

Petroleum and liquid petroleum products — Direct static measurements — Contents of vertical storage tanks —

Part 1: Mass measurement by
hydrostatic tank gauging

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee PTI/12, Petroleum measurement and sampling, upon which the following bodies were represented:

- Department of Trade and Industry (National Engineering Laboratory)
- Department of Trade and Industry (Oil and Gas Office)
- Institute of Petroleum
- Salvage Association

The following body was also represented in the drafting of the standard, through subcommittees and panels:

- GAMBICA (BEAMA Ltd.)

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The following BSI references relate to the work on this standard:
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National foreword

This British Standard has been prepared by Technical Committee PTI/12. It is identical with ISO 11223-1:1995, *Petroleum and liquid petroleum products — Direct static measurements — Contents of vertical storage tanks — Part 1: Mass measurement by hydrostatic tank gauging*, published by the International Organization for Standardization (ISO). ISO 11223-1 was prepared by Technical Committee ISO/TC 28, Petroleum products and lubricants, Subcommittee SC 3, Static petroleum measurement, in which the UK participated.

Cross-references

International Standard	Corresponding British Standard
ISO 91-1:1992	BS 6441:1993 <i>Schedule for petroleum measurement tables</i> (Identical)
ISO 3838:1983	BS 4699:1985 <i>Methods for determination of density or relative density of petroleum and petroleum products (pycnometer methods)</i> (Identical)
ISO 3993:1984	BS EN ISO 3993:1996 <i>Liquefied petroleum gas and light hydrocarbons — Determination of density or relative density — Pressure hydrometer method</i> (Identical)
ISO 4267-2:1988	BS 7286 <i>Method for calculation of quantities of petroleum and liquid petroleum products</i> Part 2:1990 <i>Dynamic measurement</i> (Identical)
ISO 7078:1985	BS 6953:1988 <i>Glossary of terms for procedures for setting out, measurement and surveying in building construction (including guidance notes)</i> (Identical)
ISO 7507-1:1993	BS 7723 <i>Methods for calibration of vertical cylindrical tanks for petroleum and liquid petroleum products</i> Part 1:1994 <i>Strapping method</i> (Identical)
ISO 8311:1989	BS 7627:1993 <i>Method for calibration by physical measurement of membrane tanks and prismatic tanks in ships for carriage of refrigerated light-hydrocarbon fluids</i> (Identical)

The Technical Committee has reviewed the provisions of IEC 79-0:1983 (with Amendment No. 1:1987) to which normative reference is made in the text, and has decided that it is acceptable for use in conjunction with this standard.

CAUTION. Attention is drawn to the Health and Safety at Work etc. Act 1974, and the need for ensuring that the guidance given in this British Standard is used with suitable precautions.

The guidance given in this British Standard is intended to be used by appropriately qualified and experienced persons or other suitable trained and/or supervised personnel. Normal safety precautions should be observed in the use of the guidance.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 16, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Introduction

Hydrostatic tank gauging (HTG) is a method for the determination of total static mass of liquid petroleum and petroleum products in vertical cylindrical storage tanks.

HTG uses high-precision stable pressure sensors mounted at specific locations on the tank shell.

Total static mass is derived from the measured pressures and the tank capacity table. Other variables, such as level, observed and standard volumes and observed and reference densities, can be calculated from the product type and temperature using the established industry standards for inventory calculations.

The term “mass” is used in this part of ISO 11228 to indicate mass in vacuum (true mass). In the petroleum industry it is not uncommon to use apparent mass (in air) for commercial transactions.

1 Scope

This part of ISO 11223 gives guidance on the installation, commissioning, maintenance, validation and calibration of hydrostatic tank gauging (HTG) systems for the direct measurement of static mass in petroleum storage tanks.

This part of ISO 11223 is applicable to hydrostatic tank gauging systems which use pressure sensors with one port open to the atmosphere. It is applicable to the use of hydrostatic tank gauging on vertical, cylindrical, atmospheric storage tanks with either fixed or floating roofs.

This part of ISO 11223 is not applicable to the use of hydrostatic tank gauging on pressurized tanks.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 11223. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 11223 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 91-1:1992, *Petroleum measurement tables — Part 1: Tables based on reference temperatures of 15 °C and 60 degrees F*.

ISO 91-2:1991, *Petroleum measurement tables — Part 2: Tables based on a reference temperature of 20 °C*.

ISO 3838:1983, *Crude petroleum and liquid or solid petroleum products — Determination of density or relative density — Capillary-stoppered pycnometer and graduated bicapillary pycnometer methods*.

ISO 3993:1984, *Liquefied petroleum gas and light hydrocarbons — Determination of density or relative density — Pressure hydrometer method*.

ISO 4266:1994, *Petroleum and liquid petroleum products — Measurement of temperature and level in storage tanks — Automatic methods*.

ISO 4267-2:1988, *Petroleum and liquid petroleum products — Calculation of oil quantities — Part 2: Dynamic measurement*.

ISO 7078:1985, *Building construction — Procedures for setting out, measurement and surveying — Vocabulary and guidance notes*.

ISO 7507-1:1993, *Petroleum and liquid petroleum products — Calibration of vertical cylindrical tanks — Part 1: Strapping method*.

IEC 79-0:1983, *Electrical apparatus for explosive gas atmospheres — Part 0: General requirements*.

API¹⁾ Standard 2545, *Standard practice for gaging petroleum and petroleum products*, 1965; reapproved 1990 (ANSI/ASTM D 1085).

3 Definitions

For the purposes of this part of ISO 11223, the following definitions apply.

3.1

ambient air density

density of ambient air at the tank side on which the pressure sensors are mounted

3.2

ambient air temperature

representative temperature of the ambient air at the tank side on which the HTG pressure sensors are mounted

3.3

critical zone height

- 1) Upper limit of the critical zone.
- 2) Level at which one or more of the floating roof or floating blanket legs first touch the tank bottom.

3.4

critical zone

level range through which the floating roof or floating blanket is partially supported by its legs

¹⁾ American Petroleum Institute.

3.5**dipped volume**

observed volume of product, sediment and water, calculated from the dip level and the tank capacity table

3.6**floating-roof mass**

value of the floating-roof mass, inclusive of any mass load on the roof, manually entered in the data processor

3.7**free water level**

level of any water and sediment that exist as layers separate from the product and lie beneath the product

3.8**gauge pressure sensor**

sensor that uses the ambient air pressure as pressure reference

3.9**head mass**

total measured mass between the HTG bottom sensor and the top of the tank

3.10**head space**

space inside the tank, above the bottom HTG sensor, in which product and in-tank vapour are present

3.11**heel space**

space inside the tank, below the bottom HTG sensor

3.12**HTG reference point**

stable reference point from which the HTG sensor positions are measured

3.13**hydrostatic tank gauging (HTG)**

method of direct measurement of liquid mass in a storage tank based on measuring static pressures caused by the liquid head above the pressure sensor

3.14**in-tank vapour density**

density of the gas or vapour (mixture) in the ullage space at the observed conditions (product temperature and pressure)

3.15**pin height**

lower limit of the critical zone; the level at which the floating roof or floating blanket rests fully on its legs

3.16**pressure sensor effective centre**

point on the sensor from which the hydrostatic pressure head is measured

3.17**product heel mass**

mass of product below the bottom HTG sensor

3.18**product heel volume**

observed volume of product below the bottom HTG sensor, calculated by subtracting the water volume from the total heel volume

3.19**product mass**

sum of the head mass and the product heel mass, reduced by the floating-roof mass (if applicable) and the vapour mass

3.20**product temperature**

temperature of the tank liquid in the region where the HTG measurements are performed

3.21**reference density**

density at the reference temperature

3.22**reference temperature**

temperature to which reference density and standard volumes are referred

3.23**tank average cross-sectional area**

average cross-sectional area between the elevation of the bottom HTG sensor and the dip level, over which the hydrostatic pressures are integrated in order to obtain the head mass

3.24**tank lip**

tank bottom plate on the outside of the tank shell

3.25**total heel volume**

observed volume below the bottom HTG sensor, calculated from the bottom sensor elevation and the tank capacity table, corrected for observed temperature

3.26**ullage pressure**

absolute pressure of the air (air or vapour) inside the tank, above the product