

Manual of Petroleum Measurement Standards Chapter 2—Tank Calibration

Section 2C—Calibration of Upright Cylindrical Tanks Using the Optical-triangulation Method

ANSI/API MPMS 2.2C
FIRST EDITION, JANUARY 2002

REAFFIRMED, APRIL 2013

**ISO 7507-3:2007 (Modified), Petroleum and liquid
petroleum products—Calibration of vertical
cylindrical tanks—Part 3: Optical-triangulation
method**



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FOREWORD

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Chapter 2—Tank Calibration

SECTION 2C—CALIBRATION OF UPRIGHT CYLINDRICAL TANKS USING THE OPTICAL-TRIANGULATION METHOD

0 Introduction

This method describes the calibration of vertical cylindrical tanks by means of optical triangulation using theodolites. The circumference of the tank is determined at different levels by reference to a base line, which may be either a reference circumference measured by strapping or a base line between two stations of a theodolite measured by means of a tape or by an optical method. External circumferences are corrected to give true internal circumferences. The method is an alternative to other methods such as strapping (Chapter 2, Section 2A) and the optical-reference-line method (Chapter 2, Section 2B).

1 Scope

1.1 This part specifies a calibration procedure for application to tanks above 26 ft in diameter with cylindrical courses that are substantially vertical. It provides a method for determining the volumetric quantity contained within a tank at gauged liquid levels. The measurement required to determine the radius may be made internally (Clause 8) or externally (Clause 9). The external method is applicable only to tanks that are free of insulation.

1.2 Abnormally deformed tanks; e.g., dented or non-circular tanks are excluded from this section, API *MPMS* Chapter 2.

1.3 This method is suitable for tilted tanks up to 3% deviation from the vertical, provided that a correction is applied for the measured tilt as described in [API *MPMS* Chapter 2.2A](#).

2 Normative Reference

The following standard contains provisions which through reference in this text, constitutes provisions of this part of Chapter 2. At the time of publication, the edition indicated was valid. All standards are subject to revision and parties to agreements based on this section of Chapter 2 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of API maintain registers of currently valid API Standards.

3 Definitions

For the purposes of this part of Chapter 2, the definitions given in Chapter 2.2A apply.

4 Precautions

The general precautions and safety precautions specified in Chapter 2.2A shall apply to this section of Chapter 2.

5 Equipment

5.1 EQUIPMENT FOR MEASUREMENT OF ANGLES

Equipment for measurement of angles as listed in 5.1.1 to 5.1.4 below.

5.1.1 Theodolites, with angular graduations and a resolution equal to or better than 5 seconds. Each theodolite shall be mounted on a tripod which is firm and stable. The legs of the tripod shall be steadied by means of magnetic bearers when being used for the internal method. Repeat readings shall agree to within 5 seconds.

5.1.2 Low-power laser-beam emitter, equipped with a device such as a fiber-optic light-transfer system and a theodolite-telescope eye-piece connection, by which the laser beam can be transmitted through a theodolite. The laser beam shall be coincident with the optical axis of the telescope.

5.1.3 Heavy weights, to set around the theodolite stations to prevent movement of the tank bottom plate.

5.1.4 Lighting, for use inside the tank to allow measurements to be read accurately.

5.2 STADIA

5.2.1 Stadia, 2 m long, such that the graduated length, between two marks, remains constant to within + 0.02 mm, at the temperature at which it is used.

Note: Conversion to USC units is not recommended for use of the stadia.

5.3 EQUIPMENT FOR BOTTOM CALIBRATION

Either:

- a. A liquid method, equipment as specified in Appendix E, or
- b. For a survey method, a theodolite, a dumpy level, a surveyor's level or water-filled tubes.

6 Equipment Set-up and Procedure

6.1 PREPARATION OF TANK

Fill the tank to its normal working capacity at least once and allow it to stand for a minimum of 24 hours prior to calibration.

If the tank is calibrated with liquid in it, record the depth, temperature and density of the liquid at the time of calibration. However, if the temperature of the wall surface could differ by more than 18°F (10°C) between the empty part and full part of the tank, the tank shall be completely full or empty. Do not make transfers of liquid during the calibration.

6.2 THEODOLITE SET-UP

6.2.1 Set up each theodolite with care, according to the procedure and instructions given by the manufacturer.

6.2.2 Set up the instrument to be stable.

For the internal method, steady the bottom of the tank near the theodolite station by installing weights or other heavy objects around the station. Mount the legs of the theodolite on magnetic bearers to prevent the legs from sliding on the tank bottom.

For the external method, drive the legs of the tripod fully home into the ground.

6.2.3 Set the bed plate of the instrument as near as possible to the horizontal.

Note: This will ensure verticality of the swivel axis of the theodolite.

6.3 STADIA SET-UP AND PROCEDURE

6.3.1 Mount the stadia on the tripod according to the procedure and instructions given by the manufacturer.

6.3.2 Mount the stadia horizontally and perpendicular to the aiming axis by adjusting the device on the stadia.

6.3.3 Once setting-up is complete, lock the stadia in position and verify the horizontality and the perpendicularity.

7 Measurement of Distance between Two Theodolite Stations

7.1 Take the measurement prior to the commencement of the optical readings. Set up the stadia as described in 6.3.

Measure the horizontal angle 2θ subtended at the theodolite by the two marks on the stadia, using the theodolite.

7.2 Compute the horizontal distance D between the two theodolite stations from the formula.

$$D = \frac{B}{2} \times \cot \theta \quad (1)$$

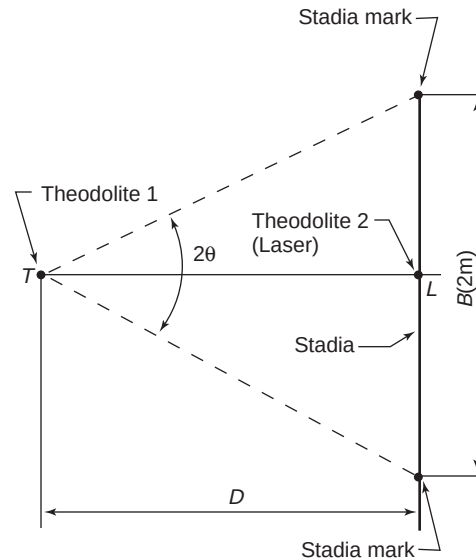


Figure 1—Measurement of Distance between Two Theodolites

where

B = the distance in meters between the two reference marks on the stadia, i.e., 2 meters,

θ = is half the angle in degrees, subtended at theodolite 1, by the two reference marks.

7.3 Carry out the measurement of the angle 2θ and the computation of the distance D a minimum of five times and calculate and record the average value. The computed distance D shall be within the tolerances given in Table 3, or the entire procedure shall be repeated.

7.4 Redetermine the distance D after completion of all the optical measurements described in 8.13.

The distances computed before and after the optical measurements shall agree within the tolerances given in Table 3. If they do not, repeat the calibration procedure until a set of measurements is obtained with the values for D at the beginning and end in agreement.

8 Procedure for Internal Optical Tank Wall Measurements

8.1 Set up two theodolite stations inside the tank as illustrated in Figure 2 and described in 6.2.

8.2 Locate the two stations approximately on a diametrical plane and at least one quarter diameter apart. Adjust the theodolites and measure the distance TL ($TL = D$) as described in Clause 7.