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Specifications and Tolerances for Reference Standards and Field Standard Weights and Measures

3. Specifications and Tolerances for Metal Volumetric Field Standards

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Specifications and Tolerances for Reference Standards and Field Standard Weights and Measures

3. Specifications and Tolerances for Metal Volumetric Field Standards

Blayne C. Keysar

Office of Weights and Measures
Institute for Applied Technology
National Bureau of Standards
Washington, D.C. 20234

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Specifications and Tolerances For Reference Standards and Field Standard Weights and Measures

3. Specifications and Tolerances for Metal Volumetric Field Standards

T se specifications and tolerances are recommended as minimum requirements for standards used in the field by State and local weights and measures officials in quantity determinations of liquid commodities.
Key words: Accurate measurement of volumes; field standard; metal volumetric field standards; provers; specifications; test measures; tolerances; weights and measures inspection.

1. Introduction

These specifications and tolerances are limited to open top graduated neck type, metal volumetric field standards.

Metal volumetric field standards are intended to be used by weights and measures officials.[1] Manufacturers and distributors of liquid products, research and testing laboratories personnel, and others concerned with measurements of volumes of liquids may find these standards useful.

The materials, design, fabrication, and error limitation of the field standards herein specified are intended to permit their use in normal testing operations as standards having nominal values. Field standards are relatable to the U.S. prototype standards for length and mass, through standards which have been supplied to the State Weights and Measures laboratories by the National Bureau of Standards, as authorized under Public Law 89–164. Field standards must be recalibrated periodically. The frequency of calibration required will depend upon usage of the standards. Comparisons against other standards should be performed occasionally to detect those standards in need of recalibration.

Use of these volumetric standards at all appropriate levels of manufacture, distribution, and weights and measures inspection will help promote accuracy and uniformity in commerce.

These standards fall into two general size categories. Sizes up to and including 10 gallons are commonly referred to as test measures and those above 10 gallons are referred to as provers.

In some cases, larger or special purpose standards may be required which are not specifically covered here. Interested parties are urged to submit proposed designs to the Office of Weights and Measures, National Bureau of Standards, Washington, D.C. 20234 for consideration before fabrication is begun.

[1] Procedures for weights and measures inspection of commercial devices are contained in NBS Handbook 44, "Specifications, Tolerances, and Other Technical Requirements for Commercial Weighing and Measuring Devices."

Specifications

1. Sizes

1.1. The sizes of field standard test measures commonly used are 1 gallon, 5 gallon, and 10 gallon. Field standard prover sizes are 25 gallon, 30 gallon, 50 gallon, 100 gallon, 200 gallon, 500 gallon, 1,000 gallon, and 1,500 gallon. This listing does not preclude the use of smaller, intermediate, or larger sizes if so desired.

2. Material

2.1. A field standard shall be constructed of a low carbon (mild) steel or 18–8 stainless steel. The interior surface of those made of low carbon steel shall be corrosion resistant or coated with an epoxy resin, baked phenolic, or other suitable material which is impervious to petroleum products.

2.2. These specifications are not intended to preclude the use of other suitable materials (i.e., plastic, reinforced plastic, aluminum, etc.), provided a measure made of such materials conforms to the applicable parts of these specifications. However, the material shall be thermally stable and not have an unduly high coefficient of thermal expansion to render it unsuitable for field use. All applicable physical property data must be accurately documented for the material chosen.

3. Design

3.1. Any cross section taken in a plane perpendicular to the vertical axis shall be circular, and the shape shall permit complete emptying and draining. Dimensional requirements are shown in table 1.

3.2. Reinforcing bands shall be used where appropriate to prevent distortion of the standard when full of liquid. Figure 1.

3.3. The opening at the top of the neck shall be reinforced by a rolled bead or a band welded to the neck. Figures 1 and 2.

3.4. The bottom shall be designed to prevent distortion when filled and to provide protection against damage in use.

TABLE 1. *Dimensional requirements*

Size	Minimum Metal Gage (U.S.)	Neck Diameter (Inside)	Gage Tube Diameter (Inside)	Minimum Top Cone Pitch	Minimum Bottom Cone Pitch	Minimum Drain Size
		Inch	*Inch*			*Inch*
1 gal.	[a]22	3⅞	½	35°	—	—
5	[a]22	3⅞	½	35°	—	—
10	[a]22	3⅞	½	35°	—	—
25	12	5	⅝	25°	10°	1½
30	12	5	⅝	25°	10°	1½
50	12	5	⅝	25°	10°	2
100	12	7	⅝	25°	10°	2
200	12	10	⅝	25°	10°	2
500	10	17	⅝	25°	10°	3
1000	8	17	⅝	25°	10°	3
1500	8	20	⅝	25°	10°	3

[a] Minimum for the bottom shall be 18 gage.

3.5. A test measure must stand solidly on a level surface with its vertical axis perpendicular to that surface.

3.6. A test measure shall be equipped with a bail handle and shall hang with its axis vertical. The bail handle shall be attached by strong trunions to the neck rather than to the cone to minimize any possibility of distortion of the measure when it is suspended while full of liquid. Figure 1.

3.7. A field standard shall be equipped with a gage glass mounted on the side of the neck. Figures 1 and 2. The glass shall be borosilicate and free of any irregularities or defects which will distort the appearance of the liquid surface. The glass shall be open at the top to facilitate cleaning and removal. The bottom mounting of the gage glass shall be made leakproof without the use of cement, by using compressable gaskets or "O" rings. Removal and replacement of the glass shall be accomplished without difficulty. Replacement gage glass shall conform to table 1.

3.8. A submerged fill pipe (fig. 4) where used, shall be permanently installed, and equipped with a bleed valve. The pipe shall pass through the conical top of the prover adjacent to the neck. This pipe shall be of sufficient size to accommodate the maximum flow rate of the meter being tested.

3.9. If the drain line extends outward from the center of a prover it shall slope at least 5 degrees to insure proper drainage. Figure 2.

3.10. A prover not permanently installed shall be equipped with three adjustable legs for leveling. Figure 2.

3.11. A two wheel trailer used for mounting a prover shall be equipped with three leveling jacks; two at the rear and one at the front near the hitch. Figure 4.

3.12. A truck on which a prover is mounted shall be equipped with four leveling jacks; one near each corner of the vehicle.

3.13. The neck diameter of a test measure shall be sufficient to permit insertion of a hand and arm for manual cleaning and inspection.

4. Scales

4.1. The scale plate shall be corrosion resistant and mounted approximately on a tangent to the front of or directly behind the gage glass. In either case, it shall be not more than ¼ inch from the glass. Figure 3.

4.2. Where the scale is mounted behind the gage glass, protection of the glass shall be provided by a gage shield. Figure 3. This protective device shall allow replacement of the gage glass without difficulty.

4.3. Where the design of the scale adjustment provides for movement of the scale by increments only, the maximum increment shall be ¼ of the smallest scale division (see 4.5).

4.4. The basic scale on all standards shall be cubic inches or cubic centimeters. To avoid confusion and possible reading errors, dual scales on any one scale plate are not permitted, e.g., cubic inches and decimal fractions of a gallon. Dual scales are possible only when two scale plates are used such as shown in figure 3. In this case the cubic inch (basic) scale shall be on the left side of the gage when viewed from the front. If a scale graduated in units other than cubic inches or cubic centimeters is desired it shall be placed on a plate to the right of the gage. Provisions shall be made to adjust each of the scales individually so the two zero lines lie in the same plane.

4.5. The minimum distance between basic scale graduation lines shall be 1/16 (0.0625 inch).

4.6. The scales shall be graduated both above and below the zero line as shown in table 2. For neck sizes less than 17 inches in diameter every fifth line on the scale shall be considered a major division line and be longer than the intermediate (subdivision) lines. Each major line shall be numbered with the volume of that interval. For neck diameters of 17 inches or more every tenth line may be designated a major division line. Figure 3.

4.7. An adjusting rod shall be provided with a means for positive sealing which will prevent play. The scale plate shall be securely attached to the brackets and be provided with a means for sealing. Removal or movement of the adjusting mechanism or scale plate shall not be possible without breaking the seal. Figure 3.

4.8. There shall be a sufficient number of scale brackets (minimum of two) to hold the plate rigid. The brackets shall be mounted on two adjusting rods. Figure 3.

5. Scale Markings

5.1. The graduation lines, numbers and other inscriptions on the scale plate shall be permanent, and of a contrasting color to that of the plate.

5.2. Graduation lines shall be of uniform width. The width of the lines shall be not more than 0.025 inch or less than 0.015 inch.

5.3. On scale plates mounted tangent to the front of the gage glass the major (numbered) lines shall be at least ¼ inch in length. Intermediate lines shall be at least ⅛ inch in length. The major and intermediate lines shall extend to the edge of the scale plate adjacent to the gage glass. The zero line shall extend completely across the plate. Figure 3.

5.4. On a scale plate mounted behind the gage glass the major (numbered) lines shall be at least ¾ inch in length. Intermediate lines shall be at least ½ inch in length. The zero line shall extend completely across the plate. Figure 3.

TABLE 2. *Scale graduations*

Size	Min. No. of Cubic Inches Above and Below 0	Value of Graduations
		Cubic inches
1 gal.	15	1
5	15	1
10	30	1
25	60	2
50	120	2
100	250	5
200	500	10
500	1250	25
1000	2500	25
1500	3500	25

6. Special Requirements

6.1. A prover outlet valve shall be of one of the following types: "Quick acting" gate, ball, or plug. The valve shall be provided with a "block and bleed" feature.

6.2. Each standard shall bear, in a conspicuous place, the name or trade mark of the manufacturer, the nominal volume in gallons, (or liters) and a serial or identification number. The materal from which it is constructed shall be identified together with the cubical coefficient of thermal expansion per degree F (or degree C) for that material.

6.3. A prover shall be equipped with two adjustable spirit levels, mounted at right angles to each other, on the upper cone. The adjusting screw shall be provided with a means of wire sealing. Each level shall be equipped with a hinged protective cover. Figures 2 and 4.

6.4. The top of the neck of a field standard shall be finished so that, by placing a precision machinists spirit level across it, the level position of the standard can be determined. This also provides for the proper adjustment of replacement levels on provers.

6.5. All parts of the gage assembly of a field standard, and all piping and valves which affect the volume of a prover shall be fully assembled by the manufacturer or supplier.

6.6. A prover mounted on a trailer or truck shall be provided with a gravity drain line extending to the side or rear of the vehicle. This line shall be easily accessible and threaded with a standard pipe thread and capped. If the line is equipped with a "quick-disconnect type" fitting it shall be capped. Figure 4.

6.7. A prover system equipped with a return pump shall be provided with a 3-way "block and bleed" valve connected to the pump line and to the gravity line.

6.8. A return pump shall be of a centrifugal design, and self priming preferred. The pump and piping shall be sized for minimum 65 gpm flow rate.

7. Workmanship

7.1. All interior seams shall be filled and smooth to prevent the entrapment of air or liquid.

7.2. Fabrication shall insure that no pockets, dents, or crevices will be present which may entrap air or liquid, or impair the proper filling or draining of the standard.

7.3. A valve shall operate freely and positively, and there shall be no leakage from seams or fittings.

7.4 Leveling jacks shall operate freely and be stable under load.

7.5. If a standard is painted, the surface shall be thoroughly cleaned and primed, and the paint shall be durable and resistant to chipping,scratching, and the affects of petroleum products.

TABLE 3. *Capacity tolerances for metal volumetric field standards*

Size	Tolerance[a]
1 gal.	0.25 cu.in.
5	.5
10	1.0
25	3.0
50	6.0
100	12.0
200	23.0
500	62.5
1000	112.5
1500	175.0

[a] The basis for these tolerances is 1 part in 2000, except for the one gallon size which is 1 part in 1000. For intermediate or larger sizes a tolerance based on 1 part in 2000 shall apply.

8. **Capacity Tolerances**

8.1. The capacity tolerances for metal volumetric field standards shall be those shown in table 3.

Definitions

1. Submerged fill pipe—Pipe used in filling to minimize foaming of liquids, such as fuel oil and milk by discharging into the bottom of the prover.

2. Bleed valve—Valve to bleed any entrapped air in fill pipe to allow liquid within pipe to attain same level as that in the prover neck.

3. Borosilicate glass—Glass of a low coefficient of expansion and known by such trade names[2] as Kimax (KG–33) or Pyrex.

4. Epoxy resin—Any of the various (usually heat-setting) resins that are made by polymerization of an epoxide (e.g., ethylene oxide or epichlorohydrin) with a diphenol.

5. "Block and bleed"—A feature of a valve to detect leakage into the interior of the ball or plug.

[2] Trade names used in this paper do not imply recommendation or endorsement by the National Bureau of Standards.

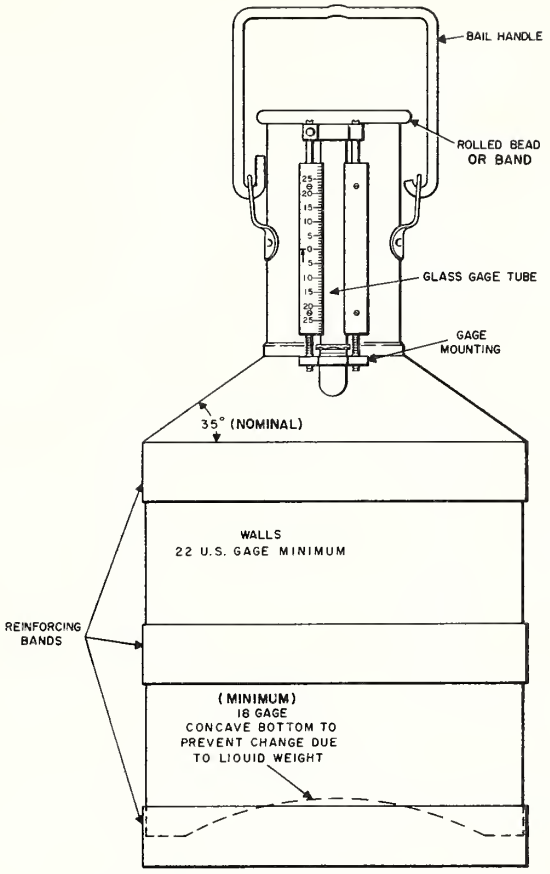

FIGURE 1. *Field standard test measure.*

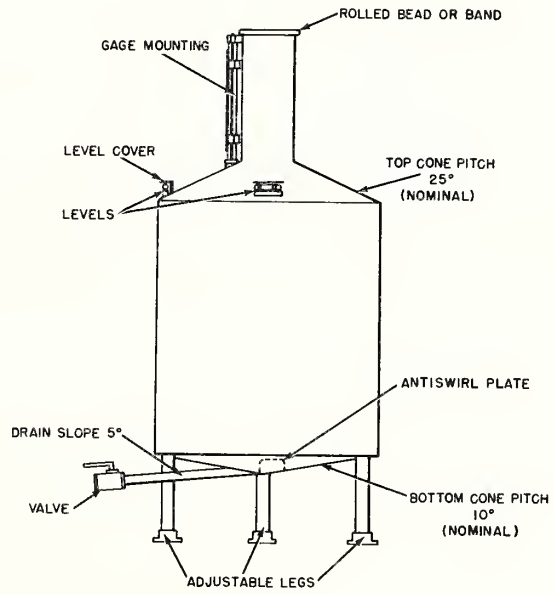

FIGURE 2. *Field standard prover.*

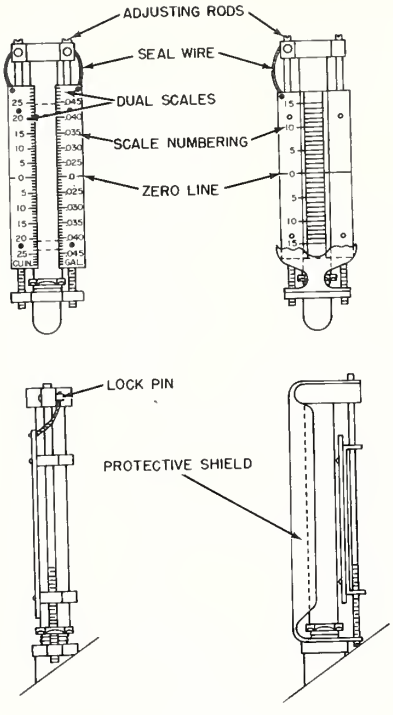

FIGURE 3. *Gage assembly.*

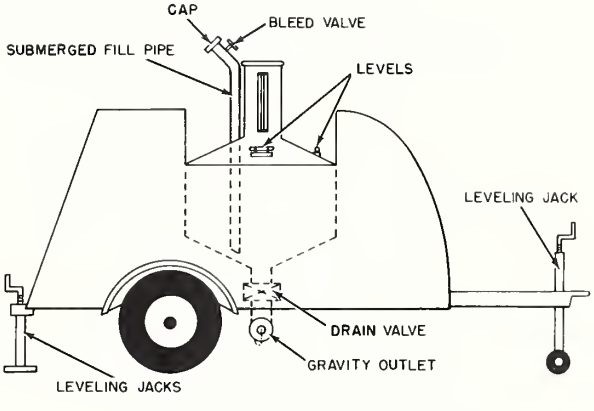

FIGURE 4. *Portable prover.*

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