

Manual of Petroleum Measurement Standards Chapter 3.1A

Standard Practice for the Manual Gauging of Petroleum and Petroleum Products

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Introduction

Personnel involved with the gauging of petroleum and petroleum-related substances should be familiar with their physical and chemical characteristics, including potential for fire, explosion, and reactivity, and with the appropriate emergency procedures as well as potential toxicity and health hazards. Personnel should comply with the individual company safe operating practices and with local, state, and federal regulations, including the use of proper protective clothing and equipment.

API Publication 2217, API Publication 2026, API Recommended Practice 2003, and any applicable regulations should be consulted when gauging. Information regarding particular materials and conditions should be obtained from the employer, the manufacturer or supplier of that material, or the material safety datasheet.

Information on exposure limits can be found by consulting the most recent editions of the Occupational Safety and Health Standards, 29 *CFR* Section 1910.1000 and following and the ACGIH publication *Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment*.

Standard Practice for the Manual Gauging of Petroleum and Petroleum Products

1 Scope

This standard describes the following:

- a) the procedures for manually gauging the liquid level of petroleum and petroleum products in nonpressure fixed-roof, floating-roof tanks and marine tank vessels;
- b) procedures for manually gauging the level of free water that may be found with the petroleum or petroleum products;
- c) methods used to verify the length of gauge tapes under field conditions and the influence of bob weights and temperature on the gauge tape length; and
- d) influences that may affect the position of gauging reference point (either the datum plate or the reference gauge point).

Throughout this standard the term petroleum will be used to denote petroleum, petroleum products, or the liquids normally associated with the petroleum industry.

This standard is applicable for gauging quantities of liquids having Reid vapor pressures less than 103 kPa (15 psia).

The method used to determine the volume of tank contents from gauge readings is not covered in this standard.

The determination of temperature, density, API gravity, and suspended sediment and water of the tank contents are not within the scope of this standard; however, methods used for these determinations may be found in the API *Manual of Petroleum Measurement Standards (MPMS)*.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API *Manual of Petroleum Measurement Standards (MPMS)* Chapter 2, (all sections) *Tank Calibration*

API MPMS Chapter 12.1, *Calculation of Static Petroleum Quantities*

API MPMS Chapter 17, (all sections) *Marine Measurement*

API Recommended Practice 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*

3 Terms and Definitions

For the purposes of this document, the following definitions apply.

3.1

closing gauge

Is an innage or outage gauge taken after the transfer of material into or out of the tank.

3.2

critical zone

The distance between the point where a floating roof is resting on its normal supports and the point where the roof is floating freely is referred to on a tank capacity table as the "critical zone."

3.3**cut**

The line of demarcation on the measuring scale made by the material being measured.

3.4**datum plate**

A level metal plate located directly under the reference gauge point to provide a fixed contact surface from which liquid depth measurement can be made.

3.5**emulsion**

An oil/water mixture that does not readily separate.

3.6**free water**

Water that exists as a separate phase.

3.7**innage gauge (dip)**

Is the level of liquid in a tank measured from the datum plate or tank bottom to the surface of the liquid.

3.8**list**

The leaning or inclination of a vessel, expressed in degrees port or starboard away from the vertical.

3.9**master tape**

A tape that is used for calibrating working tapes for tank measurement and is identified with a Report of Calibration at 68 degrees Fahrenheit (68 °F) [20 degrees Celsius (20 °C)] and at a specific tension designated by the National Institute of Standards and Technology (NIST) or an equivalent international standard organization.

3.10**observed gauge height**

The distance actually measured from the tank bottom or datum plate to the reference gauge point at the time of gauging a tank.

3.11**opening gauge**

Is an innage or outage gauge taken before the transfer of material into or out of the tank.

3.12**outage gauge (ullage)**

The distance from the surface of the liquid in a tank to the reference gauge point of the tank.

3.13**reference gauge height**

The vertical distance, noted on the tank capacity table, between the reference gauge point on the gauge hatch and the datum strike point on the tank floor or the gauge datum plate.

3.14**reference gauge point**

The point from which all liquid level measurements shall be taken:

- a) as determined at the time of the tank calibration and as reflected by the tank capacity table; or



- b) as modified in keeping with guidelines in API *MPMS* Ch. 2 and API *MPMS* Ch. 3 and for which either adjustment calculations shall be made or a new tank capacity table issued reflecting the new location of the reference gauge point.

3.15

tank capacity table (tank gauge table)

Shows the capacities of, or volumes in a tank for, various liquid levels measured from the reference gauge point.

3.16

trim

The condition of a vessel with reference to its longitudinal position in the water. It is the difference between the forward and aft drafts and is expressed “by the head” or “by the stern.”

4 Gauging Equipment

4.1 General

This part of the standard refers to equipment presently in use. It is not intended that it should exclude new equipment not yet developed for commercial use, provided that the accuracy of such equipment is within the maximum permissible error tolerances specified herein and that the procedures for its use are capable of achieving equivalent levels of accuracy.

All gauging equipment shall be suitable for use in hazardous environments and grounded as appropriate—see API 2003, *Protection against Ignitions Arising out of Static, Lightning, and Stray Currents*.

4.2 Nonelectronic Gauge Tapes, Bobs, and Bars

4.2.1 General

Graduated tapes (see Figure 1) that conform to the following specifications are required for innage and outage/ullage gauging procedures.

- a) *Material*: Steel (or corrosion-resistant material, if the tape is to be used for gauging the contents of tanks that contain corrosive liquids).
- b) *Length*: One continuous tape of sufficient length for the height of the tank to be gauged.
- c) *Width Thickness*: The cross-sectional area of the tape shall be such that the tape in a horizontal position on a flat surface will not stretch by more than a unit strain of 0.0075 %.
- d) *Housing*: A durable reel and crank; the assembly mounted in a frame or case.
- e) *Free End*: Fitted with a spring snap catch or other locking device to which the bob can be attached. A swivel-type snap catch will reduce tape breakage.
- f) *Scale*:
 - 1) Innage Tape—Graduated in feet, inches, and fractions of an inch; in feet and hundredths of a foot; or in meters, centimeters, and millimeters. The tip of the bob will be the zero point of the scale.
 - 2) Outage/Ullage Tape—Graduated in feet, inches, and fractions of an inch; in feet and hundredths of a foot; or in meters, centimeters, and millimeters. The zero point of the scale is the point of contact between the snap catch and the eye of the bob.

NOTE 1 Tapes that have been kinked or spliced or that contain illegible markings shall not be used.

NOTE 2 Innage tapes may be used to take both innages and outage/ullages; however, outage/ullage tapes should only be used to take outage/ullage gauges.

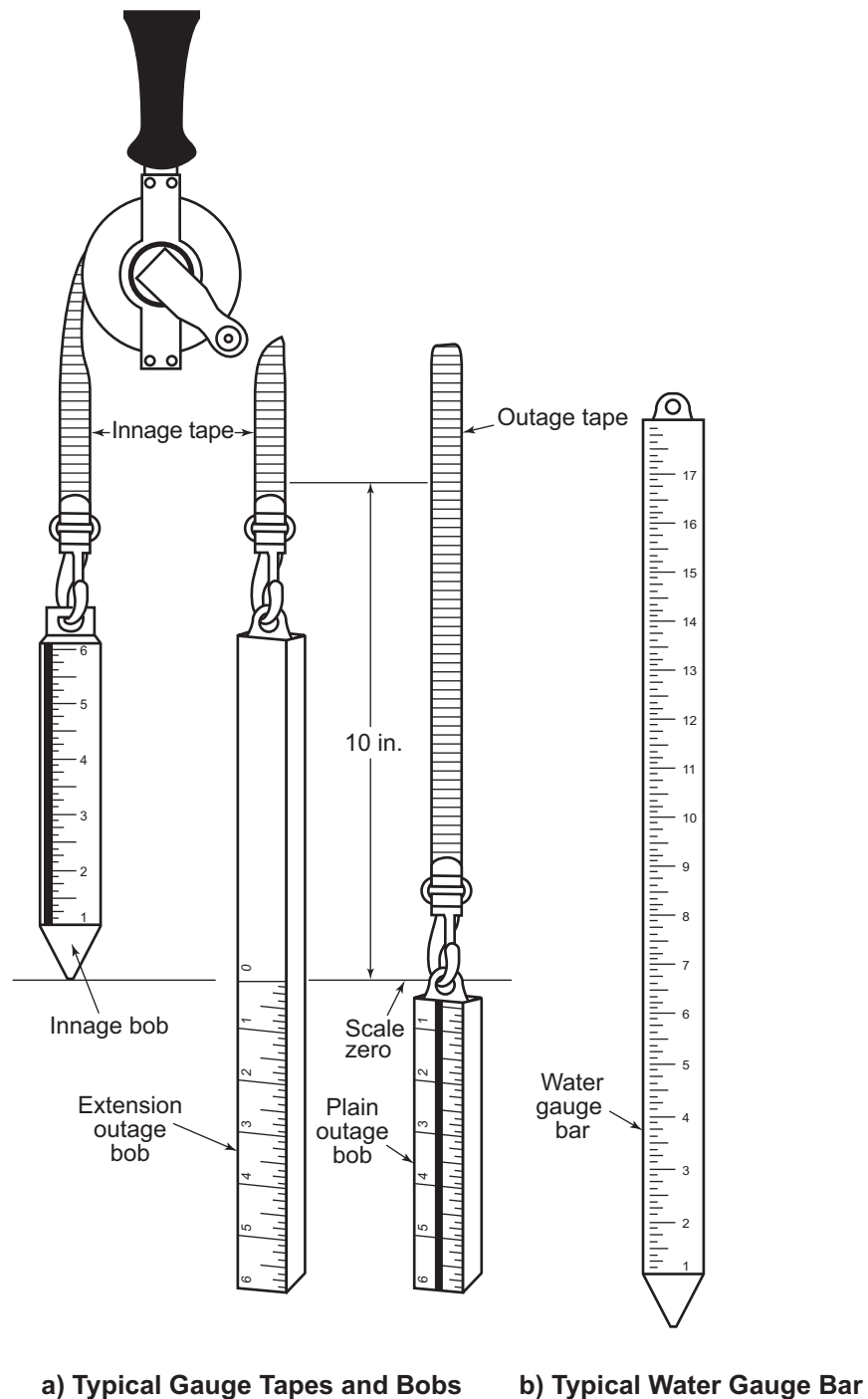


Figure 1—Typical Gauge Tapes and Bobs and Typical Water Gauge Bar

Graduated cylindrical, square, or rectangular bobs, or water gauge bars (see Figure 1) that conform to the following specifications are required.

- a) *Materials*: Spark and corrosion-resistant.
- b) *Typical Length*: Bobs or bars, 15 cm (6 in.), 30 cm (12 in.), or 45 cm (18 in.).
- c) *Weight*: Sufficient to extend the tape to meet accuracy requirements.
- d) *Eye*: An integral part of the bob or bar, preferably reinforced with a hardened bushing to prevent wear.
- e) *Tip*: Innage bobs and bars shall have a conical tip of sufficient hardness to prevent damage by contact with other metal.
- f) *Scale*:
 - 1) Innage Bobs and Bars—Graduated on one side in inches with at least $\frac{1}{8}$ in. subdivisions; in tenths of a foot with at least hundredths of a foot subdivisions; or in centimeters with at least 1 mm subdivisions. The zero point of the scale is at the tip of the bob.
 - 2) Outage/Ullage Bobs—Graduated on one side in inches with at least $\frac{1}{8}$ in. subdivisions; in tenths of a foot with at least hundredths of a foot subdivisions; or in centimeters with 1 mm subdivisions. The zero point of the scale is at the inside of the eye, except for the extension outage/ullage bob (see Figure 1).

4.2.2 Accuracy Requirements of Nonelectronic Tape and Bob

4.2.2.1 Accuracy

New tapes shall be inspected throughout their entire length to determine that the numerals and increments between the numerals have been placed on the tape correctly. The accuracy of the working tape and bob attached shall be verified by comparison with a reference measurement device (e.g. master tape) that has been certified by or is traceable to NIST, or other national weights and measures standards authorities, using the procedure in Annex A. The accuracy of the working tape shall meet the requirements in A.3.

4.2.2.2 Frequency of Verification

The tape and bob assembly shall be inspected daily, or prior to use (whichever is less frequent), to ensure that wear in the tape snap catch, bob eye, or bob tip does not introduce error when the tape scale is being read. The tape shall also be inspected for kinks. Kinked, illegible, or spliced tapes shall not be used.

The working tape with bob attached shall be verified for accuracy when new and at least annually thereafter following the procedure in Annex A.

4.2.2.3 Marking

The graduated tape and bob of each gauge tape shall be marked with unique serial number(s) that can be annotated on the calibration certificate for the purpose of audit trail.

4.3 Portable Electronic Gauging Equipment

4.3.1 General

Portable electronic gauging devices (PEGDs) usually consist of an electronic sensing device suspended on a measuring tape, and a housing with readouts. These devices shall be capable of demonstrating the same measurement accuracy as the nonelectronic gauging tape and bob and shall be calibrated or verified against a reference measurement (see Annex A).