality control under §§ 1090.1360 through 1090.1375.
 - (6) Records related to gasoline deposit control testing under § 1090.1395.
 - (7) Records demonstrating the actions taken to stop the sale of any fuel, fuel additive, or regulated blendstock that is found not to be in compliance with applicable standards under this part, and the actions taken to identify the cause of any noncompliance and prevent future instances of noncompliance.
- (d) **Registration.** Any party required to register under subpart I of this part must maintain records supporting the information required to complete and maintain the registration for the party's company and each registered facility. The party must also maintain copies of any confirmation received from the submission of such registration information to EPA.
- (e) **Reporting.** Any party required to submit reports under subpart J of this part must maintain copies of all reports submitted to EPA. The party must also maintain copies of any confirmation received from the submission of such reports to EPA.
- (f) **Exemptions.** Any party that produces or distributes exempt fuel, fuel additive, or regulated blendstock under subpart G of this part must keep the following records:
 - (1) Records demonstrating the designation of the fuel, fuel additive, or regulated blendstock under subparts G and K of this part.
 - (2) Copies of PTDs generated or accompanying the exempt fuel, fuel additive, or regulated blendstock.
 - (3) Records demonstrating that the exempt fuel, fuel additive, or regulated blendstock was actually used in accordance with the requirements of the applicable exemption(s) under subpart G of this part.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4356, Jan. 15, 2025]

§ 1090.1210 Recordkeeping requirements for gasoline manufacturers.

- (a) **Overview.** In addition to the requirements in § 1090.1205, a gasoline manufacturer must keep records for each of their facilities that include the information in this section.

- (b) **Batch records.** For each batch of gasoline, a gasoline manufacturer must keep records of the following information:
- (1) The results of tests, including any calculations necessary to transcribe or correlate test results into reported values under subpart J of this part, performed to determine gasoline properties and characteristics as specified in subpart N of this part.
 - (2) The batch volume.
 - (3) The batch number.
 - (4) The date the batch was produced or imported.
 - (5) The designation of the batch under § 1090.1010.
 - (6) The PTDs for any gasoline produced or imported.
 - (7) The PTDs for any gasoline received.
- (c) **Downstream oxygenate accounting.** For BOB for which the gasoline manufacturer has accounted for oxygenate added downstream under § 1090.710, a gasoline manufacturer must keep records of the following information:
- (1) The test results for hand blends prepared under § 1090.1340.
 - (2) Records that demonstrate that the gasoline manufacturer participates in the NFSP under § 1090.1405.
 - (3) Records that demonstrate that the gasoline manufacturer participates in the NSTOP under § 1090.1450.
 - (4) Compliance calculations specified in § 1090.700 based on an assumed addition of oxygenate.
- (d) **PCG and TGP.** For new batches of gasoline produced by adding blendstock to PCG or TGP, a gasoline manufacturer must keep records of the following information:
- (1) Records that reflect the storage and movement of the PCG or TGP and blendstock within the gasoline manufacturing facility to the point such PCG or TGP is used to produce gasoline or BOB.
 - (2) For new batches of gasoline produced by adding blendstock to PCG or TGP under § 1090.1320(a)(1) or § 1090.1325, respectively, keep records of the following additional information:
 - (i) The results of tests to determine the sulfur content, benzene content, oxygenate(s) content, and in the summer, RVP, for the PCG or TGP and volume of the PCG or TGP when received at the gasoline manufacturing facility.
 - (ii) Records demonstrating which specific batches of PCG or TGP were used in each new batch of gasoline.
 - (iii) Records demonstrating which blendstocks were used in each new batch of gasoline.
 - (iv) Records of the test results for sulfur content, benzene content, oxygenate(s) content, distillation parameters, and in the summer, RVP, for each new batch of gasoline.
 - (3) For new batches of gasoline produced by adding blendstock to PCG or TGP under § 1090.1320(a)(2), keep records of the following additional information:

- (i) Records of the test results for sulfur content, benzene content, oxygenate(s) content, and in the summer, RVP, of each blendstock used to produce the new batch of gasoline.
 - (ii) Records of the test results for sulfur content and in the summer, RVP, of each new batch of gasoline.
 - (iii) Records demonstrating which blendstocks were used in each new batch of gasoline.
- (e) **Certified butane and certified pentane blenders.** For certified butane or certified pentane blended into gasoline or BOB under § 1090.1320, a certified butane or certified pentane blender must keep records of the following information:
 - (1) The volume of certified butane or certified pentane added.
 - (2) The purity and properties of the certified butane or certified pentane specified in § 1090.250 or § 1090.255, respectively.
- (f) **Importation of gasoline treated as blendstock.** For any imported GTAB, an importer must keep records of documents that reflect the storage and physical movement of the GTAB from the point of importation to the point of blending to produce gasoline or the point at which the GTAB was certified as gasoline.
- (g) **ABT.** A gasoline manufacturer must keep records of the following information related to their ABT activities under subpart H of this part, as applicable:
 - (1) Compliance sulfur values and compliance benzene values under § 1090.700, and the calculations used to determine those values.
 - (2) The number of valid credits in possession of the gasoline manufacturer at the beginning of each compliance period, separately by facility and compliance period of generation.
 - (3) The number of credits generated by the gasoline manufacturer under § 1090.725, separately by facility and compliance period of generation.
 - (4) If any credits were obtained from or transferred to other parties, all the following for each other party:
 - (i) The party's name.
 - (ii) The party's EPA company registration numbers.
 - (iii) The number of credits obtained from or transferred to the party.
 - (5) The number of credits that expired at the end of each compliance period, separately by facility and compliance period of generation.
 - (6) The number of credits that will be carried over into the next compliance period, separately by facility and compliance period of generation.
 - (7) The number of credits used, separately by facility and compliance period of generation.
 - (8) Contracts or other commercial documents that establish each transfer of credits from the transferor to the transferee.
 - (9) Documentation that supports the number of credits transferred between facilities within the same company (i.e., intracompany transfers).

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4356, Jan. 15, 2025]

§ 1090.1215 Recordkeeping requirements for diesel fuel, ECA marine fuel, and distillate global marine fuel manufacturers.

- (a) **Overview.** In addition to the requirements in § 1090.1205, a diesel fuel, ECA marine fuel, or distillate global marine fuel manufacturer must keep records for each of their facilities that include the information in this section.
- (b) **Diesel fuel and ECA marine fuel records.** For each batch of ULSD, 500 ppm LM diesel fuel, or ECA marine fuel, a diesel fuel or ECA marine fuel manufacturer must keep records of the following information:
 - (1) The batch volume.
 - (2) The batch number.
 - (3) The date the batch was produced or imported.
 - (4) The designation of the batch under § 1090.1015.
 - (5) All documents and information created or used for the purpose of batch designation under § 1090.1015, including PTDs for the batch.
- (c) **Distillate global marine fuel records.** For distillate global marine fuel, a distillate global marine fuel manufacturer must keep records of the following information:
 - (1) The designation of the fuel as distillate global marine fuel.
 - (2) The PTD for the distillate global marine fuel.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4356, Jan. 15, 2025]

§ 1090.1220 Recordkeeping requirements for oxygenate blenders.

- (a) **Overview.** In addition to the requirements in § 1090.1205, an oxygenate blender that blends oxygenate into gasoline must keep records that include the information in this section.
- (b) **Oxygenate blenders.** For each occasion that an oxygenate blender blends oxygenate into gasoline, the oxygenate blender must keep records of the following information:
 - (1) The date, time, location, and identification of the blending tank or truck in which the blending occurred.
 - (2) The volume and oxygenate requirement of the gasoline to which oxygenate was added.
 - (3) The volume, type, and purity of the oxygenate that was added, and documents that show the supplier(s) of the oxygenate used.

§ 1090.1225 Recordkeeping requirements for gasoline additives.

- (a) **Gasoline additive manufacturers.** In addition to the requirements in § 1090.1205, a gasoline additive manufacturer must keep records of the following information for each batch of additive produced or imported:
 - (1) The batch volume.
 - (2) The date the batch was produced or imported.
 - (3) The PTD for the batch.

- (4) The maximum recommended treatment rate.
- (5) The gasoline additive manufacturer's control practices that demonstrate that the additive will contribute no more than 3 ppm on a per-gallon basis to the sulfur content of gasoline when used at the maximum recommended treatment rate.
- (b) **Parties that take custody of gasoline additives.** Except for gasoline additives packaged for addition to gasoline in the vehicle fuel tank, all parties that take custody of gasoline additives for bulk addition to gasoline—from the producer through to the gasoline additive blender that adds the additive to gasoline—must keep records of the following information:
 - (1) The PTD for each batch of gasoline additive.
 - (2) The treatment rate at which the additive was added to gasoline, as applicable.
 - (3) The volume of gasoline that was treated with the additive, as applicable. A new record must be initiated in each case where a new batch of additive is mixed into a storage tank from which the additive is drawn to be injected into gasoline.

§ 1090.1230 Recordkeeping requirements for oxygenate producers.

- (a) **Oxygenate producers.** In addition to the requirements in § 1090.1205, an oxygenate producer must keep records of the following information for each batch of oxygenate:
 - (1) The batch volume.
 - (2) The batch number.
 - (3) The date the batch was produced or imported.
 - (4) The PTD for the batch.
 - (5) The sulfur content of the batch.
 - (6) The sampling and testing records specified in § 1090.1205(c), if the sulfur content of the batch was determined by analytical testing.
- (b) **DFE producers.** In addition to the requirements of paragraph (a) of this section, a DFE producer must keep records of the following information for each batch of DFE if the sulfur content of the batch was determined under § 1090.1330:
 - (1) The name and title of the person who calculated the sulfur content of the batch.
 - (2) The date the calculation was performed.
 - (3) The calculated sulfur content.
 - (4) The sulfur content of the neat (un-denatured) ethanol.
 - (5) The date each batch of neat ethanol was produced.
 - (6) The neat ethanol batch number.
 - (7) The neat ethanol batch volume.
 - (8) The neat ethanol production quality control records or the test results on the neat ethanol, as applicable.

- (9) The sulfur content of each batch of denaturant used, and the volume percent at which the denaturant was added to neat (un-denatured) ethanol to produce DFE.
- (10) The PTD for each batch of denaturant used.
- (c) **Parties that take custody of oxygenate.** All parties that take custody of oxygenate—from the oxygenate producer through to the oxygenate blender—must keep records of the following information:
 - (1) The PTD for each batch of oxygenate.
 - (2) [Reserved]

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4357, Jan. 15, 2025]

§ 1090.1235 Recordkeeping requirements for ethanol denaturant.

- (a) **Certified ethanol denaturant producers.** In addition to the requirements in § 1090.1205, a certified ethanol denaturant producer must keep records of the following information for each batch of certified ethanol denaturant:
 - (1) The batch volume.
 - (2) The batch number.
 - (3) The date the batch was produced or imported.
 - (4) The PTD for the batch.
 - (5) The sulfur content of the batch.
- (b) **Parties that take custody of ethanol denaturants.** All parties that take custody of denaturant designated as suitable for use in the production of DFE under § 1090.270(b) must keep records of the following information:
 - (1) The PTD for each batch of denaturant.
 - (2) The volume percent at which the denaturant was added to ethanol, as applicable.

§ 1090.1240 Recordkeeping requirements for gasoline detergent blenders.

- (a) **Overview.** In addition to the requirements in § 1090.1205, a gasoline detergent blender must keep records that include the information in this section.
- (b) **Gasoline detergent blenders.** A gasoline detergent blender must keep records of the following information:
 - (1) The PTD for each detergent used.
 - (2) For an automated detergent blending facility, the following information:
 - (i) The dates of the VAR period.
 - (ii) The total volume of detergent blended into gasoline, as determined using one of the following methods, as applicable:
 - (A) For a facility that uses in-line meters to measure the amount of detergent blended, the total volume of detergent measured, together with supporting data that includes one of the following:

- (1) The beginning and ending meter readings for each meter being measured.
- (2) Other comparable metered measurements.
- (B) For a facility that uses a gauge to measure the inventory of the detergent storage tank, the total volume of detergent must be calculated as follows:

Equation 1 to paragraph (b)(2)(ii)(B)

$$V_D = DI_i - DI_f + DI_a - DI_w$$

Where:

V_D = Volume of detergent, in gallons.

DI_i = Initial detergent inventory of the tank, in gallons.

DI_f = Final detergent inventory of the tank, in gallons.

DI_a = Sum of any additions to detergent inventory, in gallons.

DI_w = Sum of any withdrawals from detergent inventory for purposes other than the additization of gasoline, in gallons.

- (C) The value of each variable in the equation in paragraph (b)(2)(ii)(B) of this section must be separately recorded. Recorded volumes of detergent must be expressed to the nearest gallon (or smaller units), except that detergent volumes of five gallons or less must be expressed to the nearest tenth of a gallon (or smaller units). However, if the blender's equipment is unable to accurately measure to the nearest tenth of a gallon, then such volumes must be rounded downward to the next lower gallon.
- (iii) The total volume of gasoline to which detergent has been added, together with supporting data that includes one of the following:
 - (A) The beginning and ending meter measurements for each meter being measured.
 - (B) The metered batch volume measurements for each meter being measured.
 - (C) Other comparable metered measurements.
- (iv) The actual detergent concentration, calculated as the total volume of detergent added (as determined under paragraph (b)(2)(ii) of this section) divided by the total volume of gasoline (as determined under paragraph (b)(2)(iii) of this section). The concentration must be calculated and recorded to four digits and rounded as specified in § 1090.50.
- (v) The initial detergent concentration rate, together with the date and description of each adjustment to any initially set concentration.

- (vi) If the detergent injector is set below the applicable LAC, or adjusted by more than 10 percent above the concentration initially set in the VAR period, documentation establishing that the purpose of the change is to correct a batch misadditization prior to the end of the VAR period and prior to the transfer of the batch to another party or to correct an equipment malfunction and the date and adjustments of the correction.
 - (vii) Documentation reflecting the performance and results of the calibration of detergent equipment under § 1090.1390.
- (3) For a non-automated detergent blending facility, keep records of the following information:
- (i) The date of additization.
 - (ii) The volume of detergent added.
 - (iii) The volume of gasoline to which the detergent was added.
 - (iv) The actual detergent concentration, calculated as the volume of detergent added (per paragraph (b)(3)(ii) of this section) divided by the volume of gasoline (per paragraph (b)(3)(iii) of this section). The concentration must be calculated and recorded to four digits and rounded as specified in § 1090.50.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4357, Jan. 15, 2025]

§ 1090.1245 Recordkeeping requirements for independent surveyors.

- (a) **Overview.** In addition to the requirements in § 1090.1205, an independent surveyor must keep records that include the information in this section.
- (b) **Independent surveyors.** An independent surveyor must keep records of the following information, as applicable:
 - (1) Records related to the NFSP under § 1090.1405.
 - (2) Records related to a geographically focused E15 survey program under § 1090.1420(b).
 - (3) Records related to the NSTOP under § 1090.1450.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4357, Jan. 15, 2025]

§ 1090.1250 Recordkeeping requirements for auditors.

- (a) **Overview.** In addition to the requirements in § 1090.1205, an auditor must keep records that include the information in this section.
- (b) **Auditors.** An auditor must keep records of the following information:
 - (1) Documents pertaining to the performance of each audit performed under subpart S of this part, including all correspondence between the auditor and the fuel manufacturer.
 - (2) Copies of each attestation engagement report prepared and all related records developed to prepare each report.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4357, Jan. 15, 2025]

§ 1090.1255 Recordkeeping requirements for transmix, 500 ppm LM diesel fuel, and pipeline interface.

- (a) **Overview.** In addition to the requirements in § 1090.1205, a transmix processor, transmix blender, transmix distributor, manufacturer or distributor of 500 ppm LM diesel fuel using transmix, or pipeline operator must keep records that include the information in this section.
- (b) **Transmix.**
 - (1) A transmix processor or transmix distributor must keep records that reflect the results of any sampling and testing required under subpart F or M of this part.
 - (2) A transmix processor must keep records showing the volumes of TGP recovered from transmix and the type and amount of any blendstock or PCG added to make gasoline from TGP under § 1090.505.
 - (3) A transmix processor that adds blendstock to TGP or PCG must keep records under § 1090.1210(d).
 - (4) A transmix blender must keep records showing compliance with the quality assurance program and/or sampling and testing requirements in § 1090.500, and for each batch of gasoline with which transmix is blended, the volume of the batch, and the volume of transmix blended into the batch.
- (c) **500 ppm LM diesel fuel.** A manufacturer or distributor of 500 ppm LM diesel fuel using transmix must keep records of the following information, as applicable:
 - (1) Copies of the compliance plan required under § 1090.515(g).
 - (2) Documents demonstrating how the party complies with each applicable element of the compliance plan under § 1090.515(g).
 - (3) Documents and copies of calculations used to determine compliance with the 500 ppm LM diesel fuel volume requirements under § 1090.515(c).
 - (4) Documents or information that demonstrates that the 500 ppm LM diesel fuel was only used in locomotive or marine engines that are not required to use ULSD under 40 CFR 1033.815 or 40 CFR 1042.660, respectively.
- (d) **Pipeline interface.** A pipeline operator must keep records that demonstrate compliance with the pipeline interface handling practices in § 1090.520.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4357, Jan. 15, 2025]

Subpart N—Sampling, Testing, and Retention

§ 1090.1300 General provisions.

- (a) This subpart is organized as follows:
 - (1) Sections 1090.1310 through 1090.1330 specify the scope of required testing, including special provisions that apply in several unique circumstances.
 - (2) Sections 1090.1335 through 1090.1345 specify handling procedures for collecting and retaining samples. Sections 1090.1350 through 1090.1375 specify the procedures for measuring the specified parameters. These procedures apply to anyone who performs testing under this subpart.

- (3) Section 1090.1390 specifies the requirements for calibrating automated detergent blending equipment.
- (4) Section 1090.1395 specifies the procedures for testing related to gasoline deposit control test procedure.
- (b) If you need to meet requirements for a quality assurance program at a minimum frequency, the first shipment of product you receive from each distributor triggers the testing requirement for that distributor. Perform testing with the first shipment of product to demonstrate compliance for the testing period. The following example illustrates the requirements for testing based on sampling the more frequent of every 90 days or 500,000 gallons of certified butane you receive from each distributor:
 - (1) If you receive an initial shipment of certified butane from a distributor on March 1, perform testing on that batch to show that it meets standards. A passing result qualifies all further shipments of certified butane from that distributor until May 29, as long as you receive less than 500,000 gallons of certified butane from that distributor during those 90 days. In that case, the testing period ends May 29 and the next testing period starts when you receive another shipment of certified butane from that distributor on or after May 30.
 - (2) If you receive a shipment from that distributor before May 29 that causes the total volume of certified butane from that distributor to exceed 500,000 gallons over the testing period, the date that batch is received represents the end of the testing period. The next testing period starts when you receive another shipment of certified butane from that distributor.
- (c) Anyone acting on behalf of a regulated party to demonstrate compliance with requirements under this part must meet the requirements of this subpart in the same way that the party needs to meet those requirements for its own testing. The regulated party and the third party will both be liable for any violations arising from the third party's failure to meet the requirements of this subpart.
- (d) Anyone performing tests under this subpart must apply good laboratory practices for all sampling, measurement, and calculations related to testing required under this part. This requires performing these procedures in a way that is consistent with generally accepted scientific and engineering principles and properly accounting for all available relevant information. The following examples illustrate how to apply good laboratory practices:
 - (1) You may exclude outlier data points for quality testing under § 1090.1375 as specified in ASTM D6299 (incorporated by reference, see § 1090.95), subject to the following requirements:
 - (i) The justification for exclusion must be an assignable cause that is not part of the normal process and does not result from common causes.
 - (ii) You must meet requirements for documenting and supporting exclusion of data points as specified in § 1090.1375(a)(4).
 - (2) [Reserved]
- (e) Subpart Q of this part has provisions related to importation, including additional provisions that specify how to meet the sampling and testing requirements of this subpart.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4357, Jan. 15, 2025]

SCOPE OF TESTING

§ 1090.1310 Testing to demonstrate compliance with standards.

- (a) Perform testing as needed to certify fuel, fuel additive, or regulated blendstock as specified in subpart K of this part. This section specifies additional test requirements.
- (b) A fuel manufacturer, fuel additive manufacturer, or regulated blendstock producer must perform the following measurements before fuel, fuel additive, or regulated blendstock from a given batch leaves the facility, except as specified in paragraph (f) of this section and § 1090.1315:
 - (1) **Diesel fuel.** Perform testing for each batch of ULSD (including nonpetroleum diesel fuel), 500 ppm LM diesel fuel, and ECA marine fuel to demonstrate compliance with sulfur standards.
 - (2) **Gasoline.** Perform testing for each batch of gasoline to demonstrate compliance with sulfur standards and perform testing for each batch of summer gasoline to demonstrate compliance with RVP standards.
- (c) The following testing provisions apply for gasoline, oxygenate, certified ethanol denaturant, certified butane, and certified pentane:
 - (1) A gasoline manufacturer producing BOB for which oxygenate added downstream is accounted for under § 1090.710 must prepare a hand blend as specified in § 1090.1340 and perform the following measurements:
 - (i) Measure the sulfur content of both the BOB and the hand blend.
 - (ii) Except as specified in § 1090.1325(c), measure the benzene content of the hand blend.
 - (iii) For Summer CG, measure the RVP of the BOB.
 - (iv) For Summer RFG, measure the RVP of the hand blend.
 - (2) A gasoline manufacturer producing gasoline for which oxygenate added downstream is not accounted for under § 1090.710 (e.g., E0 or so-called suboctane gasoline) must perform the following measurements:
 - (i) Measure the sulfur content of the gasoline.
 - (ii) Except as specified in § 1090.1325(c), measure the benzene content of the gasoline.
 - (iii) For Summer CG and Summer RFG, measure the RVP of the gasoline.
 - (iv) For Summer RFG that is designated as “Intended for Oxygenate Blending” under § 1090.1010(a)(4), create a hand blend as specified in § 1090.1340 and measure the RVP of the hand blend.
 - (v) For gasoline blended with oxygenate, measure the oxygenate content of the gasoline.
 - (3) An oxygenate producer must measure the sulfur content of each batch of oxygenate, except that a DFE producer may meet the alternative requirements in § 1090.1330.
 - (4) An ethanol denaturant producer that certifies denaturant under § 1090.1330 must measure the sulfur content of each batch of denaturant.
 - (5) A certified butane or certified pentane producer must perform sampling and testing to demonstrate compliance with purity specifications and sulfur and benzene standards as specified in § 1090.1320.

- (6) A transmix processor producing gasoline from TGP must test each batch of gasoline for parameters required to demonstrate compliance with § 1090.505 as specified in § 1090.1325.
- (d) A blending manufacturer producing gasoline by adding blendstock to PCG must comply with § 1090.1320.
- (e) For gasoline produced at a fuel blending facility or a transmix processing facility, a gasoline manufacturer must measure such gasoline for oxygenate and for distillation parameters (i.e., T10, T50, T90, final boiling point, and percent residue). However, a fuel manufacturer or transmix processor does not need to measure the oxygenate content of gasoline if PCG, transmix, TGP, and blendstocks used to produce the batch did not contain any oxygenates, based on the following documentation:
 - (1) For PCG, documentation consists of oxygenate content identified on PTDs.
 - (2) For transmix, TGP, and blendstocks, documentation consists of affidavits or oxygenate test results from the person providing the transmix or blendstock stating that these products do not contain oxygenate.
- (f) Refiners and blending manufacturers may meet the testing requirements of paragraph (b) of this section by loading gasoline or diesel fuel onto a marine vessel, subject to the following conditions:
 - (1) The marine vessel remains within 15 miles of the fuel manufacturing facility after loading.
 - (2) Each vessel compartment is sampled for meeting certification testing requirements as specified in § 1090.1605(b)(1).
 - (3) No additional loading or blending occurs after sampling and certification are complete.
 - (4) The refiner or blending manufacturer ensures that the fuel meets all applicable per-gallon standards before the fuel leaves the area specified in paragraph (f)(1) of this section.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4357, Jan. 15, 2025; 91 FR 16500, Apr. 1, 2026]

§ 1090.1315 In-line blending.

A fuel manufacturer using in-line blending equipment may qualify for a waiver from the requirement in § 1090.1310(b) to test every batch of fuel before the fuel leaves the fuel manufacturing facility. This section describes in-line blending waiver provisions that apply instead of or in addition to the requirements in § 1090.1335(c).

- (a) Submit a request signed by the RCO, or their delegate, to EPA with the following information:
 - (1) Describe the location of your in-line blending operation, how long it has been in operation, and how much of each type and grade of fuel you have blended over the preceding 3 years (or since starting the in-line blending operation if it is less than 3 years). Describe the physical layout of the blending operation and how you move the blended fuel into distribution. Also describe how your automated system monitors and controls blending proportions and the properties of the blended fuel. For new installations, describe these as a planned operation with projected volumes by type and grade. Describe clearly which portions of your blending operation are the subject of your waiver request.

- (2) Describe how you collect and test composite fuel samples in a way that is equivalent to measuring the fuel properties of a batch of blended fuel as specified in this subpart. Also describe how your procedures conform to the sampling specifications in ASTM D4177 and the composite calculations in ASTM D5854 (both incorporated by reference in § 1090.95).
- (3) Describe any expectation or plan for you or another party to perform additional downstream testing for the same fuel parameters.
- (4) Describe your quality assurance procedures. Explain how you will ensure that all fuel will meet all applicable per-gallon standards. Describe any experiences from the previous 3 years where these quality assurance procedures led you to make corrections to your in-line blending operation. Describe how you will deal with release of fuel that fails to meet a per-gallon standard.
- (5) Describe any times from the previous 3 years that you modified fuel after it left your facility. Describe how you modified the fuel and why that was necessary.
- (6) Describe how you will meet the auditing requirements specified in § 1090.1850 and any additional, facility-specific considerations that relate to those auditing requirements.
- (7) Describe which blendstock parameters you intend to measure for managing the blending process and the typical sampling frequency for those measurements.
- (8) Describe any circumstances in which it is not possible to meet the requirements for sampling frequency as specified in § 1090.1335(c)(3). Also describe how you will adjust target values to account for the greater measurement variability. For example, if the greater margin of error corresponds to a 2 percent increase in measurement variability, adjust target values of all parameters subject to per-gallon and average standards downward by at least 2 percent.
- (9) Describe an alternative sampling plan to meet requirements to test head, middle, and tail samples for small batches. Your alternative sampling plan may allow you to collect a single sample anytime during the blend for a batch involving up to 8 hours of blending or up to 1 million gallons of fuel, and it may allow you to collect two evenly distributed samples during the blend for a batch involving up to 16 hours of blending or up to 2 million gallons of fuel.
- (10) Describe your plans to meet requirements to test head, middle, and tail samples in cases where unforeseen circumstances cause the batch to be complete before blending the anticipated batch volume. Any failure to perform required tests must not occur in more than 10 percent of in-line blending batches for the calendar year.
- (11) Describe contingency plans for alternative sampling and testing in cases involving failure of the automatic compositor or other essential equipment. For example, the contingency plan may identify collecting a second composite sample with a redundant system.
- (12) Describe any contingency plans for an alternative sampling demonstration if an automatic sampling test result fails to meet a per-gallon standard. For example, the plan may include certifying the batch based on manual sampling in a tank if you collect the whole batch in the tank before it leaves the fuel manufacturing facility gate. As another example, as long as the fuel remains at the facility, you may certify the batch based on secondary automatic sampling as fuel comes out of a holding tank that you use to collect the fuel that failed to meet a per-gallon standard.
- (13) In the case of in-line blending into a marine vessel, describe an alternative, equivalent method for meeting the requirement in § 1090.1335(c)(4) to collect head-middle-tail samples.

- (14) Include the following statement: "The information in this submission is true, accurate, and complete to the best of my knowledge. I am aware that there are significant civil and criminal penalties for submitting false, misleading, or incomplete information."
- (b) You must arrange for an audit of your blending operation each calendar year as specified in § 1090.1850. The audit must review procedures and documents to determine whether measured and calculated values properly represent the aggregate fuel properties for the blended fuel.
- (c) The following provisions apply for amending an approved waiver under this section:
 - (1) You must submit an updated waiver request to EPA 60 days before making any material change to your in-line blending process. Material changes generally include anything that causes the previously approved waiver to be incorrect or incomplete. Examples of material changes may include changing analyzer hardware or programming, changing the analyzer's location for drawing samples of blended fuel, changing the piping configuration, changing the mixing control hardware or programming logic, changing sample compositors or compositor settings, or expanding fuel blending capacity. Changing the name of the company or business unit is an example of a change that is not material.
 - (2) The request must include a description of the intended changes and a comparison document that clearly and comprehensively identifies the proposed changes to the waiver. The request must also include the statement in paragraph (a)(14) of this section.
 - (3) Your request to amend a waiver under this section is deemed to be approved effective 60 days after EPA acknowledges receiving the request if there is no EPA response to the request. Such a response may be in the form of denying the request, identifying deficiencies, or requiring additional information. If we require that you correct a deficiency or submit additional information, your waiver request is deemed to be approved effective 60 days after EPA acknowledges receiving the responsive submission.
- (d) If EPA approves your request for a waiver under this section, you may need to update your procedures for more effective control and documentation of measured fuel parameters based on audit results, development of improved practices, or other information.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4358, Jan. 15, 2025]

§ 1090.1320 Adding blendstock to PCG.

The requirements of this section apply for a refiner or blending manufacturer that adds blendstock to PCG to produce a new batch of gasoline. Paragraph (b) of this section specifies an alternative approach for a certified butane or certified pentane blender. Section 1090.1325 describes additional provisions that apply to a transmix processor.

- (a) Sample and test using one of the following methods to exclude PCG from the compliance demonstration for sulfur content and benzene content:
 - (1) **Compliance by subtraction.**
 - (i) Determine the sulfur content, benzene content, and oxygenate content of the PCG before blending blendstocks to produce a new batch of gasoline as follows:

- (A) Sample and test the sulfur content, benzene content, and oxygenate content of each batch of PCG using the procedures in § 1090.1350. Demonstrate homogeneity for the consolidated batch as specified in § 1090.1337 if blending involves multiple batches of PCG, or if a single batch of PCG was certified without demonstrating homogeneity under § 1090.1337(a)(4). The blending manufacturer does not need to test PCG for oxygenate content if they can demonstrate that the PCG does not contain oxygenates as specified in paragraph (a)(1)(i)(C) of this section or § 1090.1310(e)(1). For PCG sampled from a pipeline as specified in § 1090.1335(c), homogeneity provisions apply as specified in § 1090.1337, except that no homogeneity testing is required for a volume less than 1 million gallons. Evaluate homogeneity based on two evenly distributed samples if volume is between 1 million and 2 million gallons, and based on three evenly distributed samples if volume is greater than 2 million gallons. If multiple samples meet homogeneity requirements, composite the collected samples for testing sulfur, benzene, and oxygenate.
- (B) If the PCG is a BOB and the blending manufacturer is accounting for downstream oxygenate under § 1090.710, also prepare a hand blend under § 1090.1340 and test the hand blend for sulfur content and benzene content.
- (C) The blending manufacturer may use the PCG manufacturer's certification test results if the PCG was received directly from the PCG manufacturer by an in-tank transfer or tank-to-tank transfer within the same terminal as long as the results are from the PCG that is being transferred.
- (D) If multiple samples do not meet homogeneity requirements, demonstrate compliance based on the lowest measured values as specified in § 1090.1337(a)(4).
- (E) If you are unable to measure a PCG parameter, you must comply using either the presumed value for the PCG volume or an EPA-approved alternative value as described in § 1090.1710(g).
- (ii) Determine the volume of PCG that was blended with blendstock to produce a new batch of gasoline. Report the PCG as a negative batch as specified in § 1090.905(c)(3)(i).
- (iii) After adding blendstock to PCG, sample and test the sulfur content, benzene content, and for summer gasoline, RVP, of the new batch of gasoline.
- (iv) Determine the volume of the new batch of gasoline. Report the new batch of gasoline as a positive batch as specified in § 1090.905(c)(3)(ii).
- (v) Include the PCG batch and the new batch of gasoline in compliance calculations as specified in § 1090.700(d)(4)(i).
- (vi) The sample retention requirements in § 1090.1345 apply for both the new batch of gasoline and the associated PCG.
- (2) **Compliance by addition.**
 - (i) Sample and test the sulfur content and benzene content of each batch of blendstock used to produce a new batch of gasoline from PCG using the procedures in § 1090.1350. The homogeneity requirements for gasoline specified in § 1090.1337 apply to blendstock and GTAB collected with manual sampling.
 - (ii) Determine the volume of each batch of blendstock used to produce the new batch of gasoline.

- (iii) Determine the volume of each blended batch of gasoline, and measure the sulfur content and for summer gasoline, RVP, for each blended batch of gasoline using the procedures specified in § 1090.1350. Testing the blended batch of gasoline for sulfur content, however, is not required if the fuel manufacturer tests the added blendstock and determines that both the blendstock and PCG meet the fuel manufacturing facility gate sulfur per-gallon standard in § 1090.205(b).
 - (iv) Report each batch of blendstock as specified in § 1090.905(c)(4).
 - (v) Include each batch of blendstock in compliance calculations as specified in § 1090.700(d)(4)(ii).
 - (vi) The sample retention requirements in § 1090.1345 apply for the new batch of gasoline and for each blendstock.
- (b) A certified butane or certified pentane blender that blends certified butane or certified pentane into PCG, other than Summer RFG or Summer RBOB, to make a new batch of gasoline may comply with the following requirements instead of the requirements of paragraph (a) of this section:
- (1) For summer gasoline, measure the RVP of the blended fuel. The fuel manufacturer may rely on test results from the certified butane or certified pentane producer for sulfur content and benzene content.
 - (2) Before blending the certified butane or certified pentane with PCG, obtain a copy of the producer's test results indicating that the certified butane or certified pentane meets the standards in § 1090.250 or § 1090.255, respectively.
 - (3) The certified pentane blender must enter into a contract with the certified pentane producer to verify that the certified pentane producer has an adequate quality assurance program to ensure that the certified pentane received will not be contaminated in transit.
 - (4) The certified butane or certified pentane blender must conduct a quality assurance program to demonstrate that the certified butane or certified pentane meets the standards specified in § 1090.250 or § 1090.255, respectively. The quality assurance program must be based on sampling the more frequent of every 90 days or 500,000 gallons of certified butane or certified pentane received from each distributor. The certified butane or certified pentane blender may rely on a third party to perform the testing.
 - (5) If the quality assurance testing under paragraph (b)(4) of this section shows that certified butane or certified pentane fails to meet one or more of the standards specified in § 1090.250 or § 1090.255, the certified butane or certified pentane received from that distributor at that butane blending facility or pentane blending facility during that testing period is deemed to be in violation of the relevant per-gallon standard. Any later shipment of certified butane or certified pentane received from that distributor at that butane blending facility or pentane blending facility will also be deemed to be in violation of the relevant per-gallon standard unless another quality assurance test is conducted demonstrating that certified butane or certified pentane received from that distributor meets the standards specified in § 1090.250 or § 1090.255.
 - (6) If certified butane or certified pentane is deemed to be in violation under paragraph (b)(5) of this section, the certified butane or certified pentane blender must calculate its compliance obligations using paragraph (a)(1) or (2) of this section using the test results from the quality assurance

program and obtain any necessary sulfur or benzene credits. For purposes of averaging, banking, and trading, the certified butane or certified pentane deemed to be in violation will be subject to the sulfur and benzene standards in §§ 1090.205 and 1090.210, respectively.

- (c) This paragraph describes provisions that apply in cases where PCG is a BOB for which the PCG manufacturer accounted for oxygenate added downstream under § 1090.710 and the blending manufacturer makes a new batch that includes less oxygenate than was specified for the BOB by the PCG manufacturer. A blending manufacturer in this circumstance does not qualify for the small volume blender exemption for BOB recertification under § 1090.740(a)(3) and must comply with all the following.
 - (1) Calculate and incur sulfur and benzene deficits under the BOB recertification provisions of § 1090.740.
 - (2) Comply with either the compliance by subtraction requirements of paragraph (a)(1) of this section or the compliance by addition requirements of paragraph (a)(2) of this section. For compliance by subtraction, test the PCG without adding oxygenate (i.e., test the PCG “neat”), and report the PCG volume without adjusting for the volume of oxygenate that the PCG manufacturer specified under § 1090.740.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4358, Jan. 15, 2025]

§ 1090.1325 Adding blendstock or PCG to TGP.

The following provisions apply to a transmix processor or blending manufacturer producing gasoline by adding blendstock or PCG to TGP:

- (a) Determine the volume, sulfur content, and benzene content of each blendstock batch used to produce gasoline for reporting and compliance calculations by following the sampling and testing requirements in § 1090.1320 and treating the TGP used to produce the gasoline as PCG.
- (b) Sample and test the gasoline made from TGP and PCG or blendstock to demonstrate compliance with the fuel manufacturing facility gate sulfur per-gallon standard in § 1090.205(b) and the applicable RVP standard in § 1090.215.
- (c) A transmix processor producing gasoline by only adding TGP to PCG does not have to measure the benzene content of the finished gasoline.

§ 1090.1330 Preparing denatured fuel ethanol.

Instead of measuring every batch, a DFE producer or importer may calculate the sulfur content of a batch of DFE as follows:

- (a) Determine the sulfur content of ethanol before adding denaturant by measuring it as specified in § 1090.1310 or by estimating it based on your production quality control procedures.
- (b) Use the ppm sulfur content of certified ethanol denaturant specified on the PTD for the batch. If the sulfur content is specified as a range, use the maximum specified value.
- (c) Calculate the weighted sulfur content of the DFE using the values determined under paragraphs (a) and (b) of this section.

HANDLING AND PREPARING SAMPLES

§ 1090.1335 Collecting, preparing, and testing samples.

- (a) **General provisions.** Use good laboratory practice to collect samples to represent the batch you are testing. For example, take steps to ensure that a batch is always well mixed before sampling. Also, always take steps to prevent sample contamination, such as completely flushing sampling taps and piping and pre-rinsing sample containers with the product being sampled. Follow the procedures in paragraph (b) of this section for manual sampling. Follow the procedures in paragraph (c) of this section for automatic sampling. Additional requirements for measuring RVP are specified in paragraph (d) of this section. A description of how to determine compliance based on single or multiple tests on single or multiple samples is specified in paragraph (e) of this section.
- (b) **Manual sampling.** Perform manual sampling using one of the methods specified in ASTM D4057 (incorporated by reference; see § 1090.95) to demonstrate compliance with standards as follows:
- (1) Collect a “running” or “all-levels” sample from the top of the tank. Drawing a sample from a standpipe is acceptable only if it is slotted or perforated to ensure that the drawn sample properly represents the whole batch.
 - (2) Use tap sampling (or other spot sampling) to collect upper, middle, and lower samples. Collect samples that most closely match the recommendations in ASTM D4057. Adjust spot sampling for partially filled tanks as shown in Table 1, Table 5, or Table 6 of ASTM D4057, as applicable.
 - (3) If the procedures in paragraphs (b)(1) and (2) of this section are impractical for a given storage configuration, you may use alternative sampling procedures as specified in ASTM D4057. This applies primarily for sampling with railcars, trucks, retail outlets, and other downstream locations.
 - (4) Test results with manual sampling are valid only after you demonstrate homogeneity as specified in § 1090.1337. Once a batch meets homogeneity specifications, you may use any properly drawn sample to represent the batch, subject to the hand-blending provisions of § 1090.1340. The entire batch volume is noncompliant if a sample fails to meet any applicable per-gallon standard.
 - (5) Except as specified for marine vessels in § 1090.1605, you must not do certification testing with a composite sample from manual sampling.
- (c) **Automatic sampling.** Perform automatic sampling as specified in ASTM D4177 (incorporated by reference; see § 1090.95), with the additional provisions specified in this paragraph (c). Automatic sampling is intended to apply for in-line blending, including configurations that involve a pipeline filling a tank that will be certified as compliant before it leaves the fuel manufacturing facility gate.
- (1) Follow all specifications for automatic sampling in this paragraph (c) unless EPA approves an in-line blending waiver that authorizes specific exceptions under § 1090.1315.
 - (2) Configure the system to ensure a well-mixed stream at the sampling point. Align the start and end of sampling with the start and end of creating the batch.
 - (3) Set a sampling frequency to represent a batch by meeting one or more of the following specifications, keeping records to show that the sampling frequency meets specifications:
 - (i) Collect 9,604 grabs.
 - (ii) Collect a number of grabs that achieves a margin of error of 0.01 or less as specified in Section 19.1.3 of ASTM D4177.
 - (iii) Collect grabs at regular intervals that do not exceed 20 seconds throughout the batch.

- (4) Collect three samples for individual measurements in addition to the composite sample. Draw head, middle, and tail samples that come from the initial, middle, and final thirds of the estimated batch volume, respectively.
- (5) If the composite sample fails to meet any applicable per-gallon standard, the entire batch volume is noncompliant. If one or more separate samples fail to meet any applicable per-gallon standard, the volume of noncompliant fuel is the volume starting with the last valid passing result before the failing result (or the start of the batch), up to the first valid passing result after the failing result (or the end of the batch).
- (6) EPA may approve a different sampling strategy under an approved in-line blending waiver under § 1090.1315 if it is appropriate for a given facility or for a small-volume batch.
- (d) ***Sampling provisions related to measuring RVP of summer gasoline.*** The following additional provisions apply for preparing samples to measure the RVP of summer gasoline:
 - (1) Meet the additional specifications for manual and automatic sampling in ASTM D5842 (incorporated by reference; see § 1090.95).
 - (2) If you measure other fuel parameters for a given sample in addition to RVP testing, always measure RVP first.
- (e) ***Testing and reporting to demonstrate compliance with standards.*** Perform testing as specified in this subpart and report values to demonstrate compliance with per-gallon and average standards as follows:
 - (1) For parameters subject to per-gallon standards, report the highest measured value (or the lowest measured value for testing related to cetane index or other parameters that are subject to a standard representing a minimum value). This applies for repeat tests on a given sample and for testing multiple samples (including head, middle, and tail samples from automatic sampling).
 - (2) In the case of automatic sampling for parameters subject to average standards, report the result from the composite sample to represent the batch for demonstrating compliance with the average standard. For any repeat testing with the composite sample, calculate the arithmetic average from all tests to represent the batch.
 - (3) In the case of manual sampling for parameters subject to average standards, determine the value representing the batch as follows:
 - (i) For testing with only a single sample, report that value to represent the batch. If there are repeat tests with that sample, report the arithmetic average from all tests to represent the sample.
 - (ii) For testing with more than one sample, report the arithmetic average from all tested samples to represent the batch. If there are repeat tests for any sample, calculate the arithmetic average of those repeat tests to determine a single value to represent that sample before calculating the average value to represent the batch.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4359, Jan. 15, 2025]

§ 1090.1337 Demonstrating homogeneity.

- (a) Certification test results corresponding to manual sampling as specified in § 1090.1335(b) are valid only if collected samples meet the homogeneity specifications in this section, except that the homogeneity testing requirement does not apply in the following cases:

- (1) There is only a single sample using the procedure specified in § 1090.1335(b)(2).
 - (2) Upright cylindrical tanks that have a liquid depth of less than 10 feet.
 - (3) Horizontal tanks with circular or elliptical cross section with a volume less than 42,000 gallons used for storing ethanol denaturant. Draw samples from the approximate mid-depth of the product level.
 - (4) You draw spot samples as specified in paragraph (c) of this section, test each sample for every parameter subject to a testing requirement, and use the worst-case test result for each parameter for purposes of reporting, meeting per-gallon and average standards, and all other aspects of compliance.
 - (5) Your tank configuration depends on roof sampling for homogeneity demonstration, but inclement weather prevents collecting roof samples and EPA has already approved a plan for a mixing procedure to ensure a homogeneous batch for your specific tank configuration. EPA approval of the mixing procedure will include consideration of product type, fill level, and other relevant parameters for specific tank configurations and batch characteristics. Keep records to document EPA approval of the mixing procedure, your actions to follow the approved mixing procedure, and the forcing weather event.
 - (6) Sampling occurs at a downstream location where it is not possible to collect separate samples and steps are taken to ensure that the batch is well mixed.
 - (7) The product being tested is certified butane or certified pentane.
- (b) Any test to establish homogeneity is considered a certification test relative to a per-gallon standard for a given parameter if the test result is the worst-case value from all testing performed for the batch. Report the highest measured value as specified in § 1090.1335(e)(1).
- (c) Use spot sampling as specified in § 1090.1335(b)(2) for homogeneity testing.
- (d) Demonstrate homogeneity for gasoline and TGP using two of the procedures specified in this paragraph (d) with each sample. For summer gasoline, the homogeneity demonstration must include RVP measurement.
- (1) Measure density or API gravity using ASTM D287, ASTM D1298, ASTM D4052, or ASTM D7777 (incorporated by reference, see § 1090.95).
 - (2) Measure the sulfur content as specified in § 1090.1360.
 - (3) Measure the benzene content as specified § 1090.1360.
 - (4) Measure the RVP as specified in § 1090.1360.
- (e) For testing of diesel fuel (including nonpetroleum diesel fuel) and ECA marine fuel to meet the standards in subpart D of this part, demonstrate homogeneity using one of the procedures specified in paragraph (d)(1) or (2) of this section.
- (f) Consider the batch to be homogeneous for a given parameter if the measured values for all tested samples vary by no more than the published reproducibility of the test method multiplied by 0.75 ($R \times 0.75$). If reproducibility is a function of measured values, calculate reproducibility using the average value of the measured parameter representing all tested samples. Calculate using all meaningful significant figures as specified for the test method, even if § 1090.1350(c) describes a different precision. For cases that do not require a homogeneity demonstration under paragraph (a) of this section, the lack of

homogeneity demonstration does not prevent a quantity of fuel, fuel additive, or regulated blendstock from being considered a batch for demonstrating compliance with the requirements of this part. The following additional provisions apply for special cases:

- (1) Do not use test results for a given test method for a parameter to demonstrate homogeneity if multiple measured values are at or below the test method's PLOQ, LLOQ, or valid range, as applicable. You may instead use a different test method as allowed under this subpart to get test results with the same parameter or with a different parameter.
- (2) If you have homogeneity test results for more than the required number of parameters and not all parameters meet the criteria, all testing results except density or API gravity must meet applicable homogeneity criteria to demonstrate that the batch is homogeneous.
- (3) If using ASTM D4052 (incorporated by reference; see § 1090.95) for measuring density or API gravity to demonstrate homogeneity through December 31, 2026, you may calculate the homogeneity criterion based on the reproducibility of the test method at the limit of the valid range for testing, even if measured results extend beyond the valid range. You may request to use an updated version of ASTM D4052 if the updated version has expanded the range of reproducibility to include your measured results. You may also request to use the provisions of this paragraph (f)(3) beyond December 31, 2026, if there is no updated version of ASTM D4052 with reproducibility that applies for your measured results.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4360, Jan. 15, 2025; 91 FR 16500, Apr. 1, 2026]

§ 1090.1340 Preparing a hand blend from BOB.

- (a) If you produce or import BOB and instruct downstream blenders to add oxygenate, you must meet the requirements of this subpart by blending oxygenate that reflects the anticipated sulfur content and benzene content of the oxygenate for blending into a BOB sample. To do this, prepare each hand blend by adding oxygenate to the BOB sample in a way that corresponds to your instructions to downstream blenders for the sampled batch of fuel. Prepare hand blends as follows:
 - (1) Take steps to avoid introducing high or low bias in sulfur content when selecting from available samples to prepare the hand blend. For example, if there are three samples with discrete sulfur content measurements, select the sample with the mid-range sulfur content. In other cases, randomly select the sample. If you omit the homogeneity demonstration under § 1090.1337(a)(4), prepare a single hand blend using the BOB sample that has the highest sulfur content.
 - (2) If your instructions allow for a downstream blender to add more than one type or concentration of oxygenate, prepare the hand blend as follows:
 - (i) For summer gasoline intended for blending with ethanol, use the lowest specified ethanol blend.
 - (ii) For all winter gasoline and for summer gasoline intended for blending only with oxygenate other than ethanol, use the lowest specified oxygenate concentration, regardless of the type of oxygenate.
 - (iii) As an example, if you give instructions for a given batch of BOB to perform downstream blending to make E10, E15, and a blend that contains 8 volume percent butanol, prepare a hand blend for testing winter gasoline with 8 volume percent butanol, and prepare an E10 hand blend for testing summer gasoline.

- (b) Prepare the hand blend using the procedures specified in ASTM D7717 (incorporated by reference in § 1090.95). The hand blend must have an amount of oxygenate that does not exceed the oxygenate concentration specified on the PTD for the BOB under § 1090.1110(b)(1).

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4361, Jan. 15, 2025]

§ 1090.1345 Retaining samples.

- (a) Retain samples as follows:
 - (1) A fuel manufacturer, regulated blendstock producer, or independent surveyor must keep representative samples of gasoline, diesel fuel, or oxygenate that is subject to certification testing requirements under this subpart for at least 30 days after testing is complete, except that a longer sample retention of 90 days applies for a blending manufacturer that produces gasoline.
 - (2) A certified pentane producer must keep representative samples of certified pentane for at least 30 days after testing is complete.
 - (3) A blending manufacturer required to test blendstock under § 1090.1320(a)(2) must keep representative samples of the blendstock and the new batch of gasoline for at least 90 days after testing is complete.
 - (4) An oxygenate producer or importer must keep oxygenate samples as follows:
 - (i) Keep a representative sample of any tested oxygenate. Also keep a representative sample of DFE if you used the provisions of § 1090.1330 to calculate its sulfur content.
 - (ii) Keep all the samples you collect over the previous 21 days. If you have fewer than 20 samples from the previous 21 days, continue keeping the most recent 20 samples collected up to a maximum of 90 days for any given sample.
 - (5) The nominal volume of retained liquid samples must be at least 330 ml.
 - (6) If you have only a single sample for testing, keep that sample after testing is complete. If you collect multiple samples from a single batch, keep any sample that represents the batch, except that samples of summer gasoline must be untested.
 - (7) If you test a hand blend under § 1090.1340, keep a sample of the BOB and a sample representative of the oxygenate used to prepare the hand blend.
- (b) Keep records of all calculations, test results, and test methods for the batch associated with each stored sample.
- (c) If EPA requests a test sample, you must follow EPA's instructions and send it to EPA by a courier service (or equivalent). The instructions will describe where and when to send the sample. For each test sample, you must identify the test results and test methods used.
- (d) You are responsible for meeting the requirements of this section even if a third party performs testing and stores the fuel samples for you.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4361, Jan. 15, 2025]

MEASUREMENT PROCEDURES

§ 1090.1350 Overview of test procedures.

A fuel manufacturer, fuel additive manufacturer, regulated blendstock producer, or independent surveyor meets the requirements of this subpart based on laboratory measurements of the specified fuel parameters. Test procedures for these measurements apply as follows:

- (a) Except as specified in paragraph (b) of this section, the Performance-based Measurement System specified in §§ 1090.1360 through 1090.1375 applies for all testing specified in this subpart for the following fuels and fuel parameters:
 - (1) Sulfur content of diesel fuel.
 - (2) Sulfur content of ECA marine fuel.
 - (3) RVP, sulfur content, benzene content, and oxygenate content of gasoline. The procedures for measuring sulfur in gasoline in this subpart also apply for testing sulfur in certified ethanol denaturant; however, demonstrating compliance for alternative procedures in § 1090.1365 and statistical quality control in § 1090.1375 do not apply for sulfur concentration above 80 ppm.
 - (4) Sulfur content of butane.
- (b) Specific test procedures apply for measuring other fuel parameters, as follows:
 - (1) Determine the cetane index of diesel fuel as specified in ASTM D976 or ASTM D4737 (incorporated by reference in § 1090.95). There is no cetane-related test requirement for biodiesel that meets ASTM D6751 (incorporated by reference in § 1090.95).
 - (2) Measure aromatic content of diesel fuel as specified in ASTM D1319 or ASTM D5186 (incorporated by reference in § 1090.95). You may use an alternative procedure if you correlate your test results with ASTM D1319 or ASTM D5186. There is no aromatics-related test requirement for biodiesel that meets ASTM D6751.
 - (3) Measure the purity of butane as specified in ASTM D2163 (incorporated by reference in § 1090.95). Measure the purity of pentane as specified in ASTM D2163 or ASTM D5134 (incorporated by reference in § 1090.95).
 - (4) Measure the benzene content of butane and pentane as specified in ASTM D2163, ASTM D5134, ASTM D6729, or ASTM D6730 (incorporated by reference in § 1090.95).
 - (5) Measure the sulfur content of pentane as specified in ASTM D5453 (incorporated by reference in § 1090.95).
 - (6) Measure distillation parameters as specified in ASTM D86 (incorporated by reference in § 1090.95). You may use an alternative procedure if you correlate your test results with ASTM D86.
 - (7) Measure the sulfur content of neat ethanol as specified in ASTM D5453. You may use an alternative procedure if you adequately correlate your test results with ASTM D5453.
 - (8) Measure the phosphorus content of gasoline as specified in ASTM D3231 (incorporated by reference in § 1090.95).
 - (9) Measure the lead content of gasoline as specified in ASTM D3237 (incorporated by reference in § 1090.95).

- (10) Measure the sulfur content of gasoline additives and diesel fuel additives as specified in ASTM D2622 (incorporated by reference in § 1090.95).
- (11) Use referee procedures specified in § 1090.1360(d) and the following additional methods to measure gasoline fuel parameters to meet the survey requirements of subpart O of this part:

TABLE 1 TO PARAGRAPH (b)(11)—ADDITIONAL SURVEY TEST METHODS

Fuel parameter	Units	Test method ¹
Distillation	°C	ASTM D86.
Aromatic content	volume percent	ASTM D5769.
Olefin content	volume percent	ASTM D6550.

¹ ASTM specifications are incorporated by reference, see § 1090.95.

- (12) Updated versions of the test procedures specified in this section are acceptable as alternative procedures if both repeatability and reproducibility are the same or better than the values specified in the earlier version.
- (c) Record measured values with the following precision, with rounding in accordance with § 1090.50:
 - (1) Record sulfur content to the nearest whole ppm.
 - (2) Record benzene to the nearest 0.01 volume percent.
 - (3) Record RVP to the nearest 0.01 psi.
 - (4) Record oxygenate content to the nearest 0.01 mass percent for each measured oxygenate.
 - (5) Record diesel fuel aromatic content to the nearest 0.1 volume percent, or record cetane index to the nearest whole number.
 - (6) Record gasoline aromatic and olefin content to the nearest 0.1 volume percent.
 - (7) Record distillation parameters to the nearest whole degree.
- (d) For any measurement or calculation that depends on the volume of the test sample, correct the volume of the sample to a reference temperature of 15.56 °C. Use a correction equation that is appropriate for each tested compound. This applies for all fuels, blendstocks, and additives, except butane.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4361, Jan. 15, 2025]

§ 1090.1355 Calculation adjustments and corrections.

Adjust measured values as follows:

- (a) Adjust measured values for total vapor pressure as follows:

Equation 1 to paragraph (a)

$$\text{RVP} = 0.956 \cdot P_{\text{total}} - 0.347$$

Where:

RVP = Reid vapor pressure, in psi.

P_{total} = Measured total vapor pressure, in psi.

- (b) For measuring the sulfur content and benzene content of gasoline, adjust a given test result upward in certain circumstances, as follows:
 - (1) If your test method involves a published procedure with a Pooled Limit of Quantitation (PLOQ), treat the PLOQ as your final result if your measured result is below the PLOQ.
 - (2) If your test method involves a published procedure with a limited scope but no PLOQ, treat the lower bound of the scope as your final result if your measured result is less than that value.
 - (3) If you establish a Laboratory Limit of Quantitation (LLOQ) below the lower bound of the scope of the procedure as specified in ASTM D6259 (incorporated by reference in § 1090.95), treat the LLOQ as your final result if your measured result is less than the LLOQ. Note that this option is meaningful only if the LLOQ is less than a published PLOQ, or if there is no published PLOQ.
- (c) For measuring the sulfur content of ULSD at a downstream location, subtract 2 ppm from the result.
- (d) For measuring the benzene content of butane and pentane, report a zero value if the test result is at or below the PLOQ or Limit of Detection (LOD) that applies for the test method.
- (e) If measured content of any oxygenate compound is less than 0.20 percent by mass, record the result as "None detected."

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4361, Jan. 15, 2025; 90 FR 24518, June 11, 2025]

§ 1090.1360 Performance-based Measurement System.

- (a) The Performance-based Measurement System (PBMS) is an approach that allows for laboratory testing with any procedure that meets specified performance criteria. This subpart specifies the performance criteria for measuring certain fuel parameters to demonstrate compliance with the standards and other specifications of this part. These provisions do not apply to process stream analyzers used with in-line blending.
- (b) Different requirements apply for absolute fuel parameters and method-defined fuel parameters.
 - (1) Absolute fuel parameters are those for which it is possible to evaluate measurement accuracy by comparing measured values of a test sample to a reference sample with a known value for the measured parameter. The following are absolute fuel parameters:
 - (i) Sulfur.
 - (ii) [Reserved]

- (2) Method-defined fuel parameters are all those that are not absolute fuel parameters. Additional test provisions apply for method-defined fuel parameters under this section because there is no reference sample for evaluating measurement accuracy.

(c) The performance criteria of this section apply as follows:

- (1) Section 1090.1365 specifies the initial qualifying criteria for all measurement procedures. You may use an alternative procedure only if testing shows that you meet the initial qualifying criteria.
- (2) Section 1090.1375 specifies ongoing quality testing requirements that apply for a laboratory that uses either referee procedures or alternative procedures.
- (3) Streamlined requirements for alternative procedures apply for procedures adopted by a voluntary consensus standards body (VCSB). Certification testing with non-VCSB procedures requires advance approval by EPA. Procedures are considered non-VCSB testing as follows:
 - (i) Procedures developed by individual companies or other parties are considered non-VCSB procedures.
 - (ii) Draft procedures under development by a VCSB organization are considered non-VCSB procedures until they are approved for publication.
 - (iii) A published procedure is considered non-VCSB for testing with fuel parameters that fall outside the range of values covered in the research report of the ASTM D6708 (incorporated by reference in § 1090.95) assessment comparing candidate alternative procedures to the referee procedure specified in paragraph (d) of this section.
- (4) You may use updated versions of the referee procedures as alternative procedures subject to the limitations of § 1090.1365(a)(2). You may ask EPA for approval to use an updated version of the referee procedure for qualifying other alternative procedures if the updated referee procedure has the same or better repeatability and reproducibility compared to the version specified in § 1090.95. If the updated procedure has worse repeatability or reproducibility compared to the earlier version, you must complete the required testing specified in § 1090.1365 using the older, referenced version of the referee procedure.
- (5) Any laboratory may use the specified referee procedure without qualification testing. To use alternative procedures at a given laboratory, you must perform the specified testing to demonstrate compliance with precision and accuracy requirements, with the following exceptions:
 - (i) Testing you performed to qualify alternative procedures under 40 CFR part 80 continues to be valid for making the demonstrations required in this part.
 - (ii) Qualification testing is not required for a laboratory that measures the benzene content of gasoline using Procedure B of ASTM D3606 (incorporated by reference in § 1090.95). However, qualification testing may be necessary for updated versions of this procedure as specified in § 1090.1365(a)(2).

- (d) Referee procedures are presumed to meet the initial qualifying criteria in this section. You may use alternative procedures if you qualify them using the referee procedures as a benchmark as specified in § 1090.1365. The following are the referee procedures:

TABLE 1 TO PARAGRAPH (d)—REFeree PROCEDURES FOR QUALIFYING ALTERNATIVE PROCEDURES

Tested product	Parameter	Referee procedure ¹
ULSD, 500 ppm diesel fuel, ECA marine fuel, gasoline	Sulfur	ASTM D2622.
Butane	Sulfur	ASTM D6667.
Gasoline	oxygenate content	ASTM D5599.
Gasoline	RVP	ASTM D5191, except as specified in § 1090.1355(a).
Gasoline	benzene	ASTM D5769.

¹ ASTM specifications are incorporated by reference, see § 1090.95.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4361, Jan. 15, 2025]

§ 1090.1365 Qualifying criteria for alternative measurement procedures.

This section specifies how to qualify alternative procedures for measuring absolute and method-defined fuel parameters under the Performance-based Measurement System specified in § 1090.1360.

- (a) The following general provisions apply for qualifying alternative procedures:
- (1) Alternative procedures must have appropriate precision to allow for reporting to the number of decimal places specified in § 1090.1350(c).
 - (2) Testing to qualify an alternative procedure applies for the specified version of the procedure you use for making the necessary measurements. For referee procedures and for alternative procedures for method-defined fuel parameters that you have qualified for your laboratory, updated versions of those same procedures are qualified without further testing, as long as the specified reproducibility is the same as or better than the values specified in the earlier version. For absolute fuel parameters, updated versions are qualified without testing if both repeatability and reproducibility are the same as or better than the values specified in the earlier version.
 - (3) Except as specified in paragraph (d) of this section, testing to demonstrate compliance with the precision and accuracy specifications in this section apply only for the laboratory where the testing occurred. At a given laboratory, qualifying a test method applies for all associated instruments used for testing to certify fuel.
 - (4) If a procedure for measuring benzene or sulfur in gasoline has no published PLOQ and no published scope with a lower bound, you must establish a LLOQ.

- (5) Testing for method-defined fuel parameters must take place at a reference installation as specified in § 1090.1370.
- (b) All alternative procedures must meet precision criteria based on a calculated maximum allowable standard deviation for a given fuel parameter as specified in this paragraph (b). The precision criteria apply for measuring the parameters and fuels specified in paragraph (b)(4) of this section. Take the following steps to qualify the measurement procedure for measuring a given fuel parameter:
 - (1) The fuel must meet the parameter specifications in table 1 to paragraph (b)(4) of this section. This may require that you modify the fuel you typically produce to be within the specified range. Absent a specification (maximum or minimum), select a fuel representing values that are typical for your testing. Store and mix the fuel to maintain a homogenous mixture throughout the measurement period to ensure that each fuel sample drawn from the batch has the same properties.
 - (2) Measure the fuel parameter from a homogeneous fuel batch at least 20 times. Record each result in sequence. Do not omit any valid results unless you use good engineering judgment to determine that the omission is necessary and you document those results and the reason for excluding them. Perform this analysis over a 20-day period. You may make up to 4 separate measurements in a 24-hour period, as long as the interval between measurements is at least 4 hours. Do not measure RVP more than once from a single sample.
 - (3) An alternative procedure for measuring oxygenate in gasoline must account for every type of oxygenate covered by the referee method.
 - (4) Calculate the maximum allowable standard deviation as follows:

Equation 1 to Paragraph (b)(4)

$$\sigma_{\max} = X_1 \cdot \frac{X_2}{X_3}$$

Where:

$\sigma_{\max}$ = Maximum allowable standard deviation.

x_1 , x_2 , and x_3 have the values from the following table:

TABLE 1 TO PARAGRAPH (b)(4)—PRECISION CRITERIA FOR QUALIFYING ALTERNATIVE PROCEDURES

Fuel, fuel additive, or regulated blendstock	Fuel parameter	Range	x_1	x_2 repeatability (r) or reproducibility (R) ¹	x_3	Fixed values of $\sigma_{\max}$	Source ²
ULSD	Sulfur	5 ppm minimum	1.5	$r = 1.33$	2.77	0.72	ASTM D3120-08.
500 ppm LM diesel fuel	Sulfur	350 ppm minimum	1.5	$r = 21.3$	2.77	11.5	ASTM D2622-16.
ECA marine fuel	Sulfur	700 ppm minimum	1.5	$r = 37.1$	2.77	20.1	ASTM D2622-16.
Butane	Sulfur		1.5	$r = 0.1152 \cdot x$	2.77		ASTM D6667-14.
Gasoline	Sulfur		1.5	$r = 0.4998 \cdot x^{0.54}$	2.77		ASTM D7039-15a.
Gasoline	Oxygenate		0.3	$R = 0.13 \cdot x^{0.83}$	1		ASTM D5599-18.
Gasoline	RVP ³		0.3	$R = 0.40$	1	0.12	ASTM D5191-15
Gasoline	Benzene		0.15	$R = 0.221 \cdot x^{0.67}$	1		ASTM D5769-20.

¹ Calculate repeatability and reproducibility using the average value determined from testing. Use units as specified in § 1090.1350(c).

² Note that the listed procedure may be different than the referee procedure identified in § 1090.1360(d), or it may be an older version of the referee procedure.

³ Use only 1-liter containers for testing to qualify alternative methods.

- (c) Alternative VCSB procedures for measuring absolute fuel parameters (sulfur) must meet accuracy criteria based on the following measurement procedure:
- (1) Obtain gravimetric sulfur standards to serve as representative reference samples. The samples must have known sulfur content within the ranges specified in paragraph (c)(3) of this section. The known sulfur content is the accepted reference value (ARV) for the fuel sample.
 - (2) Measure the sulfur content of the fuel sample at your laboratory at least 10 times, without interruption. Use good laboratory practice to compensate for any known chemical interferences; however, you must apply that same compensation for all tests to measure the sulfur content of a test fuel. Calculate the arithmetic average of all the measured values, including any compensation.
 - (3) The measurement procedure meets the accuracy requirement as follows:
 - (i) Demonstrate accuracy for measuring sulfur in gasoline and butane using samples to represent sulfur values from 1 to 10 ppm, 11 to 20 ppm, and 21 to 95 ppm. You may omit any of these ranges if you do not perform testing with fuel in that range. Calculate the maximum allowable difference between the average measured value and the ARV for each applicable range as follows:

Equation 2 to Paragraph (c)(3)(i)

$$\Delta_{\max} = 0.75 \cdot \sigma_{\max}$$

Where:

$\Delta_{\max}$ = Maximum allowable difference.

$\sigma_{\max}$ = Maximum allowable standard deviation, per paragraph (b)(4) of this section, using the sulfur content represented by the ARV.

- (ii) Demonstrate accuracy for measuring sulfur in diesel fuel using test fuels meeting the specifications in table 2 to this section. For testing diesel fuel-related blendstocks and additives, use representative test samples meeting the appropriate sulfur specification. Table 2 to this paragraph also identifies the maximum allowable difference between average measured

value and the ARV corresponding to the ARV at the upper end of each specified range. These values are based on calculations with the equation in paragraph (c)(3)(i) of this section, with parameter values set equal to the standard.

**TABLE 2 TO PARAGRAPH (c)(3)(ii)—ACCURACY CRITERIA FOR QUALIFYING
ALTERNATIVE PROCEDURES WITH DIESEL FUEL AND DIESEL FUEL-RELATED
BLENDSTOCKS AND ADDITIVES**

Fuel	Sulfur content (ppm)	Illustrated maximum allowable difference
ULSD	10-20	0.54
500 ppm LM diesel fuel	450-500	8.65
ECA marine fuel	900-1,000	15.1

- (d) Alternative VCSB procedures for measuring method-defined fuel parameters must meet accuracy criteria as follows:
- (1) You may use the alternative procedure only if you follow all the statistical protocols and meet all the criteria specified in Section 6 of ASTM D6708 (incorporated by reference in § 1090.95) when comparing your measurements using the alternative procedure to measurements at a reference installation using the appropriate referee procedure identified in § 1090.1360(d).
 - (2) For qualifying alternative procedures, determine whether the alternative procedure needs a correlation equation to correct bias relative to the reference test method. Create such a correlation equation as specified in Section 7 of ASTM D6708. For all testing, apply the correlation equation to adjust measured values to be statistically consistent to measuring with the reference test method.
 - (3) If an alternative VCSB procedure states that the procedure has a successful assessment relative to the referee procedures in this section under ASTM D6708, that finding applies for all laboratories using that procedure.
- (e) Alternative non-VCSB procedures for measuring absolute fuel parameters (sulfur) must meet accuracy criteria as follows:
- (1) Demonstrate whether the procedure meets statistical criteria and whether it needs a correlation equation as specified in paragraphs (d)(1) and (2) of this section. Apply the correlation equation for all testing with the alternative procedure.
 - (2) Demonstrate at your laboratory that the alternative procedure meets the accuracy criteria specified in paragraph (c) of this section.
 - (3) Send EPA a written request to use the alternative procedure. In your request, fully describe the procedure to show how it functions for achieving accurate measurements and include detailed information related to your assessment under paragraph (e)(1) and (2) of this section.

- (f) Alternative non-VCSB procedures for measuring method-defined fuel parameters must meet accuracy and precision criteria as follows:
- (1) Demonstrate whether the procedure meets statistical criteria and whether it needs a correlation equation as specified in paragraphs (e)(1) and (2) of this section. Apply the correlation equation for all testing with the alternative procedure.
 - (2) Test with a range of fuels that are typical of those you will analyze at your laboratory. Use either consensus-named fuels or locally named reference materials. Consensus-named fuels are homogeneous fuel quantities sent around to different laboratories for analysis, which results in a "consensus name" representing the average value of the parameter for all participating laboratories. Locally named reference materials are fuel samples analyzed using the reference test method, either at your laboratory or at a reference installation, to establish an estimated value for the fuel parameter; locally named reference materials usually come from the fuel you produce.
 - (3) You may qualify your procedure as meeting the requirements of paragraph (f)(1) of this section only for a narrower, defined range of fuels. If this is the case, identify the appropriate range of fuels in your request for approval and describe how you will screen fuel samples accordingly.
 - (4) Qualify the precision of the alternative procedure by comparing results to testing with the referee procedure based on "between methods reproducibility," R_{xy} , as specified in ASTM D6708. The R_{xy} must be at or below 75 percent of the reproducibility of the referee procedure in § 1090.1360(d).
 - (5) Perform testing at your laboratory as specified in paragraph (b) of this section to establish the repeatability of the alternative procedure. The repeatability must be as good as or better than that specified in paragraph (b)(4) of this section.
 - (6) Fully describe the procedure to show how it functions for achieving accurate measurements. Describe the technology, test instruments, and testing method so a competent person lacking experience with the procedure and test instruments would be able to replicate the results.
 - (7) Engage a third-party auditor to review and verify your information as follows:
 - (i) The auditor must qualify as an independent third party and meet the specifications for technical ability as specified in § 1090.55.
 - (ii) The auditor must send you a report describing their inspection of your laboratories and their review of the information supporting your request to use the alternative procedure. The report must describe how the auditor performed the review, identify any errors or discrepancies, and state whether the information supports a conclusion that the alternative procedure should be approved.
 - (iii) The auditor must keep records related to the review for at least 5 years after sending you the report and provide those records to EPA upon request.
 - (8) Send EPA a written request to use the alternative procedure. Include the specified information and any additional information EPA needs to evaluate your request.
- (g) Keep fuel samples from any qualification testing under this section for at least 180 days after you have taken all steps to qualify an alternative procedure under this section. This applies for testing at your laboratory and at any reference installation you use for demonstrating the accuracy of an alternative procedure.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4361, Jan. 15, 2025]

§ 1090.1370 Qualifying criteria for reference installations.

- (a) A reference installation refers to a laboratory that uses the referee procedure specified in § 1090.1360(d) to evaluate the accuracy of alternative procedures for method-defined parameters, by comparing measured values to companion tests using one of the referee procedures in § 1090.1360(d). This evaluation may result in an equation to correlate results between the two procedures. Once a laboratory qualifies as a reference installation, that qualification is valid for five years from the qualifying date, consistent with good laboratory practices.
- (b) You may qualify a reference installation for VCSB procedures by participating in an inter-laboratory crosscheck program with at least 16 separate measurements that are not identified as outliers. This presumes that the results for the candidate reference installation are not outliers.
- (c) You may qualify a reference installation for VCSB or non-VCSB procedures based on the following measurement protocol:
 - (1) Use the precision testing procedure specified in § 1090.1365(b) to show that your standard deviation for tests using the reference test method is at or below 0.3 times the reproducibility for a given fuel parameter.
 - (2) You must correlate your test results for a given fuel parameter against the accepted reference values from a monthly crosscheck program based on Section 6.2.2.1 and Note 7 of ASTM D6299 (incorporated by reference in § 1090.95) as follows:
 - (i) If there are multiple fuels available from the crosscheck program, select the fuel that has the closest value to the standard. If there is no standard for a given fuel parameter, select the fuel with values for the fuel parameter that best represent typical values for fuels you test.
 - (ii) Measure the fuel parameter for the crosscheck fuel at your laboratory using the appropriate referee procedure. Calculate a mean value that includes all your repeat measurements.
 - (iii) Determine the mean value from the crosscheck program and calculate the difference between this value and the mean value from your testing. Express this difference as a certain number of standard deviations relative to the data set from the crosscheck program.
 - (iv) The calculated monthly difference between the mean values from § 1090.1365(c)(3)(ii) for 5 consecutive months must fall within the central 50 percent of the distribution of data at least 3 times. The central 50 percent of the distribution corresponds to 0.68 standard deviations.
 - (v) Calculate the mean value of the differences from § 1090.1365(c)(3)(ii) for all 5 months. This mean value must fall within the central 50 percent of the distribution of data from the crosscheck program. For example, if the difference was 0.5 standard deviations for two months, 0.6 for one month, and 0.7 for two months, the mean value of the difference is 0.6 standards deviations, and the reference installation meets the requirements of this paragraph.
 - (3) You must demonstrate that the reference installation is in statistical quality control for at least 5 months with the designated procedure as specified in ASTM D6299. If at any point the reference installation is not in statistical quality control, you must make any necessary changes and restart testing toward meeting the requirement to achieve statistical quality control for at least 5 months, except as follows:

- (i) Do not consider measurements you perform as part of regular maintenance or recalibration for evaluating statistical quality control.
- (ii) If you find that the reference installation is not in statistical quality control during an initial 5-month period and you are able to identify the problem and make the necessary changes to again achieve statistical quality control before the end of the 5-month demonstration period, you may consider the reference installation as meeting the requirement to be in statistical quality control for at least 5 months.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4363, Jan. 15, 2025]

§ 1090.1375 Quality control procedures.

This section specifies ongoing quality testing requirements as part of the Performance-based Measurement System specified in § 1090.1360.

- (a) **General provisions.** You must perform testing to show that your laboratory meets specified precision and accuracy criteria as follows:
 - (1) The testing requirement applies for the referee procedures in § 1090.1360(d) and for alternate procedures that are qualified or approved under § 1090.1365. The testing requirements apply separately for each test instrument at each laboratory.
 - (2) If you fail to conduct specified testing, your test instrument is not qualified for measuring fuel parameters to demonstrate compliance with the standards and other specifications of this part until you perform this testing. Similarly, if your test instrument fails to meet the specified criteria, it is not qualified for measuring fuel parameters to demonstrate compliance with the standards and other specifications of this part until you make the necessary changes to your test instrument and perform testing to show that the test instrument again meets the specified criteria.
 - (3) If you perform major maintenance such as overhauling an instrument, confirm that the instrument still meets precision and accuracy criteria before you start testing again based on the procedures specified in ASTM D6299 (incorporated by reference in § 1090.95).
 - (4) Keep records to document any test results excluded for being out of control under Section 8.5 and A1.5.4.1 of ASTM D6299. Identify the assignable cause and include any appropriate additional supporting justification.
 - (5) Keep records to document your testing under this section for 5 years.
- (b) **Precision demonstration.** Show that you meet precision criteria as follows:
 - (1) Meeting the precision criteria of this paragraph (b) qualifies your test instrument for performing up to 20 tests or 7 days, whichever is less. Include all tests except for testing to meet precision or accuracy requirements.
 - (2) Perform precision testing using the control-chart procedures in ASTM D6299. If you opt to use procedure 2A (Q-Procedure) or 2B (dynamically updated exponentially weighted moving average), validate the first run on the new QC batch by either an overlap in-control result of the old batch, or by a single execution of an accompanying standard reference material. The new QC material result would be considered validated if the single result of the standard reference material is within the established site precision (R') of the ARV of the standard reference material.

- (3) Use I charts and MR charts as specified in ASTM D6299 to show that the standard deviation for the test instrument meets the precision criteria specified in § 1090.1365(b).
- (c) **Accuracy demonstration.** For absolute fuel parameters (VCSB and non-VCSB) and for method-defined fuel parameters using non-VCSB methods, you must show that you meet accuracy criteria as specified in this paragraph (c). For method-defined VCSB procedures, you may meet accuracy requirements as specified in this paragraph (c) or by comparing your results to the accepted reference value in an inter-laboratory crosscheck program as specified in paragraph (d) of this section.
- (1) Meeting the accuracy criteria of this paragraph (c) qualifies your test instrument for 130 days.
- (2) Except as specified in paragraph (c)(3) of this section, test every instrument using a check standard meeting the specifications of ASTM D6299. Select a fuel sample with an ARV representing fuel that is typical for your testing.
- (3) The following provisions apply for method-defined non-VCSB alternative procedures with high sensitivity to sample-specific bias:
- (i) Procedures have high sensitivity if the closeness sum of squares (CSS) statistic exceeds the 95th percentile value, as specified in ASTM D6708 (incorporated by reference in § 1090.95).
 - (ii) Create a check standard from production fuel representing the fuel you will routinely analyze. Determine the ARV of your check standard using the protocol in ASTM D6299 at a reference installation as specified in § 1090.1370.
 - (iii) You must send EPA a fuel sample from every twentieth batch of gasoline or diesel fuel and identify the procedures and corresponding test results from your testing. EPA may return one of your samples to you for further testing; if this occurs, you must repeat your measurement and report your results within 180 days of receiving the fuel sample.
- (4) You meet accuracy requirements under this section if the difference between your measured value for the check standard and the ARV is less than the value from the following equation:

Equation 1 to paragraph (c)(4)

$$\Delta_{\max} = 0.75 \cdot R \cdot \sqrt{1 + \frac{1}{L}}$$

Where:

$\Delta_{\max}$ = Maximum allowable difference.

L = Total number of test results used to determine the ARV of a consensus-named fuel. For testing locally named fuels for which no consensus-based ARV applies, use L equal to ∞ .

R = Reproducibility of the referee procedure identified in § 1090.1360(d), as noted in table 1 to § 1090.1365(b)(4) or in the following table:

TABLE 1 TO PARAGRAPH (c)(4)—CRITERIA FOR QUALIFYING ALTERNATIVE PROCEDURES

Tested product	Referee procedure ¹	Reproducibility (R) ²
ULSD, 500 ppm diesel fuel, ECA marine fuel, diesel fuel additive, gasoline, gasoline regulated blendstock, and gasoline additive	ASTM D2622	$R = 0.4273 \cdot x^{0.8015}$
Butane	ASTM D6667	$R = 0.3130 \cdot x$

¹ ASTM specifications are incorporated by reference, see § 1090.95.

² Calculate reproducibility using the average value determined from testing. Use units as specified in § 1090.1350(c).

- (d) **Demonstrating accuracy by participating in crosscheck programs.** You may meet accuracy requirements under paragraph (c) of this section by comparing your results to the accepted reference value in an inter-laboratory crosscheck program sponsored by ASTM International or another VCSB at least three times per year (two times per year for RVP), subject to the following provisions:
- (1) Your results from the crosscheck program are not valid for demonstrating compliance with accuracy requirements for a test instrument under this section if any of the following apply:
 - (i) The crosscheck program does not have a robust ARV based on the check standard requirements in Section 6.2 of ASTM D6299.
 - (ii) The difference between the test result and the ARV is greater than the maximum allowable difference in paragraph (c)(4) of this section.
 - (iii) The measured value lies outside of the three-sigma range for the data from the relevant inter-laboratory crosscheck program.
 - (2) If your results from the crosscheck program are not valid under paragraph (a)(1) of this section, perform a root cause analysis and document your findings and the steps you take to correct the problem. You continue to meet accuracy requirements under this section for the affected parameter only if you correct the problem and demonstrate compliance with the accuracy requirements of this section within 45 days after learning of a failure under paragraph (d)(1) of this section. The compliance demonstration may be based on in-house testing using a check standard qualified by a third party, on a non-VCSB correlation program administered by a third party, or on testing in the next crosscheck program.
- (e) **Failure to meet precision or accuracy requirements.** The presumed values specified in § 1090.1710(g) apply relative to certification for parameter measurements with test instruments failing to meet precision or accuracy requirements under this section. If you fail to meet the deadlines for resolving crosscheck-

related issues under paragraph (d)(2) of this section, the presumed values apply relative to certification for parameter measurements with the test instruments failing to meet precision or accuracy requirements starting at the point of learning of a failure under paragraph (d)(1) of this section.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4363, Jan. 15, 2025]

TESTING RELATED TO GASOLINE DEPOSIT CONTROL

§ 1090.1390 Requirement for automated detergent blending equipment calibration.

- (a) An automated detergent blending facility must calibrate their automated detergent blending equipment once in each calendar half-year, with the acceptable calibrations being no less than 120 days apart.
- (b) Equipment recalibration is also required each time the detergent package is changed, unless written documentation indicates that the new detergent package has the same viscosity as the previous detergent package. Calibrating after changing the detergent package may be used to satisfy the semiannual recalibration requirement in paragraph (a) of this section, provided that the calibrations occur in the appropriate calendar half-year and are no less than 120 days apart.

§ 1090.1395 Gasoline deposit control test procedures.

A gasoline detergent manufacturer must perform testing using one of the methods specified in this section to establish the lowest additive concentration (LAC) for the detergent.

- (a) **Top Tier-based test method.** Use the procedures specified in ASTM D6201 (incorporated by reference, see § 1090.95), as follows:
 - (1) Use a base fuel that conforms to the specifications for gasoline-alcohol blends in ASTM D4814 (incorporated by reference in § 1090.95). Blendstocks used to formulate the test fuel must be derived from conversion units downstream of distillation, with all processes representing normal fuel manufacturing facility operations. Blendstocks must not come from chemical grade streams. Butane and pentane may be added to adjust vapor pressure. The base fuel should include any nondetergent additives typical of commercially available fuel if they may positively or negatively affect deposit formation. In addition, the base fuel must have the following properties:
 - (i) 8.0-10.0 volume percent ethanol that meets the requirements in § 1090.270 and conforms to the specifications of ASTM D4806 (incorporated by reference, see § 1090.95).
 - (ii) At least 8.0 volume percent olefins.
 - (iii) At least 15 volume percent aromatics.
 - (iv) No more than 80 ppm sulfur.
 - (v) T90 distillation temperature at or above 143 °C.
 - (vi) No detergent-active substance. A base fuel with typical nondetergent additives, such as antioxidants, corrosion inhibitors, and metal deactivators, may be used.
 - (2) Perform the 100-hour test for intake valve deposits with the base fuel to demonstrate that the intake valves accumulate at least 500 mg on average. If the test engine fails to accumulate enough deposits, make any necessary adjustments and repeat the test. This demonstration is valid for any further detergent testing with the same base fuel.

- (3) Repeat the test on the same engine with a specific concentration of detergent added to the base fuel. If the test results in less than 50 mg average per intake valve, the tested detergent concentration is the LAC for the detergent.
- (b) **CARB test method.** Use the procedures specified by CARB in Title 13, California Code of Regulations, section 2257 (incorporated by reference, see § 1090.95).
 - (1) A detergent tested under this option or certified under 40 CFR 80.163(d) prior to January 21, 2021, may be used at the LAC specified for use in the state of California in any gasoline in the United States.
 - (2) The gasoline detergent manufacturer must cease selling a detergent immediately upon being notified by CARB that the CARB certification for this detergent has been invalidated and must notify EPA under 40 CFR 79.21.
- (c) **EPA BMW method.** Use the procedures specified in ASTM D5500 (incorporated by reference in § 1090.95), as follows:
 - (1) Prepare the test fuel with the following specification:
 - (i) Sulfur—minimum 340 ppm.
 - (ii) T90—minimum 171 °C.
 - (iii) Olefins—minimum 11.4 volume percent.
 - (iv) Aromatics—minimum 31.1 volume percent.
 - (v) Ethanol—minimum 10 volume percent.
 - (vi) Sulfur, T90, olefins, and aromatics specifications must be met before adding ethanol.
 - (vii) Di-tert-butyl disulfide may be added to the test fuel.
 - (2) The duration of testing may be less than 10,000 miles. Measured deposits must meet the following specified values to qualify the test fuel and establish a detergent's LAC:
 - (i) Measured deposits for the fuel without detergent must be at least 290 mg per valve on average.
 - (ii) Measured deposits for the fuel with detergent must be less than 100 mg per valve on average.
- (d) **Alternative test methods.**
 - (1) An EPA-approved alternative test method may be used if the alternative test method can be correlated to any of the methods specified in paragraphs (a) through (c) of this section.
 - (2) Information describing the alternative test method and analysis demonstrating correlation must be submitted for EPA approval as specified in § 1090.10.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4364, Jan. 15, 2025]

Subpart O—Survey Provisions

§ 1090.1400 General provisions.

- (a) **Program plan approval process.**

- (1) A program plan that complies with the requirements in § 1090.1415 or § 1090.1450 must be submitted to EPA no later than October 15 of the year preceding the calendar year in which the program will be conducted.
- (2) The program plan must be signed by the RCO of the independent surveyor conducting the program.
- (3) The program plan must be submitted as specified in § 1090.10.
- (4) EPA will send a letter to the party submitting the program plan that indicates whether EPA approves or disapproves the plan.

(b) **Independent surveyor contract.**

- (1) No later than December 15 of the year preceding the year in which the survey will be conducted, the contract with the independent surveyor must be in effect, and the amount of compensation necessary to carry out the entire survey plan must either be paid to the independent surveyor or placed into an escrow account with instructions to the escrow agent to remit the compensation to the independent surveyor during the course of the survey plan.
- (2) No later than December 31 of the year preceding the year in which the survey will be conducted, EPA must receive a copy of the contract with the independent surveyor and proof that the compensation necessary to carry out the survey plan has either been paid to the independent surveyor or placed into an escrow account. If placed into an escrow account, a copy of the escrow agreement must be sent to EPA.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4364, Jan. 15, 2025]

§ 1090.1405 National fuels survey program.

(a) **Program participation.**

- (1) A gasoline manufacturer that elects to account for oxygenate added downstream under § 1090.710 must participate in the national fuels survey program (NFSP) specified in paragraph (b) of this section.
- (2) A party required to participate in an E15 survey under § 1090.1420(a) must participate in the NFSP specified in paragraph (b) of this section or a survey program approved by EPA under § 1090.1420(b) or (c).
- (3) Other parties may elect to participate in the NFSP for purposes of establishing an affirmative defense against violations of requirements and provisions under this part as specified in § 1090.1720.

(b) **Program requirements.** The NFSP must meet all the following requirements:

- (1) The survey program must be planned and conducted by an independent surveyor that meets the independence requirements in § 1090.55 and the requirements specified in § 1090.1410.
- (2) The survey program must be conducted by collecting samples representative of retail outlets in the United States as specified in § 1090.1415.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4364, Jan. 15, 2025]

§ 1090.1410 Independent surveyor requirements.

The independent surveyor conducting the NFSP must meet all the following requirements:

- (a) Submit a proposed survey program plan under § 1090.1415 to EPA for approval for each calendar year.
- (b)
 - (1) Obtain samples representative of the gasoline and diesel fuel (including diesel fuel made available at retail outlets to nonroad vehicles, engines, and equipment) offered for sale separately from all retail outlets in accordance with the survey program plan approved by EPA, or immediately notify EPA of any refusal of a retailer to allow samples to be taken.
 - (2) Obtain the number of samples representative of the number of retail outlets offering E15.
 - (3) Collect samples of gasoline produced at blender pump using “method 1” specified in NIST Handbook 158 (incorporated by reference, see § 1090.95). All other samples of gasoline and diesel fuel must be collected using the methods specified in subpart N of this part.
 - (4) Samples must be shipped via ground service to an EPA-approved laboratory within 2 business days of being collected.
- (c) Test, or arrange to be tested, the collected samples, as follows:
 - (1) Gasoline samples must be analyzed for oxygenate content, sulfur content, and benzene content. Gasoline samples collected from June 1 through September 15 must also be analyzed for RVP.
 - (2) A subset of gasoline samples, as determined under § 1090.1415(e)(3), must also be analyzed for aromatics content, olefins content, and distillation parameters.
 - (3) Diesel fuel samples must be analyzed for sulfur content.
 - (4) All samples must be tested by an EPA-approved laboratory using the test methods specified in subpart N of this part.
 - (5) All testing must be completed by an EPA-approved laboratory within 10 business days after receipt of the sample.
- (d) Verify E15 labeling requirements at retail outlets that offer E15 for sale.
- (e)
 - (1) Using procedures specified in an EPA-approved plan under § 1090.1415, notify EPA, the retailer, and the branded fuel manufacturer (if applicable) within 24 hours after an EPA-approved laboratory has completed analysis when any of the following occur:
 - (i) A test result for a gasoline sample yields a sulfur content result that exceeds the downstream sulfur per-gallon standard in § 1090.205(c).
 - (ii) A test result for a gasoline sample yields an RVP result that exceeds the applicable RVP standard in § 1090.215.
 - (iii) A test result for a diesel fuel sample yields a sulfur content result that exceeds the sulfur standard in § 1090.305(b).
 - (iv) A test result for a gasoline sample identified as “E15” yields an ethanol content result that exceeds 15 volume percent.

- (v) A test result for a gasoline sample not identified as "E15" yields an ethanol content of more than 10 volume percent ethanol.
- (2) Any notification to EPA or a branded fuel manufacturer under paragraph (e)(1) of this section must include the retail outlet's contact information, including name, title, mailing address, telephone number, and email address of a representative of the retail outlet, if available.
- (f) Provide quarterly and annual summary reports that include the information specified in § 1090.925(b) and (c), respectively.
- (g) Keep records related to the NFSP as specified in § 1090.1245(b)(1).
- (h) Submit contracts to EPA as specified in § 1090.1400(b).
- (i) Permit any representative of EPA to monitor at any time the conducting of the survey, including sample collection, transportation, storage, and analysis.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4364, Jan. 15, 2025]

§ 1090.1415 Survey program plan design requirements.

The survey program plan must include all the following:

- (a) **Number of surveys.** The survey program plan must include 4 surveys each calendar year that occur during the following time periods:
 - (1) One survey during the period of January 1 through March 31.
 - (2) One survey during the period of April 1 through June 30.
 - (3) One survey during the period of July 1 through September 30.
 - (4) One survey during the period of October 1 through December 31.
- (b) **Sampling areas.** The survey program plan must include sampling in all sampling strata during each survey. These sampling strata must be further divided into discrete sampling areas or clusters. Each survey must include sampling in at least 40 sampling areas in each stratum that are randomly selected.
- (c) **No advance notice of surveys.** The survey program plan must include procedures to keep the identification of the sampling areas that are included in the plan confidential from any participating party prior to the beginning of a survey in an area. However, this information must not be kept confidential from EPA.
- (d) **Retail outlet selection.**
 - (1) Retail outlets to be sampled in a sampling area must be selected from among all gasoline retail outlets in the United States with the probability of selection proportionate to the volume of gasoline sold at the retail outlet. The sample of retail outlets must also include gasoline retail outlets with different brand names as well as those gasoline retail outlets that are unbranded.
 - (2) For any retail outlet from which a sample of gasoline or diesel fuel was collected during a survey and was reported to EPA under § 1090.1410(e), that retail outlet must be included in the subsequent survey.

- (3) At least one sample of a product dispensed as E15 must be collected at each gasoline retail outlet when E15 is present, and separate samples must be taken that represent the gasoline contained in each storage tank at the gasoline retail outlet unless collection of separate samples is not practicable.
- (4) At least one sample of diesel fuel must be collected at each retail outlet when diesel fuel is present. Samples of diesel fuel may be collected at retail outlets that sell gasoline.

(e) **Number of samples.**

- (1) The number of retail outlets to be sampled must be independently calculated for the total number of gasoline retail outlets and the total number of diesel fuel retail outlets. The same retail outlet may represent both a gasoline retail outlet and a diesel fuel retail outlet for purposes of determining the number of samples.
- (2) The minimum number of samples to be included in the survey program plan for each calendar year is calculated as follows:

Equation 1 paragraph (e)(2)

$$n = \left(\frac{(Z_{\alpha} + Z_{\beta})^2}{4 \cdot [\arcsin(\sqrt{\phi_1}) - \arcsin(\sqrt{\phi_0})]} \right) \cdot F_a \cdot F_b \cdot Su_n \cdot St_n$$

Where:

n = Minimum number of samples in a year-long survey series. However, n must be greater than or equal to 2,000 for the number of diesel fuel samples or 5,000 for the number of gasoline samples.

Z_{α} = Upper percentile point from the normal distribution to achieve a one-tailed 95 percent confidence level (5 percent α -level). For purposes of this survey program, Z_{α} equals 1.645.

Z_{β} = Upper percentile point to achieve 95 percent power. For purposes of this survey program, Z_{β} equals 1.645.

ϕ_1 = Maximum proportion of noncompliant outlets for a region to be deemed compliant. This parameter needs to be 5 percent or greater (*i.e.*, 5 percent or more of the outlets, within a stratum such that the region is considered noncompliant).

ϕ_0 = Underlying proportion of noncompliant outlets in a sample. For the first survey program plan, ϕ_0 will be 2.3 percent. For subsequent survey program plans, ϕ_0 will be the average of the proportion of outlets found to be noncompliant over the previous 4 surveys.

F_a = Adjustment factor for the number of extra samples required to compensate for samples that could not be included in the survey (*e.g.*, due to technical or logistical considerations), based on the number of additional samples required during the previous 4 surveys. F_a must be greater than or equal to 1.1.

F_b = Adjustment factor for the number of samples required to resample each retail outlet with test results reported to EPA under § 1090.1410(e), based on the rate of resampling required during the previous 4 surveys. F_b must be greater than or equal to 1.1.

Su_n = Number of surveys per year. For purposes of this survey program, Su_n equals 4.

St_n = Number of sampling strata. For purposes of this survey program, St_n equals 3.

- (3) The number of gasoline samples that also need to be tested for aromatics, olefins, and distillation parameters under § 1090.1410(c)(2) must be calculated using the methodology specified in paragraph (e)(2) of this section without the F_a , F_b , and Su_n parameters.
- (4) The number of samples determined under paragraphs (e)(2) and (3) of this section must be distributed approximately equally among the 4 surveys conducted during the calendar year.
- (f) **Laboratory designation.** Any laboratory that the independent surveyor intends to use to test samples collected as part of the NFSP must be approved annually as part of the survey program plan approval process under § 1090.1400(a). In the survey program plan submitted to EPA, the independent surveyor must include the following information regarding any laboratory they intend to use to test samples:
 - (1) The name of the laboratory.
 - (2) The address of the laboratory.
 - (3) The test methods for each fuel parameter measured at the laboratory.
 - (4) Reports demonstrating the laboratory's performance in a laboratory crosscheck program for the most recent 12 months prior to submission of the survey program plan.
- (g) **Submission.** Survey program plans submitted under this section must be approved annually under § 1090.1400(a).

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4364, Jan. 15, 2025]

§ 1090.1420 Additional requirements for E15 misfueling mitigation surveying.

- (a) **E15 misfueling mitigation survey requirement.**
 - (1) Any gasoline manufacturer, oxygenate blender, or oxygenate producer that produces, introduces into commerce, sells, or offers for sale gasoline, BOB, DFE, or gasoline-ethanol blended fuel that is intended for use in or as E15 must comply with either survey program Option 1 (as specified in paragraph (b) of this section) or Option 2 (as specified in paragraph (c) of this section).
 - (2) For an oxygenate producer that produces or imports DFE, the DFE is deemed as intended for use in E15 unless the oxygenate producer demonstrates that it was not intended for such use. The oxygenate producer may demonstrate, at a minimum, that DFE is not intended for use in E15 by including language on PTDs stating that the DFE is not intended for use in E15, entering into contracts with oxygenate blenders to limit the use of their DFE to gasoline-ethanol blended fuels of no more than 10 volume percent ethanol, and limiting the concentration of their DFE to no more than 10 volume percent ethanol in their fuel additive registration under 40 CFR part 79.

- (b) **Survey Option 1.** The gasoline manufacturer, oxygenate blender, or oxygenate producer must properly conduct a survey program in accordance with a survey program plan that has been approved by EPA in all areas that may be reasonably expected to be supplied with their gasoline, BOB, DFE, or gasoline-ethanol blended fuel. Such approval must be based on a survey program plan that meets all the following requirements:
- (1) The survey program must consist of at least quarterly surveys that occur during the following time periods in every year during which the gasoline manufacturer, oxygenate blender, or oxygenate producer introduces E15 into commerce:
 - (i) One survey during the period of January 1 through March 31.
 - (ii) One survey during the period of April 1 through June 30.
 - (iii) One survey during the period of July 1 through September 30.
 - (iv) One survey during the period of October 1 through December 31.
 - (2) The survey program plan must meet all the requirements of this subpart, except for §§ 1090.1405(a) and (b)(2), 1090.1410(c)(2) and (3), and 1090.1415(b), (d)(1), (2), and (4), and (e). In lieu of meeting these sections, the survey program plan must specify the sampling strata, clusters, and area(s) to be surveyed, and the number of samples to be included in the survey.
- (c) **Survey Option 2.** The gasoline manufacturer, oxygenate blender, or oxygenate producer must participate in the NFSP under § 1090.1405.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4365, Jan. 15, 2025]

§ 1090.1450 National sampling and testing oversight program.

- (a) **Program participation.**
- (1) Except for a gasoline manufacturer that has an approved in-line blending waiver under § 1090.1315 that covers all gasoline produced at their facility, a gasoline manufacturer that elects to account for oxygenate added downstream under § 1090.710 must participate in the national sampling and testing oversight program (NSTOP) in this section.
 - (2) Other gasoline manufacturers may elect to participate in the NSTOP for purposes of establishing an affirmative defense to a violation under § 1090.1720. A gasoline manufacturer that has an approved in-line blending waiver under § 1090.1315 does not need to participate in the NSTOP in order to establish an affirmative defense to a violation under § 1090.1720.
 - (3) A gasoline manufacturer that elects to participate in the NSTOP must test, or arrange to be tested, samples collected from their gasoline manufacturing facilities as specified in paragraph (c)(2) of this section and report results to the independent surveyor within 10 business days of the date that the sample was collected.
- (b) **Program requirements.** The NSTOP must meet all the following requirements:
- (1) The NSTOP must be planned and conducted by an independent surveyor that meets the independence requirements in § 1090.55 and the requirements of paragraph (c) of this section.
 - (2) The NSTOP must be conducted at each gasoline manufacturing facility from all participating gasoline manufacturers.

- (c) **Independent surveyor requirements.** The independent surveyor conducting the NSTOP must meet all the following requirements:
- (1) Submit a proposed NSTOP plan that meets the requirements of paragraph (d) of this section to EPA for approval each calendar year.
 - (2)
 - (i) Obtain at least one sample representing summer gasoline and one sample representing winter gasoline for each participating gasoline manufacturing facility. If the fuel manufacturer only produces fuel during either the summer or winter season, obtain at least one sample during the season that the fuel manufacturer produces fuel.
 - (ii)
 - (A) Observe the gasoline manufacturer collect at least one sample representing each gasoline required under paragraph (c)(2)(i) of this section for each participating gasoline manufacturing facility and evaluate whether the gasoline manufacturer collected representative sample(s) in accordance with applicable sampling procedures specified in § 1090.1335. Immediately notify EPA and the gasoline manufacturer if the applicable sampling procedures are not followed.
 - (B) The independent surveyor must also obtain a portion of the sample collected by the gasoline manufacturer and ship the sample as specified in paragraph (c)(2)(v) of this section.
 - (C) The observed sample does not need to represent a batch of certified gasoline (*i.e.*, the independent surveyor may observe the collection of a simulated sample if the gasoline manufacturer does not have a batch of certified gasoline available).
 - (iii) The independent surveyor must immediately notify EPA of any refusal of a gasoline manufacturer to allow samples to be taken. A gasoline manufacturer that refuses to allow the independent surveyor to take portions of collected samples is no longer considered by EPA to be participating in the NSTOP and must not account for oxygenate added downstream under § 1090.710.
 - (iv) Samples must be retained by the independent surveyor as specified in § 1090.1345(a)(1).
 - (v) Samples collected must be shipped via ground service within 2 business days from when the samples are collected to an EPA-approved laboratory as established in an approved NSTOP plan under this section. A random subset of collected samples must also be shipped to the EPA National Vehicle and Fuel Emissions Laboratory as established in an approved NSTOP plan under this section.
 - (3) Test, or arrange to be tested, samples collected under paragraph (c)(2) of this section as follows:
 - (i) Winter gasoline samples must be analyzed for oxygenate content, sulfur content, benzene content, distillation parameters, aromatics, and olefins.
 - (ii) Summer gasoline samples must be analyzed for oxygenate content, sulfur content, benzene content, distillation parameters, aromatics, olefins, and RVP, except that samples of exempt gasoline under § 1090.630 do not need to be analyzed for RVP.

- (iii) All samples must be tested by an EPA-approved laboratory using test methods specified in subpart N of this part.
 - (iv) All analyses must be completed by an EPA-approved laboratory within 10 business days after receipt of the sample.
 - (v) A gasoline manufacturer must analyze gasoline samples for sulfur content, benzene content, and for summer gasoline, RVP, except that samples of exempt gasoline under § 1090.630 do not need to be analyzed for RVP.
- (4) Using procedures specified in an EPA-approved NSTOP plan under this section, notify EPA and the gasoline manufacturer within 24 hours after an EPA-approved laboratory has completed analysis when any of the following occur:
- (i) A test result for a gasoline sample yields a sulfur content that exceeds the fuel manufacturing facility gate sulfur per-gallon standard in § 1090.205(b).
 - (ii) A test result for a gasoline sample yields an RVP that exceeds the applicable RVP standard in § 1090.215.
- (5) Make the test results available to EPA and the gasoline manufacturer for all analyses specified in paragraph (c)(3) of this section within 5 business days of completion of the analysis.
- (6) Compare test results of all samples collected under paragraph (c)(2) of this section and all test results obtained from the gasoline manufacturer from the same samples as specified in paragraph (a)(3) of this section and notify EPA and the gasoline manufacturer if the test result for any parameter tested under paragraph (c)(3) of this section is greater than the reproducibility of the applicable method specified in subpart N of this part.
- (7) Provide quarterly reports to EPA that include the information specified in § 1090.925(d).
- (8) Keep records related to the NSTOP as specified in § 1090.1245(b)(3).
- (9) Submit contracts to EPA as specified in § 1090.1400(b).
- (10) Review the test performance index and precision ratio for each method and instrument the laboratory used to test gasoline samples collected under this section as follows:
- (i) For each test method and instrument, the surveyor must obtain the relevant records from the gasoline manufacturer to determine the site precision, either from an inter-laboratory crosscheck program or from ASTM D6299 (incorporated by reference in § 1090.95).
 - (ii) Using relevant information obtained from the gasoline manufacturers, the surveyor must determine the appropriate Test Performance Index (TPI) and Precision Ratio (PR) from Table 2 Guidelines for Action Based on TPI in ASTM D6792 (incorporated by reference in § 1090.95).
 - (iii) A gasoline manufacturer must supply copies of the necessary information to the independent surveyor to review the TPI and PR for each method and instrument used to test gasoline samples collected under this section.
- (11) Permit any representative of EPA to monitor at any time the conducting of the NSTOP, including sample collection, transportation, storage, and analysis.
- (d) **NSTOP plan requirements.** The NSTOP plan specified in paragraph (c)(1) of this section must include, at a minimum, all the following:

- (1) **Advance notice of sampling.** The NSTOP plan must include procedures on how to keep the identification of the gasoline manufacturing facilities included in the NSTOP plan confidential with minimal advanced notification from any participating gasoline manufacturer prior to collecting a sample. However, this information must not be kept confidential from EPA.
- (2) **Gasoline manufacturing facility selection.**
 - (i) Each participating gasoline manufacturing facility must be sampled at least once during each season they produce fuel. The NSTOP plan must demonstrate how these facilities will be randomly selected within the summer and winter seasons.
 - (ii) In addition to the summer and winter season samples collected at each participating gasoline manufacturing facility, additional oversight samples are required under paragraph (d)(3)(ii) of this section. The independent surveyor must identify how these samples will be randomly distributed among participating gasoline manufacturing facilities.
- (3) **Number of samples.**
 - (i) The number of gasoline manufacturing facilities to be sampled must be calculated for the total number of samples to be collected for the next calendar year as part of the NSTOP plan.
 - (ii) The minimum number of samples to be included in the NSTOP plan for each calendar year is calculated as follows:

Equation 1 to paragraph (d)(3)(ii)

$$n = R \cdot F_a \cdot F_b \cdot Su_n$$

Where:

n = Minimum number of samples in a year.

R = Number of participating gasoline manufacturing facilities.

F_a = Adjustment factor for the number of extra samples required to compensate for samples that could not be included in the NSTOP (e.g., due to technical or logistical considerations), based on the number of additional samples required during the previous 2 calendar years. F_a must be greater than or equal to 1.1.

F_b = Adjustment factor for the number of samples required to ensure oversight. For purposes of this program, F_b equals 1.25.

Su_n = Number of samples required per participating facility per year. For purposes of this program, Su_n equals 2.

- (4) **Laboratory designation.** Any laboratory that the independent surveyor intends to use to test samples collected as part of the NSTOP must be approved annually as part of the NSTOP plan approval process in § 1090.1400(a). The independent surveyor must include the following information regarding each laboratory it intends to use to test samples:
 - (i) The name of the laboratory.

- (ii) The address of the laboratory.
- (iii) The test methods for each fuel parameter measured at the laboratory.
- (iv) Records demonstrating the laboratory's performance in a laboratory crosscheck program for the most recent 12 months prior to submission of the NSTOP plan.
- (5) **Sampling procedure.** The NSTOP plan must include a detailed description of the sampling procedures used to collect samples at participating gasoline manufacturing facilities.
- (6) **Notification of test results.** The NSTOP plan must include a description of how the independent surveyor will notify EPA and gasoline manufacturers of test results under paragraph (c)(4) of this section.
- (7) **Submission.** NSTOP plans submitted under this section must be approved annually under § 1090.1400(a).

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4365, Jan. 15, 2025]

Subpart P—Retailer and Wholesale Purchaser-Consumer Provisions

§ 1090.1500 Overview.

- (a) A retailer or WPC must comply with the labeling requirements in §§ 1090.1510 and 1090.1515, as applicable, and the refueling hardware requirements in §§ 1090.1550 through 1090.1565, as applicable.
- (b) An alternative label design to those specified in this subpart may be used if the design is approved by EPA prior to use and meets all the following requirements:
 - (1) The alternative label must be similar in substance and appearance to the EPA-required label.
 - (2) The alternative label must contain the same informational elements as the EPA-required label.
 - (3) The alternative label must be submitted as specified in § 1090.10.

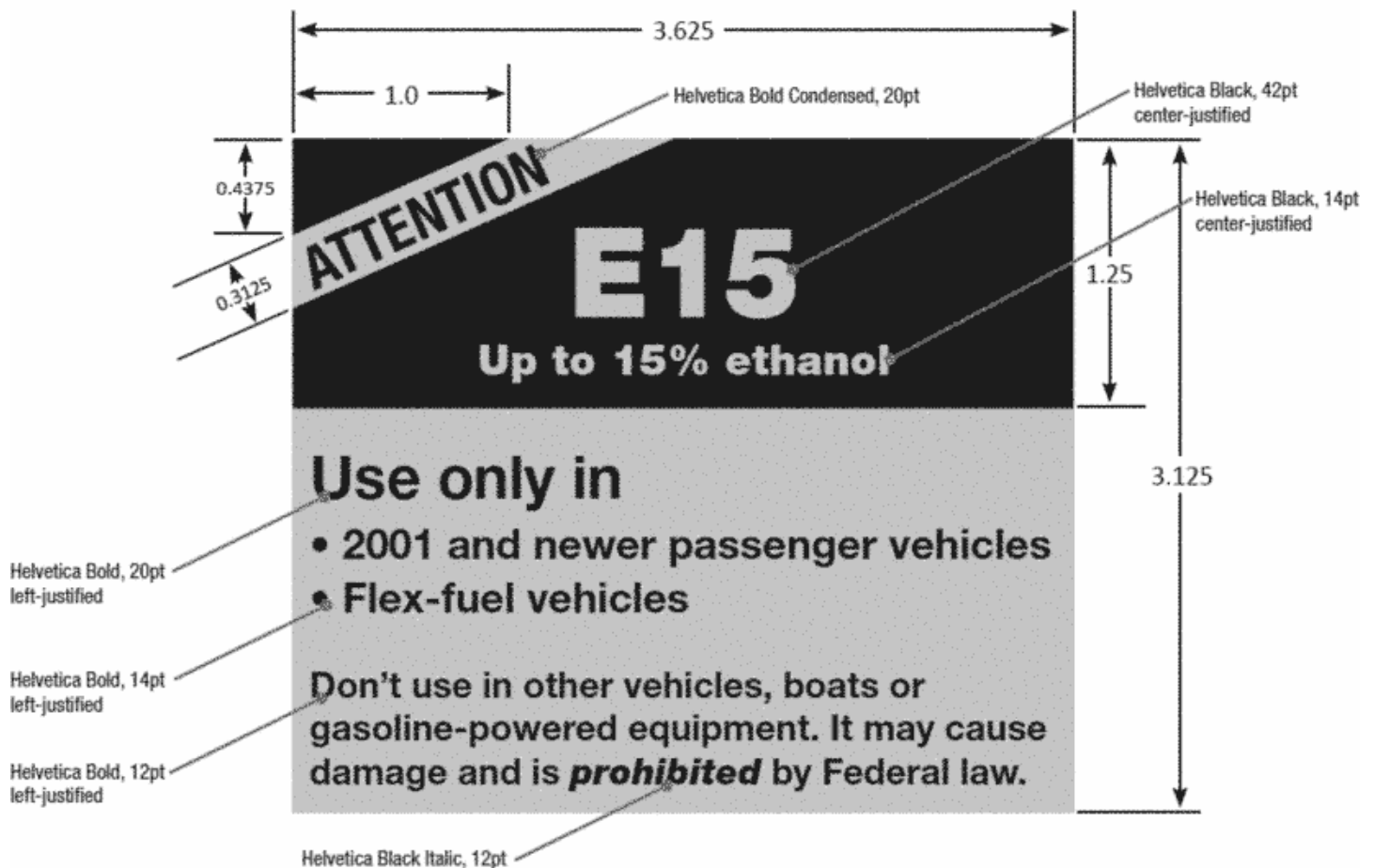
LABELING

§ 1090.1510 E15 labeling provisions.

Any retailer or WPC dispensing E15 must apply a label to the fuel dispenser as follows:

- (a) Position the label to clearly identify which control the consumer will use to select E15. If the dispenser is set up to dispense E15 without the consumer taking action to select the fuel, position the label on a vertical surface in a prominent place, approximately at eye level.
- (b) Figure 1 of this paragraph shows the required content and formatting. Use black letters on an orange background for the lower portion and the diagonal “Attention” field and use orange letters on a black background for the rest of the upper portion. Font size is shown in Figure 1. Set vertical position and line spacing as appropriate for each field. Dimensions are nominal values.

Figure 1 to paragraph (b)—E15 Label



§ 1090.1515 Diesel fuel sulfur labeling provisions.

A retailer or WPC dispensing heating oil, 500 ppm LM diesel fuel, or ECA marine fuel must apply labels to fuel dispensers as follows:

- (a) Labels must be in a prominent location where the consumer will select or dispense either the corresponding fuel or heating oil. The label content must be in block letters of no less than 24-point bold type, printed in a color contrasting with the background.
- (b) Labels must include the following statements, or equivalent alternative statements approved by EPA:
 - (1) For dispensing heating oil along with any kind of diesel fuel for any kind of engine, vehicle, or equipment, apply the following label:

Heating Oil

Warning

Federal law prohibits use in highway vehicles or engines, or in nonroad, locomotive, or marine diesel engines.

Its use may damage these diesel engines.

- (2) For dispensing 500 ppm LM diesel fuel, apply the following label:

Locomotive and Marine Diesel Fuel (500 ppm Sulfur Maximum)

Warning

Federal law prohibits use in nonroad engines or in highway vehicles or engines.

- (3) For dispensing ECA marine fuel, apply the following label:

ECA Marine Fuel (1,000 ppm Sulfur Maximum)

For use in Category 3 (C3) marine vessels only.

Warning

Federal law prohibits use in any engine that is not installed in a C3 marine vessel; use of fuel oil with a sulfur content greater than 1,000 ppm in an ECA is prohibited except as allowed by 40 CFR part 1043.

Note: If a pump dispensing 500 ppm LM diesel fuel is labeled with the “LOW SULFUR LOCOMOTIVE AND MARINE DIESEL FUEL (500 ppm Sulfur Maximum)” label, the retailer or WPC does not need to replace this label.

REFUELING HARDWARE

§ 1090.1550 Requirements for gasoline dispensing nozzles used with motor vehicles.

The following requirements apply for any nozzle installation used for dispensing gasoline into motor vehicles:

- (a) Nozzles must meet the following hardware specifications:
 - (1) The outside diameter of the terminal end must not be greater than 21.3 mm.
 - (2) The terminal end must have a straight section of at least 63 mm.
 - (3) The retaining spring must terminate at least 76 mm from the terminal end.
- (b) The dispensing flow rate must not exceed a maximum value of 10 gallons per minute. The flow rate may be controlled through any means in the pump/dispenser system, as long as it does not exceed the specified maximum value.

[88 FR 4718, Jan. 24, 2023]

§ 1090.1555 Requirements for gasoline dispensing nozzles used primarily with marine vessels.

The refueling hardware specifications of this section apply for any nozzle installation used primarily for dispensing gasoline into marine vessels. Note that nozzles meeting these specifications also meet the specifications of § 1090.1550(a).

- (a) The outside diameter of the terminal end must have a diameter of 20.93 ± 00.43 mm.
- (b) The spout must include an aspirator hole for automatic shutoff positioned with a center that is 17.0 ± 01.3 mm from the terminal end of the spout.
- (c) The terminal end must have a straight section of at least 63.4 mm with no holes or grooves other than the aspirator hole.
- (d) The retaining spring (if applicable) must terminate at least 76 mm from the terminal end.

§ 1090.1560 Requirements related to dispensing natural gas.

- (a) Except for pumps dedicated to heavy-duty vehicles, any pump installation used for dispensing natural gas into motor vehicles must have a nozzle and hose configuration that vents no more than 1.2 grams of natural gas during a complete refueling event for a vehicle that meets the requirements of 40 CFR 86.1813-17(f)(1).
- (b) Determine the amount of natural gas vented using calculations based on the geometric shape of the nozzle and hose.

§ 1090.1565 Requirements related to dispensing liquefied petroleum gas.

- (a) Except for pumps dedicated to heavy-duty vehicles, any pump installation used for dispensing liquefied petroleum gas into motor vehicles must have a nozzle that has no greater than 2.0 cm^3 dead space from which liquefied petroleum gas will be released when the nozzle disconnects from the vehicle.
- (b) Determine the volume of the nozzle cavity using calculations based on the geometric shape of the nozzle, with an assumed flat surface where the nozzle face seals against the vehicle.

Subpart Q—Importer and Exporter Provisions

§ 1090.1600 General provisions for importers.

- (a) This subpart contains provisions that apply to any person who imports fuel, fuel additive, or regulated blendstock.
- (b)
 - (1) Except as specified in paragraph (b)(2) of this section, all applicable standards in subparts C and D of this part apply to imported gasoline and diesel fuel, respectively.
 - (2) An importer that imports gasoline at multiple import facilities must comply with the gasoline average standards in §§ 1090.205(a) and 1090.210(a) as specified in § 1090.705(b), unless the importer complies with the provisions of § 1090.1610 to meet the alternative per-gallon standards for rail or truck imports specified in §§ 1090.205(d) and 1090.210(c).
- (c) An importer must separately comply with any applicable certification or other requirements for U.S. Customs.

- (d) Alternative testing requirements for an importer that imports fuel, fuel additive, or regulated blendstock by rail or truck are specified in § 1090.1610.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4366, Jan. 15, 2025]

§ 1090.1605 Importation by marine vessel.

An importer that imports fuel, fuel additive, or regulated blendstock using a marine vessel must comply with the requirements of this section.

- (a) The importer must certify each fuel, fuel additive, or regulated blendstock imported at each port, unless the fuel is certified at the first port of entry in the United States and then transported by the same vessel to subsequent ports without picking up additional fuel.
- (b) Except as specified in paragraph (d) of this section, the importer must certify each fuel, fuel additive, or regulated blendstock while it is on-board the vessel used to transport it to the United States. Certification sampling must be performed after the vessel's arrival at the port where the fuel, fuel additive, or regulated blendstock will be offloaded.
 - (1) The importer must sample each compartment of the vessel and use one of the following methods to meet testing requirements:
 - (i) Treat each compartment as a separate batch. Each individual compartment is deemed to meet the homogeneity requirements in § 1090.1337.
 - (ii) For summer gasoline, measure the RVP of a sample collected from each compartment. In the case of blending oxygenate with imported gasoline, collect samples and measure RVP before or after blending as described in § 1090.1310(c)(1) and (2). For testing all other products, combine samples from separate compartments into a single, vessel-volumetric composite sample using the procedures in Section 9.2.4 of ASTM D4057 (incorporated by reference, see § 1090.95). Test results from the composite sample are valid only if single samples collected from each affected compartment together meet the homogeneity requirements in § 1090.1337.
 - (2) The importer must ensure that all applicable per-gallon standards are met before offloading the fuel, fuel additive, or regulated blendstock.
 - (3) The importer must not rely on testing conducted by a foreign supplier.
- (c) Once the fuel, fuel additive, or regulated blendstock on a vessel has been certified under paragraph (b) of this section, it may be transferred to shore tanks using smaller vessels or barges (lightered) as a certified fuel, fuel additive, or regulated blendstock. These lightering transfers may be to terminals located in any harbor and are not restricted to terminals located in the harbor where the vessel is anchored. For example, certified gasoline could be transferred from an import vessel anchored in New York harbor to a lightering vessel and transported to Albany, New York or Providence, Rhode Island without separately certifying the gasoline upon arrival in Albany or Providence. In this lightering scenario, transfers of certified gasoline to a lightering vessel must be accompanied by PTDs that meet the requirements of subpart L of this part.
- (d) As an alternative to paragraphs (b) and (c) of this section, the importer may offload fuel, fuel additive, or regulated blendstock into shore tanks that contain the same fuel, fuel additive, or regulated blendstock if the importer meets the following requirements:

- (1) For gasoline, the importer must offload gasoline into one or more empty shore tanks or tanks containing PCG that the importer owns.
 - (i) If the importer offloads gasoline into one or more empty shore tanks, they must sample and test the sulfur content and benzene content, and for summer gasoline, RVP, of each shore tank into which the gasoline was offloaded.
 - (ii) If the importer offloads gasoline into one or more shore tanks containing PCG, they must sample the PCG already in the shore tank prior to offloading gasoline from the marine vessel, test the sulfur content and benzene content, and report this PCG as a negative batch as specified in § 1090.905(c)(3)(i). After offloading the gasoline into the shore tanks, the importer must sample and test the sulfur content, benzene content, and for summer gasoline, RVP, of each shore tank into which the gasoline was offloaded and report the volume, sulfur content, and benzene content as a positive batch.
 - (iii) Include the PCG in the shore tank before offloading and the volume and properties after offloading in compliance calculations as specified in § 1090.700(d)(4)(i).
 - (iv) The sample retention requirements in § 1090.1345 apply to the samples taken prior to offloading and those taken after offloading.
- (2) For all other fuel, fuel additive, or regulated blendstock, the importer must sample and test the fuel, fuel additive, or regulated blendstock in each shore tank into which it was offloaded. The importer must ensure that all applicable per-gallon standards are met before the fuel, fuel additive, or regulated blendstock is shipped from the shore tank.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4366, Jan. 15, 2025]

§ 1090.1610 Importation by rail or truck.

- (a) An importer that imports fuel, fuel additive, or regulated blendstock by rail or truck must meet the sampling and testing requirements of subpart N of this part by sampling and testing each compartment of the railcar or truck unless they do one of the following:
 - (1) **Use supplier results.** The importer may rely on test results from the supplier for fuel, fuel additive, or regulated blendstock imported by rail or truck if the importer meets all the following requirements:
 - (i) The importer obtains documentation of test results from the supplier for each batch of fuel, fuel additive, or regulated blendstock in accordance with the following requirements:
 - (A) The testing includes measurements for all the parameters specified in § 1090.1310 using the measurement procedures specified in § 1090.1350.
 - (B) Testing for a given batch occurs after the most recent delivery into the supplier's storage tank and before transferring the fuel, fuel additive, or regulated blendstock to the railcar or truck.
 - (ii) The importer conducts testing to verify test results from each supplier as follows:
 - (A) Collect a sample at least once every 30 days or every 50 rail or truckloads from a given supplier, whichever is more frequent. Test the sample as specified in paragraphs (a)(1)(i)(A) and (B) of this section.

- (B) Treat importation of each fuel, fuel additive, or regulated blendstock separately, but treat railcars or truckloads together if the fuel, fuel additive, or regulated blendstock is imported from a given supplier by rail or truck.
- (2) **Certify in a storage tank.** The importer may transfer the fuel, fuel additive, or regulated blendstock imported by rail or truck into storage tanks that also contain the same product if the importer meets the following requirements:
 - (i) For gasoline, the importer transfers gasoline into one or more empty tanks or tanks containing PCG that the importer owns.
 - (A) If the importer transfers gasoline into one or more empty tanks, they must sample and test the sulfur content, benzene content, and for summer gasoline, RVP, of each tank into which the gasoline was transferred.
 - (B) If the importer transfers gasoline into one or more tanks containing PCG, they must sample the PCG already in the tank prior to transferring gasoline from the train or truck, test the sulfur content and benzene content, and report this PCG as a negative batch as specified in § 1090.905(c)(3)(i). After transferring the gasoline into the tanks, the importer must sample and test the sulfur content, benzene content, and for summer gasoline, RVP, of each tank into which the gasoline was transferred and report the volume, sulfur content, and benzene content as a positive batch.
 - (C) Include the PCG in the tank before transferring and the volume and properties after transferring in compliance calculations as specified in § 1090.700(d)(4)(i).
 - (D) The sample retention requirements in § 1090.1345 apply to the samples taken prior to transferring and those taken after transferring.
 - (ii) For all other fuel, fuel additive, or regulated blendstock, the importer must sample and test the fuel, fuel additive, or regulated blendstock in each tank into which it was transferred. The importer must ensure that all applicable per-gallon standards are met before the fuel, fuel additive, or regulated blendstock is shipped from the tank.
- (b) If an importer that elects to comply with paragraph (a)(1) or (2) of this section fails to meet the applicable requirements, they must meet the sampling and testing requirements of subpart N of this part for each compartment of the railcar or truck until EPA determines that the importer has adequately addressed the cause of the failure.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4366, Jan. 15, 2025]

§ 1090.1615 Gasoline treated as a blendstock.

- (a) An importer may exclude GTAB from their compliance calculations if they meet all the following requirements:
 - (1) The importer reports the GTAB to EPA under § 1090.905(c)(7).
 - (2) The GTAB is treated as blendstock at a related gasoline manufacturing facility that produces gasoline using the GTAB.
 - (3) The related gasoline manufacturing facility must report the gasoline produced using the GTAB and must include the gasoline produced using the GTAB in their compliance calculations.

- (b) After importation, the title of the GTAB must not be transferred to another party until the GTAB has been either certified as gasoline under subpart K of this part or used to produce gasoline that meets all applicable standards and requirements under this part.
- (c) The facility at which the GTAB is used to produce gasoline must be physically located at either the same terminal at which the GTAB first arrives in the United States, the import facility, or at a facility to which the GTAB is directly transported from the import facility.
- (d)
 - (1) The importer must treat the GTAB as if it were imported gasoline and complete all the requirements for a gasoline manufacturer under § 1090.105(a) (except for the sampling, testing, and sample retention requirements in § 1090.105(a)(6)) for the GTAB at the time it is imported.
 - (2) Any GTAB that ultimately is not used to produce gasoline (e.g., a tank bottom of GTAB) must be treated as newly imported gasoline and must meet all applicable requirements for imported gasoline.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4367, Jan. 15, 2025]

§ 1090.1650 General provisions for exporters.

Except as specified in this section and in subpart G of this part, fuel produced, imported, distributed, or offered for sale in the United States is subject to the standards and requirements of this part.

- (a) Fuel designated for export by a fuel manufacturer is not subject to the standards in this part, provided all the requirements in § 1090.645 are met.
- (b) Fuel not designated for export may be exported without restriction. However, the fuel remains subject to the provisions of this part while in the United States. For example, fuel designated as ULSD must meet the applicable sulfur standards under this part even if it will later be exported.
- (c) Fuel that has been classified as American Goods Returned to the United States by the U.S. Customs Service under 19 CFR part 10 is not considered to be imported for purposes of this part, provided all the following requirements are met:
 - (1) The fuel was produced at a fuel manufacturing facility located within the United States and has not been mixed with fuel produced at a fuel manufacturing facility located outside the United States.
 - (2) The fuel must be included in compliance calculations by the producing fuel manufacturer.
 - (3) All the fuel that was exported must ultimately be classified as American Goods Returned to the United States and none may be used in a foreign country.
 - (4) No fuel classified as American Goods Returned to the United States may be combined with any fuel produced at a foreign fuel manufacturing facility prior to reentry into the United States.

Subpart R—Compliance and Enforcement Provisions

§ 1090.1700 Prohibited acts.

- (a) No person may violate any prohibited act in this part or fail to meet a requirement that applies to that person under this part.

- (b) No person may cause another person to commit an act in violation of this part.

§ 1090.1705 Evidence related to violations.

(a)

- (1) EPA may use results from any testing required under this part to determine whether a given fuel, fuel additive, or regulated blendstock meets any applicable standard. However, EPA may also use any other evidence or information to make this determination if the evidence or information supports the conclusion that the fuel, fuel additive, or regulated blendstock would fail to meet one or more of the parameter specifications in this part if the appropriate sampling and testing methodology had been correctly performed. Examples of other relevant information include business records, commercial documents, and measurements with alternative procedures.
 - (2) Testing to determine noncompliance with this part may occur at any location and be performed by any party.
- (b) Determinations of compliance with the requirements of this part other than the fuel, fuel additive, or regulated blendstock standards, and determinations of liability for any violation of this part, may be based on information from any source or location. Such information may include, but is not limited to, business records and commercial documents.

§ 1090.1710 Penalties.

- (a) Any person liable for a violation under this part is subject to civil penalties as specified in 42 U.S.C. 7524 and 7545 for each day of such violation and the amount of economic benefit or savings resulting from the violation.

(b)

- (1) Any person liable for the violation of an average standard under this part is subject to a separate day of violation for each day in the compliance period.
- (2) Any person liable under this part for a failure to fulfill any requirement for credit generation, transfer, use, banking, or deficit correction is subject to a separate day of violation for each day in any compliance period in which invalid credits are generated, transferred, used, or made available for use.

(c)

- (1) Any person liable under this part for a violation of a per-gallon standard, or for causing another party to violate a per-gallon standard, is subject to a separate day of violation for each day the non-complying fuel, fuel additive, or regulated blendstock remains any place in the distribution system.
- (2) For the purposes of paragraph (c)(1) of this section, the length of time the fuel, fuel additive, or regulated blendstock that violates a per-gallon standard remained in the distribution system is deemed to be 25 days, unless a person subject to liability or EPA demonstrates by reasonably specific showings, by direct or circumstantial evidence, that the non-complying fuel, fuel additive, or regulated blendstock remained in the distribution system for fewer than or more than 25 days.

- (d) Any person liable for failure to meet, or causing a failure to meet, any other provision of this part is liable for a separate day of violation for each day such provision remains unfulfilled.

- (e) Failure to meet separate requirements of this part count as separate violations.

- (f) Violation of any misfueling prohibition under this part counts as a separate violation for each day the noncompliant fuel, fuel additive, or regulated blendstock remains in any engine, vehicle, or equipment.
- (g) The presumed fuel parameter values in this paragraph (g) apply for cases in which any person fails to comply with the sampling or testing requirements and must be reported, unless EPA, in its sole discretion, approves a different value. Any person requesting the use of alternative test values must submit their request to EPA as specified in § 1090.10 within 30 days of discovering failure to comply with sampling and testing requirements, except that the request will be considered timely if the sampling and testing violation is self-disclosed under EPA's audit policy and the request is submitted by the certification deadline for the self-disclosure.
 - (1) For gasoline: 339 ppm sulfur, 1.64 volume percent benzene, and 11 psi RVP.
 - (2) For diesel fuel: 1,000 ppm sulfur.
 - (3) For ECA marine fuel: 5,000 ppm sulfur.
 - (4) For the PCG portion for PCG by subtraction under § 1090.1320(a)(1): 0 ppm sulfur and 0 volume percent benzene.
 - (5) For fuel additives: 339 ppm sulfur.
 - (6) For regulated blendstocks: 339 ppm sulfur and 1.64 volume percent benzene.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4367, Jan. 15, 2025]

§ 1090.1715 Liability provisions.

- (a) Any person who violates any prohibited act or requirement in this part is liable for the violation.
- (b) Any person who causes someone to commit a prohibited act under this subpart is liable for violating that prohibition.
- (c) Any parent corporation is liable for any violation committed by any of its wholly owned subsidiaries.
- (d) Each partner to a joint venture, or each owner of a facility owned by two or more owners, is jointly and severally liable for any violation of this subpart that occurs at the joint venture facility or facility owned by the joint owners, or any violation of this part that is committed by the joint venture operation or any of the joint owners of the facility.
- (e)
 - (1) Any person who produced, imported, sold, offered for sale, dispensed, supplied, offered for supply, stored, transported, caused the transportation or storage of, or introduced into commerce fuel, fuel additive, or regulated blendstock that is in the storage tank containing fuel, fuel additive, or regulated blendstock that is found to be in violation of a per-gallon standard is liable for the violation.
 - (2) In order for a carrier to be liable under paragraph (e)(1) of this section, EPA must demonstrate by reasonably specific showing, by direct or circumstantial evidence, that the carrier caused the violation.
- (f) If a fuel manufacturer's corporate, trade, or brand name is displayed at a facility where a violation occurs, the fuel manufacturer is liable for the violation. This also applies where the displayed corporate, trade, or brand name is from the fuel manufacturer's marketing subsidiary.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4367, Jan. 15, 2025]

§ 1090.1720 Affirmative defense provisions.

- (a) Any person liable for a violation under § 1090.1715(e) or (f) will not be deemed in violation if the person demonstrates all the following:
 - (1) The violation was not caused by the person or the person's employee or agent.
 - (2) If PTD requirements of this part apply, the PTDs account for the fuel, fuel additive, or regulated blendstock found to be in violation and indicate that the violating fuel, fuel additive, or regulated blendstock was in compliance with the applicable requirements while in that person's control.
 - (3) The person conducted a quality assurance program, as specified in paragraph (d) of this section.
 - (i) A carrier may rely on the quality assurance program carried out by another party, including the party that owns the fuel in question, provided that the quality assurance program is carried out properly.
 - (ii) A retailer or WPC is not required to conduct sampling and testing of fuel as part of their quality assurance program.
- (b) For a violation found at a facility operating under the corporate, trade, or brand name of a fuel manufacturer, or a fuel manufacturer's marketing subsidiary, the fuel manufacturer must show, in addition to the defense elements required under paragraph (a) of this section, that the violation was caused by one of the following:
 - (1) An act in violation of law (other than the Clean Air Act or this part), or an act of sabotage or vandalism.
 - (2) The action of any retailer, distributor, reseller, oxygenate blender, carrier, retailer, or WPC in violation of a contractual agreement between the branded fuel manufacturer and the person designed to prevent such action, and despite periodic sampling and testing by the branded fuel manufacturer to ensure compliance with such contractual obligation.
 - (3) The action of any carrier or other distributor not subject to a contract with the fuel manufacturer, but engaged for transportation of fuel, fuel additive, or regulated blendstock despite specifications or inspections of procedures and equipment that are reasonably calculated to prevent such action.
- (c) For any person to show under paragraph (a) of this section that a violation was not caused by that person, or to show under paragraph (b) of this section that a violation was caused by any of the specified actions, the person must demonstrate by reasonably specific showings, through direct or circumstantial evidence, that the violation was caused or must have been caused by another person and that the person asserting the defense did not contribute to that other person's causation.
- (d) To demonstrate an acceptable quality assurance program under paragraph (a)(3) of this section, a person must present evidence of all the following:
 - (1)
 - (i) A periodic sampling and testing program adequately designed to ensure the fuel, fuel additive, or regulated blendstock the person sold, dispensed, supplied, stored, or transported meets the applicable per-gallon standard. A person may meet this requirement by participating in the NFSP under § 1090.1405 that was in effect at the time of the violation.

- (ii) In addition to the requirements of paragraph (d)(1)(i) of this section, a gasoline manufacturer must also participate in the NSTOP specified in § 1090.1450 at the time of the violation.
- (2) On each occasion when a fuel, fuel additive, or regulated blendstock is found to be in noncompliance with the applicable per-gallon standard, the person does all the following:
 - (i) Immediately ceases selling, offering for sale, dispensing, supplying, offering for supply, storing, or transporting the non-complying fuel, fuel additive, or regulated blendstock.
 - (ii) Promptly remedies the violation and the factors that caused the violation (e.g., by removing the non-complying fuel, fuel additive, or regulated blendstock from the distribution system until the applicable standard is achieved and taking steps to prevent future violations of a similar nature from occurring).
- (3) For any carrier that transports a fuel, fuel additive, or regulated blendstock in a tank truck, the periodic sampling and testing program required under paragraph (d)(1) of this section does not need to include periodic sampling and testing of gasoline in the tank truck. In lieu of such tank truck sampling and testing, the carrier must demonstrate evidence of an oversight program for monitoring compliance with the requirements of this part relating to the transport or storage of the fuel, fuel additive, or regulated blendstock by tank truck, such as appropriate guidance to drivers regarding compliance with the applicable per-gallon standards and PTD requirements, and the periodic review of records received in the ordinary course of business concerning gasoline quality and delivery.
- (e) In addition to the defenses provided in paragraphs (a) through (d) of this section, in any case in which an oxygenate blender, distributor, reseller, carrier, retailer, or WPC would be in violation under § 1090.1715 as a result of gasoline that contains between 9 and 10 percent ethanol (by volume) but exceeds the applicable standard by more than 1.0 psi, the oxygenate blender, distributor, reseller, carrier, retailer, or WPC will not be deemed in violation if such person can demonstrate, by showing receipt of a certification from the facility from which the gasoline was received or other evidence acceptable to EPA, all the following:
 - (1) The gasoline portion of the blend complies with the applicable RVP standard in § 1090.215.
 - (2) The ethanol portion of the blend does not exceed 10 percent (by volume).
 - (3) No additional alcohol or other additive has been added to increase the RVP of the ethanol portion of the blend.
 - (4) In the case of a violation alleged against an oxygenate blender, distributor, reseller, or carrier, if the demonstration required by paragraphs (e)(1) through (3) of this section is made by a certification, it must be supported by evidence that the criteria in paragraphs (e)(1) through (3) of this section have been met, such as an oversight program conducted by or on behalf of the oxygenate blender, distributor, reseller, or carrier alleged to be in violation, which includes periodic sampling and testing of the gasoline or monitoring the volatility and ethanol content of the gasoline. Such certification will be deemed sufficient evidence of compliance provided it is not contradicted by specific evidence, such as testing results, and provided that the party has no other reasonable basis to believe that the facts stated in the certification are inaccurate. In the case of a violation alleged against a retail outlet or WPC facility, such certification will be deemed an adequate defense for the retailer or WPC, provided that the retailer or WPC is able to show certificates for all the gasoline contained in the storage tank found in violation, and, provided that the retailer or WPC has no reasonable basis to believe that the facts stated in the certifications are inaccurate.

[85 FR 78469, Dec. 4, 2020, as amended at 89 FR 14775, Feb. 29, 2024]

Subpart S—Attestation Engagements

§ 1090.1800 General provisions.

- (a) The following parties must arrange for attestation engagement using agreed-upon procedures as specified in this subpart:
 - (1) A gasoline manufacturer that produces or imports gasoline subject to the requirements of subpart C of this part.
 - (2) A gasoline manufacturer that performs testing as specified in subpart N of this part or that relies on testing from a third-party laboratory.
 - (3) A gasoline manufacturer that transacts sulfur or benzene credits under this part.
- (b) An auditor performing attestation engagements must meet the following requirements:
 - (1) The auditor must meet one of the following professional qualifications:
 - (i) The auditor may be an internal auditor that is employed by the fuel manufacturer and certified by the Institute of Internal Auditors. Such an auditor must perform the attestation engagement in accordance with the *International Standards for the Professional Practice of Internal Auditing (Standards)* (incorporated by reference in § 1090.95).
 - (ii) The auditor may be a certified public accountant, or firm of such accountants, that is independent of the gasoline manufacturer. Such an auditor must comply with the *AICPA Code of Professional Conduct*, including its independence requirements, the *AICPA Statements on Quality Control Standards (SQCS) No. 8, A Firm's System of Quality Control*, the *AICPA Statement on Quality Management Standards (SQMS) No. 1, No. 2, and No. 3* (all incorporated by reference, see § 1090.95), and applicable rules of state boards of public accountancy. Such an auditor must also perform the attestation engagement in accordance with the *AICPA Statement on Standards for Attestation Engagements (SSAE) No. 19, Agreed-Upon Procedures Engagements*, especially as noted in sections AT-C 105, 215, and 315 (incorporated by reference, see § 1090.95).
 - (2) The auditor must meet the independence requirements in § 1090.55.
 - (3) The auditor must be registered with EPA under subpart I of this part.
 - (4) Any auditor suspended or debarred under 2 CFR part 1532 or 48 CFR part 9, subpart 9.4, is not qualified to perform attestation engagements under this subpart.
- (c) An auditor must perform attestation engagements separately for each gasoline manufacturing facility for which the gasoline manufacturer submitted reports to EPA under subpart J of this part for the compliance period.
- (d) The following provisions apply to each attestation engagement performed under this subpart:
 - (1) The auditor must prepare an attestation engagement report identifying the applicable procedures specified in this subpart along with the auditor's corresponding findings for each procedure. The auditor must submit the attestation engagement report electronically to EPA by June 1 of the year following the compliance period.

- (2) The auditor must identify any instances where compared values do not agree or where specified values do not meet applicable requirements under this part.
- (3) Laboratory analysis refers to the original test result for each analysis of a product's properties. The following provisions apply in special cases:
 - (i) For a laboratory using test methods that must be correlated to the standard test method, the laboratory analysis must include the correlation factors along with the corresponding test results.
 - (ii) For a gasoline manufacturer that relies on a third-party laboratory for testing, the laboratory analysis consists of the results provided by the third-party laboratory.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4367, Jan. 15, 2025]

§ 1090.1805 Representative samples.

- (a) If the specified procedures require evaluation of a representative sample from the overall population for a given data set, determine the number of results for evaluation using one of the following methods:
 - (1) Determine sample size using the following table:

TABLE 1 TO PARAGRAPH (a)(1)—SAMPLE SIZE DETERMINATION

Population	Sample size
1-25	The smaller of the population or 19.
26-40	20.
41-65	25.
66 or more	29.

- (2) Determine sample size corresponding to a confidence level of 95 percent, an expected error rate of 0 percent, and a maximum tolerable error rate of 10 percent, using conventional statistical principles and methods.
- (3) Determine sample size using an alternate method that is equivalent to or better than the methods specified in paragraphs (a)(1) and (2) of this section with respect to strength of inference and freedom from bias. An auditor that determines a sample size using an alternate method must describe and justify the alternate method in the attestation engagement report.
- (b) Select specific data points for evaluation over the course of the compliance period in a way that leads to a simple random sample that properly represents the overall population for the data set.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4367, Jan. 15, 2025]

§ 1090.1810 General procedures for gasoline manufacturers.

An auditor must perform the procedures specified in this section for a gasoline manufacturer that produces gasoline in the United States.

(a) **Registration and reports.** An auditor must review registration and reports as follows:

- (1) Obtain copies of the gasoline manufacturer's registration information submitted under subpart I of this part and all reports (except batch reports) submitted by the gasoline manufacturer under subpart J of this part.
- (2) For each gasoline manufacturing facility, confirm that the facility's registration is accurate based on the activities reported during the compliance period, including that the registration for the facility and any related updates were completed prior to conducting regulated activities at the facility and report any discrepancies.
- (3) Confirm that the gasoline manufacturer submitted all reports required under subpart J of this part for activities they performed during the compliance period and report any exceptions.
- (4) Obtain a written statement from the gasoline manufacturer's RCO that the submitted reports are complete and accurate.
- (5) Report the name of any commercial computer program used to track any data required under this part.

(b) **Inventory reconciliation analysis.** An auditor must review an inventory reconciliation analysis as follows:

- (1) Obtain an inventory reconciliation analysis from the gasoline manufacturer for each gasoline type produced at each facility (e.g., RFG, CG, RBOB, CBOB), including the inventory at the beginning and end of the compliance period and inventory records (e.g., receipts, production volumes, shipments, transfers, and gain/loss).
- (2) Foot and cross-foot the volumes by gasoline type.
- (3) Compare the beginning and ending inventory to the inventory records for each gasoline type and report any variances.
- (4) Report the total volume of each gasoline type.

(c) **Listing of gasoline tenders.** An auditor must review a listing of gasoline tenders as follows:

- (1) Obtain a detailed listing of gasoline tenders from the gasoline manufacturer, by gasoline type.
- (2) Foot the tender volumes by gasoline type.
- (3) Compare the total volume from the tenders to the inventory reconciliation analysis obtained under paragraph (b) of this section for each gasoline type and report any variances.

(d) **Listing of gasoline batches.** An auditor must review a listing of gasoline batches as follows:

- (1) Obtain the gasoline batch reports submitted by the gasoline manufacturer under subpart J of this part.
- (2) Foot the batch volumes by gasoline type.
- (3) Compare the total volume from the batch reports to the inventory reconciliation analysis obtained under paragraph (b) of this section for each gasoline type and report any variances.

- (4) Report as a finding any batch with a reported value that does not meet a per-gallon standard in subpart C of this part.
- (e) **Test methods.** An auditor must follow the procedures specified in § 1090.1845 to determine whether the gasoline manufacturer complies with the applicable quality control requirements specified in § 1090.1375.
- (f) **Detailed testing of BOB tenders.** An auditor must review a detailed listing of BOB tenders as follows:
 - (1) Select a representative sample of BOB tenders from the listing of tenders obtained under paragraph (c) of this section.
 - (2) Obtain the associated PTD for each selected tender.
 - (3) Using a unique identifier, confirm that the correct PTDs are obtained for the selected tenders.
 - (4) Compare the volume on the listing for each selected tender to the associated PTD and report any exceptions.
 - (5) Confirm that the PTD associated with each selected tender contains all the applicable language required under subpart L of this part and report any exceptions.
- (g) **Detailed testing of BOB batches.** An auditor must review a detailed listing of BOB batches as follows:
 - (1) Select a representative sample of BOB batches from the batch reports obtained under paragraph (d) of this section.
 - (2) Obtain the volume documentation and laboratory analysis for each selected batch.
 - (3) Compare the reported volume for each selected batch to the volume documentation and report any exceptions.
 - (4) Compare the reported properties for each selected batch to the laboratory analysis and report any exceptions.
 - (5) Compare the reported test methods used for each selected batch to the laboratory analysis and report any exceptions.
 - (6) Determine each oxygenate type and amount that was required for blending with each selected batch.
 - (7) Confirm that each oxygenate type and amount included in the BOB hand blend agrees with the gasoline manufacturer's blending instructions for each selected batch and report any exceptions.
 - (8) Confirm that the gasoline manufacturer participates in the NFSP under § 1090.1405, if applicable.
 - (9)
 - (i) For a blending manufacturer, confirm that the laboratory analysis includes test results for oxygenate content, if applicable, and distillation parameters (i.e., T10, T50, T90, final boiling point, and percent residue).
 - (ii) For a blending manufacturer not required to measure oxygenate content, confirm that records demonstrate that the PCG or blendstock contained no oxygenate, no oxygenate was added to the final gasoline batch, and the blending manufacturer did not account for oxygenate added downstream under § 1090.710.

(h) **Detailed testing of finished gasoline tenders.** An auditor must review a detailed listing of finished gasoline tenders as follows:

- (1) Select a representative sample of finished gasoline tenders from the listing of tenders obtained under paragraph (c) of this section.
- (2) Obtain the associated PTD for each selected tender.
- (3) Using a unique identifier, confirm that the correct PTDs are obtained for the selected tenders.
- (4) Compare the volume on the listing for each selected tender to the associated PTD and report any exceptions.
- (5) Confirm that the PTD associated with each selected tender contains all the applicable language required under subpart L of this part and report any exceptions.

(i) **Detailed testing of finished gasoline batches.** An auditor must review a detailed listing of finished gasoline batches as follows:

- (1) Select a representative sample of finished gasoline batches from the batch reports obtained under paragraph (d) of this section.
- (2) Obtain the volume documentation and laboratory analysis for each selected batch.
- (3) Compare the reported volume for each selected batch to the volume documentation and report any exceptions.
- (4) Compare the reported properties for each selected batch to the laboratory analysis and report any exceptions.
- (5) Compare the reported test methods used for each selected batch to the laboratory analysis and report any exceptions.
- (6)
 - (i) For a blending manufacturer, confirm that the laboratory analysis includes test results for oxygenate content, if applicable, and distillation parameters (*i.e.*, T10, T50, T90, final boiling point, and percent residue).
 - (ii) For a blending manufacturer not required to measure oxygenate content, confirm that records demonstrate that the PCG or blendstock contained no oxygenate, no oxygenate was added to the final gasoline batch, and the blending manufacturer did not account for oxygenate added downstream under § 1090.710.

(j) **Detailed testing of blendstock batches.** In the case of adding blendstock to TGP or PCG under § 1090.1320(a)(2), an auditor must review a detailed listing of blendstock batches as follows:

- (1) Select a representative sample of blendstock batches from the batch reports obtained under paragraph (d) of this section.
- (2) Obtain the volume documentation and laboratory analysis for each selected batch.
- (3) Compare the reported volume for each selected batch to the volume documentation and report any exceptions.
- (4) Compare the reported properties for each selected batch to the laboratory analysis and report any exceptions.

- (5) Compare the reported test methods used for each selected batch to the laboratory analysis and report any exceptions.
- (6) For a blending manufacturer not required to measure oxygenate content, confirm that records demonstrate that the PCG or blendstock contained no oxygenate, no oxygenate was added to the final gasoline batch, and the blending manufacturer did not account for oxygenate added downstream under § 1090.710.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4367, Jan. 15, 2025]

§ 1090.1815 General procedures for gasoline importers.

An auditor must perform the procedures specified in this section for a gasoline importer.

- (a) **Registration and reports.** An auditor must review registration and reports for the importer as specified in § 1090.1810(a).
- (b) **Listing of gasoline imports.** An auditor must review a listing of gasoline imports as follows:
 - (1) Obtain a detailed listing of gasoline imports from the importer, by gasoline type.
 - (2) Foot the import volumes from the importer by gasoline type.
 - (3) Obtain a detailed listing of gasoline imports directly from the third-party customs broker, by gasoline type.
 - (4) Foot the import volumes from the third-party customs broker by gasoline type.
 - (5) Compare the total volume from the listing of imports supplied by the importer to the listing of imports supplied by the third-party customs broker for each gasoline type and report any variances.
 - (6) Report the total imported volume of each gasoline type.
- (c) **Listing of gasoline batches.** An auditor must review a listing of gasoline batches as follows:
 - (1) Obtain the gasoline batch reports submitted by the importer under subpart J of this part.
 - (2) Foot the batch volumes by gasoline type.
 - (3) Compare the total volume from the batch reports to the listing of imports supplied by the importer under paragraph (b) of this section for each gasoline type and report any variances.
 - (4) Report as a finding any batch with a reported value that does not meet a per-gallon standard in subpart C of this part.
- (d) **Test methods.** An auditor must follow the procedures specified in § 1090.1845 to determine whether the importer complies with the applicable quality control requirements specified in § 1090.1375.
- (e) **Detailed testing of BOB imports.** An auditor must review a detailed listing of BOB imports as follows:
 - (1) Select a representative sample of BOB imports from the listing of imports supplied by the importer under paragraph (b) of this section.
 - (2) Obtain the associated U.S. Customs Entry Summary and PTD for each selected import.

- (3) Using a unique identifier, confirm that the correct U.S. Customs Entry Summaries are obtained for the selected imports.
- (4) Compare the volume and location the import arrived in the United States on the listing for each selected import to the associated U.S. Customs Entry Summary and report any exceptions.
- (5) Using a unique identifier, confirm that the correct PTDs are obtained for the selected imports.
- (6) Compare the volume on the listing for each selected import to the associated PTD and report any exceptions.
- (7) Confirm that the PTD associated with each selected import contains all the applicable language required under subpart L of this part and report any exceptions.

(f) **Detailed testing of BOB batches.** An auditor must review a detailed listing of BOB batches as follows:

- (1) Select a representative sample of BOB batches from the batch reports obtained under paragraph (c) of this section.
- (2) Obtain the volume inspection report and laboratory analysis for each selected batch.
- (3) Compare the reported volume for each selected batch to the volume inspection report and report any exceptions.
- (4) Compare the reported properties for each selected batch to the laboratory analysis and report any exceptions.
- (5) Compare the reported test methods used for each selected batch to the laboratory analysis and report any exceptions.
- (6) Determine each oxygenate type and amount that was required for blending with each selected batch.
- (7) Confirm that each oxygenate type and amount included in the BOB hand blend agrees with the importer's blending instructions for each selected batch and report any exceptions.
- (8) Confirm that the importer participates in the NFSP under § 1090.1405, if applicable.

(g) **Detailed testing of finished gasoline imports.** An auditor must review a detailed listing of finished gasoline imports as follows:

- (1) Select a representative sample of finished gasoline imports from the listing of imports supplied by the importer under paragraph (b) of this section.
- (2) Obtain the associated U.S. Customs Entry Summary and PTD for each selected import.
- (3) Using a unique identifier, confirm that the correct U.S. Customs Entry Summaries are obtained for the selected imports.
- (4) Compare the volume and location the import arrived in the United States on the listing for each selected import to the associated U.S. Customs Entry Summary and report any exceptions.
- (5) Using a unique identifier, confirm that the correct PTDs are obtained for the selected imports.
- (6) Compare the volume on the listing for each selected import to the associated PTD and report any exceptions.
- (7) Confirm that the PTD associated with each selected import contains all the applicable language required under subpart L of this part and report any exceptions.

- (h) **Detailed testing of finished gasoline batches.** An auditor must review a detailed listing of finished gasoline batches as follows:
- (1) Select a representative sample of finished gasoline batches from the batch reports obtained under paragraph (c) of this section.
 - (2) Obtain the volume inspection report and laboratory analysis for each selected batch.
 - (3) Compare the reported volume for each selected batch to the volume inspection report and report any exceptions.
 - (4) Compare the reported properties for each selected batch to the laboratory analysis and report any exceptions.
 - (5) Compare the reported test methods used for each selected batch to the laboratory analysis and report any exceptions.
- (i) **Additional procedures for gasoline imported by rail or truck.** An auditor must perform the following additional procedures for an importer that imports gasoline into the United States by rail or truck under § 1090.1610:
- (1)
 - (i) Select a representative sample of gasoline batches from the batch reports obtained under paragraph (c) of this section.
 - (ii) Obtain the tank activity records for each selected batch from the party that supplied the gasoline to the importer.
 - (iii) Identify the point of sampling and testing associated with each selected batch in the tank activity records.
 - (iv) Confirm that the sampling and testing for each selected batch occurred after the most recent delivery into the supplier's storage tank and before transferring gasoline to the railcar or truck.
 - (2)
 - (i) Obtain a detailed listing of the importer's quality assurance program sampling and testing results.
 - (ii) Determine whether the frequency of sampling and testing meets the requirements in § 1090.1610(a)(2) and report any discrepancies.
 - (iii)
 - (A) Select a representative sample of gasoline batches from the sampling and testing results.
 - (B) Obtain the laboratory analysis for each selected batch.
 - (C) Determine whether the importer analyzed the test sample for each selected batch, and report as a finding any batch where the importer failed to perform the analysis using the methods specified in subpart N of this part.
 - (D) Obtain and review any terminal test results corresponding to the time of collecting the quality assurance test samples.

- (E) Compare the terminal test results to the test results from the quality assurance program. Report as a finding any test result with a difference that is greater than the reproducibility of the applicable method specified in subpart N of this part.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4368, Jan. 15, 2025]

§ 1090.1820 Additional procedures for GTAB.

In addition to any other procedure required under this subpart, an auditor must perform the procedures specified in this section for a gasoline manufacturer that imports GTAB under § 1090.1615.

(a) **Listing of GTAB imports.** An auditor must review a listing of GTAB imports as follows:

- (1) Obtain a detailed listing of GTAB imports from the importer.
- (2) Foot the import volumes from the importer.
- (3) Obtain a detailed listing of GTAB imports directly from the third-party customs broker.
- (4) Foot the import volumes from the third-party customs broker.
- (5) Compare the total volume from the listing of imports supplied by the importer to the listing of imports supplied by the third-party customs broker and report any variances.
- (6) Report the total imported volume of GTAB and the corresponding facilities at which the GTAB was blended.

(b) **Listing of GTAB batches.** An auditor must review a listing of GTAB batches as follows:

- (1) Obtain the GTAB batch reports submitted by the importer under subpart J of this part.
- (2) Foot the batch volumes.
- (3) Compare the total volume from the batch reports to the listing of imports supplied by the importer under paragraph (a) of this section and report any variances.

(c) **Detailed testing of GTAB imports.** An auditor must review a detailed listing of GTAB imports as follows:

- (1) Select a representative sample of GTAB imports from the listing of imports supplied by the importer under paragraph (a) of this section.
- (2) Obtain the associated U.S. Customs Entry Summary for each selected import.
- (3) Using a unique identifier, confirm that the correct U.S. Customs Entry Summaries are obtained for the selected imports.
- (4) Compare the volume and location the import arrived in the United States on the listing for each selected import to the associated U.S. Customs Entry Summary and report any exceptions.

(d) **Detailed testing of GTAB batches.** An auditor must review a detailed listing of GTAB batches as follows:

- (1) Select a representative sample of GTAB batches from the batch reports obtained under paragraph (b) of this section.
- (2) Obtain the volume inspection report for each selected batch.

- (3) Compare the reported volume for each selected batch to the volume inspection report and report any exceptions.
- (e) **GTAB tracing.** An auditor must trace and review the movement of GTAB from importation to gasoline production as follows:
 - (1) Compare the total volume from the batch reports obtained under paragraph (b) of this section to the inventory reconciliation analysis obtained under § 1090.1810(b).
 - (2)
 - (i) Obtain tank activity records that describe the movement of each selected batch under paragraph (d) of this section from importation to gasoline production.
 - (ii) Identify each selected batch in the tank activity records and trace each selected batch to subsequent reported batches of BOB or finished gasoline and report any exceptions.
 - (iii) Match the location of the facility where gasoline was produced from each selected batch to the location where each selected batch arrived in the United States, or to the facility directly receiving the selected batch from the import facility.
 - (iv) Determine the status of the tank(s) before receiving each selected batch (e.g., empty tank, tank containing blendstock, tank containing GTAB, tank containing PCG).
 - (v) If the tank(s) contained PCG before receiving the selected batch, take the following additional steps:
 - (A) Obtain and review a copy of the documented tank mixing procedures.
 - (B) Determine the volume and properties of the tank bottom that was PCG before adding GTAB.
 - (C) Confirm that the gasoline manufacturer determined the volume and properties of the BOB or finished gasoline produced using GTAB by excluding the volume and properties of any PCG, and that the gasoline manufacturer separately reported the PCG volume and properties under subpart J of this part and report any discrepancies.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4370, Jan. 15, 2025]

§ 1090.1825 Additional procedures for PCG used to produce gasoline.

In addition to any other procedure required under this subpart, an auditor must perform the procedures specified in this section for a gasoline manufacturer that produces gasoline from PCG under § 1090.1320.

- (a) **Listing of PCG batches.** An auditor must review a listing of PCG batches as follows:
 - (1) Obtain the PCG batch reports submitted by the gasoline manufacturer under subpart J of this part.
 - (2) Foot the batch volumes.
 - (3) Compare the total volume from the batch reports to the inventory reconciliation analysis obtained under § 1090.1810(b) and report any variances.
- (b) **Detailed testing of PCG batches.** An auditor must review a detailed listing of PCG batches as follows:

- (1) Select a representative sample of PCG batches from the batch reports obtained under paragraph (a) of this section.
- (2) Obtain the volume documentation, laboratory analysis, associated PTD, and tank activity records for each selected batch.
- (3) Identify each selected batch in the tank activity records and trace each selected batch to subsequent reported batches of BOB or finished gasoline and report any exceptions.
- (4) For each selected batch, report as a finding any instance where the reported volume was adjusted from the original receipt volume, such as for exported PCG.
- (5) Compare the reported volume for each selected batch to the volume documentation and report any exceptions.
- (6) Compare the reported gasoline type for each selected batch to the associated PTD and report any exceptions.
- (7) Compare the reported properties for each selected batch to the laboratory analysis and report any exceptions.
- (8) Compare the reported test methods used for each selected batch to the laboratory analysis and report any exceptions.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4370, Jan. 15, 2025]

§ 1090.1830 Alternative procedures for certified butane blenders.

An auditor must perform the procedures specified in this section instead of or in addition to the applicable procedures in § 1090.1810 for a certified butane blender that blends certified butane into PCG under § 1090.1320(b).

(a) **Registration and reports.** An auditor must review registration and reports as follows:

- (1) Obtain copies of the certified butane blender's registration information submitted under subpart I of this part and all reports submitted by the certified butane blender under subpart J of this part, including the batch reports for the certified butane received and blended.
- (2) For each butane blending facility, confirm that the facility's registration is accurate based on the activities reported during the compliance period, including that the registration for the facility and any related updates were completed prior to conducting regulated activities at the facility and report any discrepancies.
- (3) Confirm that the certified butane blender submitted all reports required under subpart J of this part for activities they performed during the compliance period and report any exceptions.
- (4) Obtain a written statement from the certified butane blender's RCO that the submitted reports are complete and accurate.
- (5) Report the name of any commercial computer program used to track any data required under this part.

(b) **Inventory reconciliation analysis.** An auditor must review an inventory reconciliation analysis as follows:

- (1) Obtain an inventory reconciliation analysis from the certified butane blender for each butane blending facility related to all certified butane movements, including the inventory at the beginning and end of the compliance period, receipts, blending/production volumes, shipments, transfers, and gain/loss.
 - (2) Foot and cross-foot the volumes.
 - (3) Compare the beginning and ending inventory to the certified butane blender's inventory records and report any variances.
 - (4) Compare the total volume of certified butane received from the inventory reconciliation analysis to the batch reports obtained under paragraph (a) of this section and report any variances.
 - (5) Compare the total volume of certified butane blended from the inventory reconciliation analysis to the batch reports obtained under paragraph (a) of this section and report any variances.
 - (6) Report the total volume of certified butane received and blended.
- (c) ***Listing of certified butane receipts.*** An auditor must review a listing of certified butane receipts as follows:
- (1) Obtain a detailed listing of certified butane receipts for certified butane received at each butane blending facility from the certified butane blender.
 - (2) Foot the receipt volumes.
 - (3) Compare the total volume from the receipts to the batch reports obtained under paragraph (a) of this section and report any variances.
- (d) ***Detailed testing of certified butane batches.*** An auditor must review a detailed listing of certified butane batches as follows:
- (1) Select a representative sample of certified butane batches from the batch reports obtained under paragraph (a) of this section.
 - (2) Obtain the volume documentation and laboratory analysis for each selected batch.
 - (3) Compare the reported volume for each selected batch to the volume documentation and report any exceptions.
 - (4) Compare the reported properties for each selected batch to the laboratory analysis and report any exceptions.
 - (5) Compare the reported test methods used for each selected batch to the laboratory analysis and report any exceptions.
 - (6) Report as a finding any batch with a reported value that does not meet a standard for certified butane in subpart C of this part.
- (e) ***Quality assurance program review.*** An auditor must review a certified butane blender's quality assurance program as follows:
- (1) Obtain a detailed listing of the certified butane blender's quality assurance program sampling and testing results.
 - (2) Determine whether the frequency of sampling and testing meets the requirements in § 1090.1320(b)(4) and report any discrepancies.

[85 FR 78469, Dec. 4, 2020, as amended at 88 FR 44593, July 12, 2023; 90 FR 4370, Jan. 15, 2025]

§ 1090.1835 Alternative procedures for certified pentane blenders.

- (a) An auditor must perform the procedures specified in this section instead of or in addition to the applicable procedures in § 1090.1810 for a certified pentane blender that blends certified pentane into PCG under § 1090.1320(b).
- (b) An auditor must apply the procedures in § 1090.1830 by substituting “pentane” for “butane” in all cases.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4371, Jan. 15, 2025]

§ 1090.1840 Additional procedures related to compliance with gasoline average standards.

In addition to any other procedure required under this subpart, an auditor must perform the procedures specified in this section for a gasoline manufacturer that complies with the standards in subpart C of this part using the procedures specified in subpart H of this part.

- (a) **Annual compliance demonstration review.** An auditor must review annual compliance demonstrations as follows:
 - (1) Obtain the annual compliance reports for sulfur and benzene and associated batch reports submitted by the gasoline manufacturer under subpart J of this part.
 - (2)
 - (i) For a gasoline refiner or gasoline blending manufacturer, compare the total volume of gasoline produced at each facility from the annual compliance report to the inventory reconciliation analysis obtained under § 1090.1810(b) and report any variances.
 - (ii) For a gasoline importer, compare the total volume of gasoline imported from the annual compliance report to the listing of imports supplied by the importer under § 1090.1815(b) and report any variances.
 - (3) For each facility, recalculate and report the following values:
 - (i) Compliance sulfur value, per § 1090.700(a)(1), and compliance benzene value, per § 1090.700(b)(1)(i).
 - (ii) Unadjusted average sulfur concentration, per § 1090.745(b), and average benzene concentration, per § 1090.700(b)(3).
 - (iii) Number of credits generated during the compliance period, or number of banked or traded credits needed to meet standards for the compliance period.
 - (iv) Number of credits from the preceding compliance period that are expired or otherwise no longer available for the compliance period being reviewed.
 - (v) Net average sulfur concentration, per § 1090.745(c), and net average benzene concentration, per § 1090.745(d).
 - (4) Compare the recalculated values under paragraph (a)(3) of this section to the reported values in the annual compliance reports and report any exceptions.

- (5) Report whether the gasoline manufacturer had a deficit for both the compliance period being reviewed and the preceding compliance period.

(b) **Credit transaction review.** An auditor must review credit transactions as follows:

- (1) Obtain the credit transaction reports submitted by the gasoline manufacturer under subpart J of this part and contracts or other information that documents all credit transfers. Also obtain records that support intracompany transfers.
- (2) For each reported transaction, compare the supporting documentation with the credit transaction reports for the following elements and report any exceptions:
 - (i) Compliance period of creation.
 - (ii) Credit type (i.e., sulfur or benzene) and number of times traded.
 - (iii) Quantity.
 - (iv) The name of the other company participating in the credit transfer.
 - (v) Transaction type.

(c) **Facility-level credit reconciliation.** Except as specified in paragraph (c)(4) of this section, an auditor must perform a facility-level credit reconciliation separately for each gasoline manufacturing facility as follows:

- (1) Obtain the credits remaining or the credit deficit from the previous compliance period from the credit transaction reports obtained under paragraph (b) of this section.
- (2) Calculate and report as a finding the net credits remaining at the end of the compliance period.
- (3) Compare the ending balance of credits or credit deficit recalculated under paragraph (c)(2) of this section to the corresponding value from the annual compliance report obtained under paragraph (a) of this section and report any variances.
- (4) For an importer, the procedures of this paragraph (c) apply at the company level.

(d) **Company-level credit reconciliation.** An auditor must perform a company-level credit reconciliation as follows:

- (1) Obtain a credit reconciliation listing company-wide credits aggregated by facility for the compliance period.
- (2) Foot and cross-foot the credit quantities.
- (3) Compare and report the beginning balance of credits, the ending balance of credits, the associated credit activity at the company level in accordance with the credit reconciliation listing, and the corresponding credit balances and activity submitted by the gasoline manufacturer under subpart J of this part.

(e) **Procedures for gasoline manufacturers that recertify BOB.** An auditor must perform the following procedures for a gasoline manufacturer that recertifies BOB under § 1090.740 and incurs a deficit:

- (1) Perform the procedures specified in § 1090.1810(a) to review the gasoline manufacturer's registration and reports.
- (2)

- (i) Obtain the recertified BOB batch reports submitted by the gasoline manufacturer under subpart J of this part.
- (ii) Select a representative sample of recertified BOB batches from the batch reports.
- (iii) Obtain supporting documentation (e.g., PTDs, bills of lading, etc.) for each selected batch.
- (iv) Compare the information on the batch reports to the supporting documentation and report any exceptions.
- (v) Recalculate the deficits in accordance with the provisions of § 1090.740 and report any discrepancies.
- (vi) Confirm that the deficits are included in the annual compliance report and report any exceptions.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4371, Jan. 15, 2025]

§ 1090.1845 Procedures related to meeting performance-based measurement and statistical quality control for test methods.

(a) General provisions.

- (1) In addition to any other procedure required under this subpart, an auditor must perform the procedures specified in this section for a gasoline manufacturer.
- (2) The auditor performing the procedures in this section must meet the laboratory experience requirements specified in § 1090.55(b)(2).
- (3) In cases where the auditor employs, contracts, or subcontracts an external specialist, all the requirements in § 1090.55 apply to the external specialist. The auditor is responsible for overseeing the work of the specialist, consistent with applicable professional standards specified in § 1090.1800.
- (4) In the case of quality control testing at a third-party laboratory, the auditor may perform a single attestation engagement on the third-party laboratory for multiple gasoline manufacturers if the auditor directly reviewed the information from the third-party laboratory. The third-party laboratory may also arrange for the auditor to perform a single attestation engagement on the third-party laboratory and make that available to gasoline manufacturers that have testing performed by the third-party laboratory.

(b) Non-referee method qualification review. For each test method used to measure a gasoline parameter as specified in a report submitted under subpart J of this part that is not one of the referee procedures listed in § 1090.1360(d), the auditor must review the following:

- (1) Obtain supporting documentation showing that the laboratory has qualified the alternative test method by meeting the precision and accuracy criteria specified under § 1090.1365.
- (2) Report a list of the alternative test methods used.
- (3) Confirm that the gasoline manufacturer supplied the supporting documentation for each alternative test method and report any exceptions.

- (4) If the auditor has previously reviewed supporting documentation under this paragraph (b) for an alternative test method at the laboratory, the auditor does not have to review the supporting documentation again.
- (c) **Reference installation review.** For each reference installation used by the gasoline manufacturer during the compliance period, the auditor must review the following:
 - (1) Obtain supporting documentation demonstrating that the reference installation followed the qualification procedures specified in § 1090.1370(c)(1) and (2) and the quality control procedures specified in § 1090.1370(c)(3).
 - (2) Confirm that the laboratory completed the qualification procedures and report any exceptions.
- (d) **Instrument control review.** For each test instrument used to measure gasoline parameters for batches selected as part of a representative sample under § 1090.1810, the auditor must review whether test instruments were in control as follows:
 - (1) Obtain a listing from the laboratory of the instruments and period when the instruments were used to measure gasoline parameters during the compliance period for batches selected as part of the representative sample under § 1090.1810.
 - (2) Obtain statistical quality assurance data and control charts demonstrating ongoing quality testing to meet the accuracy and precision requirements specified in § 1090.1375 or 40 CFR 80.47, as applicable.
 - (3) Confirm that the laboratory performed statistical quality assurance monitoring of its instruments under § 1090.1375 and report any exceptions.
 - (4) Report as a finding any test result that was excluded for being out of control and the laboratory did not have an assignable cause with appropriate supporting justification.
 - (5) Report as a finding the listing of instruments obtained under paragraph (d)(1) of this section and the compliance period when the instrument control review was completed.

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4372, Jan. 15, 2025]

§ 1090.1850 Procedures related to in-line blending waivers.

In addition to any other procedure required under this subpart, an auditor must perform the procedures specified in this section for a gasoline manufacturer that relies on an in-line blending waiver under § 1090.1315.

- (a)
 - (1) Obtain a copy of the gasoline manufacturer's in-line blending waiver submission and EPA's approval letter.
 - (2) Confirm that the sampling procedures and composite calculations conform to the specifications in § 1090.1315(a)(2).
 - (3) Review the gasoline manufacturer's procedure for defining a batch for compliance purposes. Review available test data demonstrating that the test results from in-line blending correctly characterize the fuel parameters for the designated batch.

- (4) Confirm that the gasoline manufacturer corrected their operations because of previous audits, if applicable.
- (5) Confirm that the equipment and procedures have not materially changed from the gasoline manufacturer's in-line blending waiver. In cases of material change in equipment or procedure, confirm that the gasoline manufacturer updated their in-line blending waiver and report any exceptions.
- (6) Perform any additional procedures unique to the blending operation, as specified in the in-line blending waiver, and report any findings, variances, or exceptions, as applicable.
- (7) Confirm that the gasoline manufacturer has complied with all provisions related to their in-line blending waiver and report any exceptions.

(b)

- (1) Obtain test data, including head, middle, and tail results, for each batch produced under the gasoline manufacturer's in-line blending waiver.
- (2) Review the alternative sampling plan to meet requirements to test head, middle, and tail samples for small batches under § 1090.1315(a)(9).
- (3) Report as a finding any instance where only a single sample was taken for a small batch involving more than 8 hours of blending or more than 1 million gallons of fuel.
- (4) Report as a finding any instance where two samples were unevenly distributed for a small batch or where only two samples were taken for a small batch involving more than 16 hours of blending or up to 2 million gallons of fuel.
- (5) Determine and report the percentage of in-line blending batches where the gasoline manufacturer failed to perform the required head, middle, and tail samples due to unforeseen circumstances. Report as a finding if this percentage is greater than 10 percent of in-line blending batches for the calendar year.
- (6) Determine and report each instance where a contingency plan for alternative sampling was utilized under § 1090.1315(a)(12).

[85 FR 78469, Dec. 4, 2020, as amended at 90 FR 4372, Jan. 15, 2025]