



BSI Standards Publication

Petroleum and liquid petroleum products — Calibration of horizontal cylindrical tanks

Part 1: Manual methods

National foreword

This British Standard is the UK implementation of ISO 12917-1:2017+A1:2025. It supersedes BS ISO 12917-1:2017, which is withdrawn.

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Petroleum and liquid petroleum products — Calibration of horizontal cylindrical tanks —

Part 1: Manual methods

*Pétrole et produits pétroliers liquides — Jaugeage des réservoirs
cylindriques horizontaux —*

Partie 1: Méthodes manuelles



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*, Subcommittee SC 2, *Measurement of petroleum and related products*.

This second edition cancels and replaces the first edition (ISO 12917-1:2002), which has been technically revised with the following changes.

- The total length of the tanks has been limited and also only the calibration via ISO 7507-1 is described in order to improve precision.
- Most of the figures have been improved in order to further clarify the measurement procedures. These, in turn, have been described more logically and in a more useful order. For instance, tank shell measurements are no longer described separately and the former Annex on “tilt” has been incorporated in the text.
- A new annex on calibration uncertainties has been added.
- Correction for tank tilt is now calculated rather than read from a figure.

It also incorporates the Technical Corrigendum ISO 12917-1:2002/Cor 1:2009.

A list of parts in the ISO 12917 series can be found on the ISO website.

Introduction

This document forms part of a series on tank calibration methods. In some countries, some or all of the items covered by this document are subject to local regulations. The attention of the user is drawn to the fact that it is possible that differences exist between this document and those regulations.

Petroleum and liquid petroleum products — Calibration of horizontal cylindrical tanks —

Part 1: Manual methods

1 Scope

This document specifies manual methods for the calibration of nominally horizontal cylindrical tanks, installed at fixed locations.

The methods in this document are applicable to insulated and non-insulated tanks, either when they are above-ground or underground. The methods are applicable to pressurized tanks and to both knuckle-dish-end and flat-end cylindrical tanks as well as elliptical and spherical head tanks.

This document is applicable to tanks inclined from the horizontal, provided a correction is applied for the measured tilt.

Although this document does not impose any limits on the maximum tank diameter and maximum tank tilt to which this document is applicable, the practical limits would be about 4 m in diameter and 10° in tilt.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 7507-1:2001, *Petroleum and liquid petroleum products — Calibration of vertical cylindrical tanks — Part 1: Strapping method*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

4 Precautions

4.1 General

The general and safety precautions specified in ISO 7507-1 shall be applied.

4.2 Internal method

Before a tank which is to be calibrated is entered, a safe-entry certificate shall be obtained. All lines entering the tank shall be disconnected and blanked.

NOTE The attention of the user is drawn to the possible existence of local regulations regarding the safe-entry certificate and entry into tanks, which have contained leaded fuels.

4.3 External method

NOTE The attention of the user is drawn to the possible existence of local regulations regarding entry to the tank area.

5 Equipment

5.1 Equipment as used in ISO 7507-1

Equipment used in the calibration of horizontal tanks shall conform to the specifications laid down in ISO 7507-1. All equipment shall be traceable to a reference standard.

NOTE The equipment required to carry out the calibration is dependent on the method to be employed. This document uses techniques and equipment described in ISO 7507-1.

5.2 Telescopic rod

For the internal method, in addition to the equipment mentioned in [5.1](#), a telescopic rod may be used. This telescopic rod shall have a scale capable of being read to 1 mm, and shall be calibrated with an uncertainty of less than 1 mm.

5.3 Distance meter

For the internal method, as an alternative to a telescopic rod, a laser-based distance meter may be used. The distance meter may also be used in measurement of tank tilt. This distance meter shall have a scale capable of being read to 1 mm, and shall be calibrated with an uncertainty of less than 1 mm.

5.4 Leveller

Level-measuring instrument used to determine vertical distances between pairs of points. It can be based on either mechanical or optical measurements.

Example Rotating optical/laser instrument that establishes horizontal reference line/plane, with a mechanical height-measuring device.

6 General requirements

6.1 The tank shall be filled to its normal working capacity and working pressure at least once and allowed to stand while full for at least 24 h prior to emptying and preparing it for calibration.

NOTE The hydrostatic test applied to new or repaired tanks will satisfy this requirement when additional pressure tests have been carried out.

6.2 The following parameters shall be determined:

- tilt;
- deadwood;

- temperature;
- pressure;
- position of gauge point, reference height and height of the dip plate, if there is one.

7 Calibration procedures

7.1 General

The calibration procedures for calibration of horizontal cylindrical tanks shall be performed as specified in [7.2](#) (external measurements) and [7.3](#) (internal measurements). The remainder of [Clause 7](#) applies to both external and internal measurements.

For both methods, measurements shall be taken at around 1/4 and 3/4 of the length of each segment in accordance with [Figure 1](#).

7.2 Measurement of circumferences — External

7.2.1 Introduction

External measurements may be executed with any depth of liquid and liquid pressure in the tank. The temperature and pressure of the liquid at the time of calibration shall be recorded.

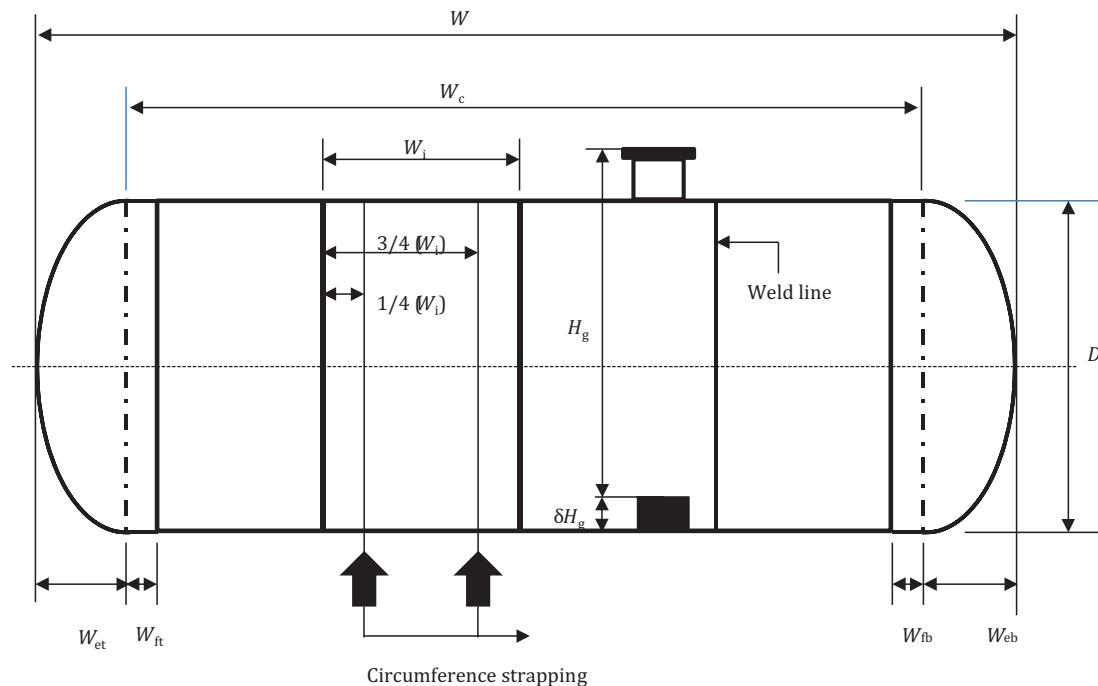
7.2.2 General

For the measurement procedures, a circumferential tape of sufficient length to completely encircle the tank should be used and measurements of the total circumference shall be taken.

- a) In all cases, the tape to be used should be applied to the tank surface at the prescribed locations by the wraparound procedure; i.e. the required length of tape should be applied in a slack condition, positioned, and tightened by the application of the proper tension.

As indicated in [Figure 1](#), strapping should be undertaken around 1/4 and 3/4 of the segment length.

- b) In the case in which the circumferential measuring tape is in contact with the tank surface at all points along its path, circumferential measurements should be made and checked in accordance with the relevant procedure given in ISO 7507-1.
- c) If the circumferential measuring tape is not in contact with the tank surface, corrections should be made for individual obstructions as specified in ISO 7507-1.



Key

- D tank diameter
- δH_g dip plate height
- H_g reference (gauge) height
- W_c cylinder length
- W_i segment length
- W_{ft} straight flange length (top of tank)
- W_{fb} straight flange length (bottom of tank)
- W_{et} head length (top of tank)
- W_{eb} head length (bottom of tank)
- W total tank length

Figure 1 — Measurements of the diameters/circumferences

7.2.3 Repetition of measurements

After the circumference has been measured, the tension shall be released and the tape brought again to the required level and tension. The readings shall then be repeated and recorded.

Take multiple measurements of the circumference. Investigate and, if necessary, remove the perceived outliers. If the first three consecutive measurements agree within ± 3 mm, take their average as the circumference and their standard deviation as the standard uncertainty. If they do not agree within this tolerance, repeat the measurements until two standard deviations of the mean of all measurements is less than the half of this tolerance. Use the average as the measured circumference and the standard deviation as the standard uncertainty.

7.3 Measurement of circumferences — Internal

7.3.1 Overview

Internal measurements shall be performed with the tank empty, at ambient temperature and with no pressure in the tank. In-tank temperature at the time of calibration shall be recorded. There is no need to do pressure recording or corrections unless the reference conditions for the tank require it.

7.3.2 General

For the measurement procedures, a telescopic rod (5.2) of sufficient length to completely measure the internal diameter of the tank or the distance meter (5.3) shall be used.

NOTE Distance meter is normally preferable for tanks with diameters exceeding 3 m.

The telescopic rod or the distance meter shall be applied to the tank at the prescribed locations, at four positions, equally divided around the circumference in accordance with Figure 2. The telescopic rod should be at a 90° angle at each touch point. The average of these four measurements shall be recorded as diameter at this particular location within this particular segment. Care should be taken to ensure that the measured diameter is indeed the minimum value in longitudinal direction and maximum value in circumferential direction.

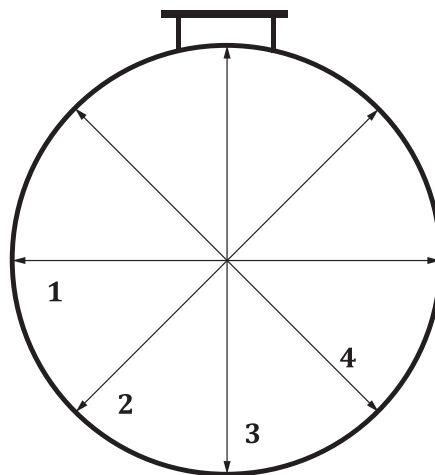


Figure 2 — Internal measurements of diameters

7.4 Measurements of lengths

7.4.1 Method

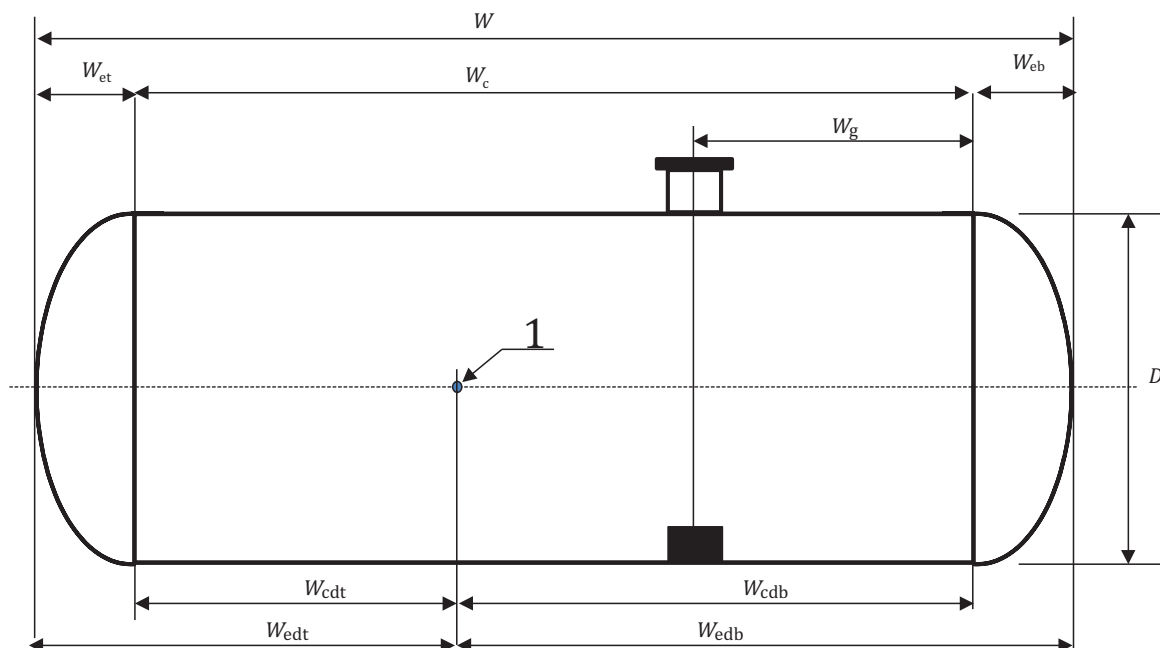
Distance between a single reference point and the extreme points of tank body as well as those of both heads shall be measured in accordance with Figure 3.

NOTE These measurements can be performed using a tape or distance meter, with help of a line or ruler.

The reference point may be anywhere on the body of the tank. Its preferred location is on one of the welds joining the ends to the body of the tank, providing that there are no obstacles.

Repeat all measurements until two consecutive readings agree within a tolerance of ± 3 mm.

Considering the uncertain width and location of the welds, the measurements of length should preferably be done to points made on the shell, on or close to the welds.



Key

1	reference
D	tank diameter
W_c	cylinder length
W_{eb}	bottom end length
W_{cdb}	bottom cylinder distance
W_{cdt}	top cylinder distance
W_{edb}	bottom end distance
W_{edt}	top end distance
W_{et}	top end length
W_{tot}	total tank length
W_g	gauge length

Figure 3 — Measurements of the lengths

7.4.2 Length of horizontal cylinder

The length of the horizontal tank (cylindrical part) is measured between the extreme welds of the extreme segments (knuckle welds) at two locations at opposite sides of the tank, preferably where there are no obstructions (see [Figure 3](#)). Take multiple measurements at each location using measuring tape or distance meter. If the first three consecutive measurements agree within ± 3 mm, take their average as the tank length and their standard deviation as the standard uncertainty. If they do not agree within this tolerance, repeat the measurements until two standard deviations of the mean of all measurements is less than the half of this tolerance. Use the average as the measured tank length and the standard deviation as its standard uncertainty.

7.4.3 Lengths of segments

The measurements may be done internally or externally.

Lengths of the individual segments shall be measured between their respective welds at 2 points and taking the average of the two measurements (see [Figure 1](#)). If the measurements agree within

± 2 mm, take their average as the length of the segment and their standard deviation as the standard uncertainty. If they do not agree within this tolerance, repeat the measurements until they do.

Lengths of the straight flanges connecting the extreme segments to the heads should be measured the same way.

Compare the sum of lengths of all segments including the straight flanges to the total length of the tank and modify length of all segments by their ratio so that the sum of the lengths of the segments is the same as the length of the tank.

7.4.4 Lengths of heads

Length of each head shall be measured as distance between the end plane (mark at the end weld of the cylinder) and the end point of the head (see [Figure 3](#)).

7.4.5 Gauge lengths

Gauge length is not measured but defined by the calibrator within the limits of the upper and lower ends of the gauge hatch (see [Figure 3](#)).

7.4.6 Measurement/calculations of radii of the heads

To measure the radii using traditional means is difficult and errors (in cm) may result. The tank heads are usually made using pre-manufactured forms, resulting in well-defined and repetitive shapes.

Head radii should be preferably obtained from manufacturer's drawings. If these are not available, other methods should be used.

- Using a theodolite to produce a three-dimensional shape of the head could be the best option.
- The radii of the heads can be determined from the measured lengths in combination with diameters of the extreme segments of the tank body, using the existing manufacturers' standards.
- There are national standards that define the radii of knuckle and dish for the given radius of the tank body. The standard, which the tank end complies with, can be determined by comparing its shape to pre-fabricated templates that conform to the standard. Once this is done, the radii can be read from tables within the standard for the given length of the head and tank diameter. Relevant standards are NF E 81-100 to 104 (French), SMS 483 and 486 (Swedish) and NEN 3350 (Dutch).

Radii of the knuckle are regarded as impossible to measure. They should be obtained from manufacturer's drawings.

NOTE Variations in head radii have very little impact on the measured volumes.

7.5 Tank tilt

If the tank segments vary in diameter and in the alignment of their vertical axes, the tilt should be measured and calculated from multiple measurements of vertical distances from horizontal reference line(s) to the points at the top and/or bottom of the tank. There should be one point in each segment of the tank. If points at both the top and the bottom of the tank are measured, the tilt angle should be calculated as an average of the slopes of fitted straight lines. If points at only one side of the tank (either top or bottom) are measured, the tilt angle should be calculated from the slope of the fitted straight line.

The same method should be used even if the diameters of the segments are regarded as (nearly) identical in order to avoid any unnecessary errors.

A leveller may be used to determine the tilt of the tank by measuring the differences in vertical heights to one or two chosen horizontal reference lines at a number of selected points.

Refer to [10.2.2.3](#) for a detailed description of the method.

NOTE “top” and “bottom” refer to the ends of the tank that are the highest and lowest positions on the tilted tank. On tanks with no tilt, either end could be “top” or “bottom”.

7.6 Plate thickness

The plate thickness shall either be measured for each segment, whenever possible, or taken from the manufacturer’s drawings. The plate thickness for each segment shall be recorded to the nearest 0,5 mm. Physical measurements are preferred to readings from drawings.

Normal procedure is to measure two points per segment in any location. Modern ultrasonic instruments can distinguish between metal and paint. If these are not available, the paint shall be scraped off prior to the measurement.

NOTE The thickness of metal is required for pressure correction; combined thickness (metal and paint) is used to calculate internal diameters from external measurements.

7.7 Reference height

Measure the overall height at the reference gauge hatch. If there is a dip plate (datum plate), its height above the bottom of the tank should also be measured in accordance with ISO 7507-1.

7.8 Deadwood

The dimensions and locations of the deadwood shall be measured, whenever possible, or taken from the drawings and the heights of the lowest and highest point of such deadwood measured in relation to the datum point of the tank. The measurements shall be recorded to the nearest 10 mm.

7.9 Measurements of temperature and pressure

Temperature of the tank shell and pressure within the tank shall be used to correct the calculated volume between the calibration and reference conditions.

NOTE Similar corrections are also done between the reference and operating conditions, but these are not the subjects of this document.

Temperature readings should be taken at a minimum of 10 well-distributed points around the tank shell. The temperature of the tank shell should be calculated as the average of these multiple measurements.

If the tank is under pressure when it is being calibrated, the pressure should be measured using the existing pressure gauge.

Corrections to the volume of horizontal cylindrical tanks due to liquid head may be ignored as the effect is minimal due to the limited dimensions, and hence hydrostatic pressures, of tanks of this type.

8 Re-calibration

Tanks shall be re-calibrated whenever the calibration becomes suspect or the tank becomes physically deformed.

Example For example, due to movement of the tank foundations, or as required by national regulations.

If new equipment affecting deadwood volume is fitted or deadwood is removed, the tank calibration table shall be recalculated. If a bigger opening is required in the process, the tank shall be recalibrated.

9 Descriptive data

Descriptive data should be entered on the tank calibration record. It should contain tank description (independent of tank calibration). These would normally include sketches, each completely identified, dated and signed, that show the following:

- a) tank number and product ID;
- b) location, lengths and thicknesses of segments from which the tank is assembled;
- c) number and size of plates per segment;
- d) typical vertical and circumferential welding seams;
- e) arrangements and sizes of nozzles and manways;
- f) locations and sizes of dents and bulges in shell plates, if there are any.

NOTE Further details of the above can be found in ISO 7507-1:2001, Annex D.

Data related to tank calibration that shows the following:

- date of calibration;
- identification of standard used for calibration (e.g. ISO 12917-1);
- method used in bypassing (or correcting for) an obstruction in the path of a circumferential measurement;
- location of the tape path if it is different from that required by this document;
- average tank diameter and corresponding volume of full tank;
- lengths of the tank body and the tank ends;
- tilt angle in degrees or radians;
- location (length from the lowest edge of the tank body) of reference (gauge) point;
- measured value of elevation of dip plate, if there is any;
- measured value of height of the reference point above the dip point (reference height);
- product level and density, pressure and shell temperature when the tank is calibrated;
- pressure and ambient temperature at reference conditions (at which the calibration table is presented);
- type of gauge (innage or ullage) and its direction of measurement (vertical or aligned with the tank ends);
- total measurable level;
- detailed tank calibration table (volume as function of gauged level);
- signature/seal of the certifying authority.