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SS-ISO 11223:2004**

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Utgåva 1

**Petroleum och flytande petroleumprodukter –  
Direkta statiska mätningar – Mätning av innehåll  
i vertikala lagringstankar genom hydrostatisk  
tankmätning (ISO 11223:2004, IDT)**

**Petroleum and liquid petroleum products –  
Direct static measurements – Measurement of  
content of vertical storage tanks by hydrostatic  
tank gauging (ISO 11223:2004, IDT)**

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Denna standard ersätter SS-ISO 11223-1, utgåva 1.

The International Standard ISO 11223:2004 has the status of a Swedish Standard. This document contains the official English version of ISO 11223:2004.

This standard supersedes the Swedish Standard SS-ISO 11223-1, edition 1.

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## SS-ISO 11223:2004

### 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 11223 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*, Subcommittee SC 3, *Static petroleum measurement*.

This first edition of ISO 11223 cancels and replaces ISO 11223-1:1995, which has been technically revised.

## **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 International Standard to indicate mass in vacuum (true mass). In the petroleum industry, it is not uncommon to use apparent mass (in air) for commercial transactions.



# Petroleum and liquid petroleum products — Direct static measurements — Measurement of content of vertical storage tanks by hydrostatic tank gauging

## 1 Scope

This International Standard gives guidance on the selection, installation, commissioning, maintenance, validation and calibration of hydrostatic tank-gauging (HTG) systems for the direct measurement of static mass in petroleum storage tanks. It is intended to cover custody transfer applications, although details of other, less accurate, measurements are included for information. It also gives guidance on calculations of standard volume from measured mass and independently measured reference density. Information is also included on measurements of observed and standard volume using density measured by the HTG system itself.

This International Standard 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 International Standard is not applicable to the use of hydrostatic tank gauging on pressurized tanks.

## 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.

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

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

ISO 1998 (all parts), *Petroleum industry — Terminology*

ISO 3170:2004, *Petroleum liquids — Manual sampling*

ISO 3675:1998, *Crude petroleum and liquid petroleum products — Laboratory determination of density — Hydrometer method*

ISO 3838:2004, *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 4266-4:2002, *Petroleum and liquid petroleum products — Measurement of level and temperature in storage tanks by automatic methods — Part 4: Measurement of temperature in atmospheric tanks*

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

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ISO 4268:2000, *Petroleum and liquid petroleum products — Temperature measurements — Manual methods*

ISO 4512:2000, *Petroleum and liquid petroleum products — Equipment for measurement of liquid levels in storage tanks — Manual methods*

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

ISO 7507-1:2003, *Petroleum and liquid petroleum products — Calibration of vertical cylindrical tanks — Part 1: Strapping method*

ISO 9857:—<sup>1)</sup> *Petroleum and liquid petroleum products — Continuous density measurement*

ISO 12185:1996, *Crude petroleum and petroleum products — Determination of density — Oscillating U-tube method*

IEC 60079-0:2004, *Electrical apparatus for explosive gas atmospheres — Part 0: General requirements*

API, *Manual of Petroleum Measurement Standards Chapter 3 — Tank Gauging Section 1A — Standard Practice for the Manual Gauging of Petroleum and Petroleum Products*, First Edition

### 3 Terms and definitions

For the purposes of this document, the following terms and 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 apparent mass in air**  
value obtained by weighing in air against standard masses without making correction for the effect of air buoyancy on either the standard masses or the object weighed
- [ISO 3838]
- 3.4 capacity table**  
table, often referred to as a tank table or a tank calibration table, showing the capacities of, or volumes in a tank corresponding to various liquid levels measured from a stable reference point
- [ISO 7507-1]
- 3.5 critical zone height**  
upper limit of the critical zone; the level at which one or more of the floating-roof or floating-blanket legs first touch the tank bottom

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1) To be published.

### 3.6

#### **critical zone**

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

### 3.7

#### **density**

mass of the substance divided by its volume

[ISO 3838]

NOTE When reporting the density, it is necessary to explicitly state the unit of density used, together with the temperature. The standard reference temperature for international trade in petroleum and its products is 15 °C (see ISO 5024). Other reference temperatures might be required for legal metrology or other special purposes (see ISO 3993).

### 3.8

#### **dip**

#### **innage**

depth of a liquid in a tank

[adapted from ISO 7507-1]

### 3.9

#### **dipped volume**

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

### 3.10

#### **fixed-roof tank**

vertical cylindrical storage vessel with either a cone- or domed-shaped roof of either the non-pressurized (freely vented) type or the low-pressure type

[ISO 1998]

### 3.11

#### **floating blanket**

#### **cover**

#### **screen**

light-weight cover of either metal or plastic material designed to float on the surface of the liquid in a fixed-roof tank

NOTE The blanket is used to retard the evaporation of volatile products in a tank.

[adapted from ISO 7507-1]

### 3.12

#### **floating-roof mass**

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

### 3.13

#### **floating-roof tank**

tank in which the roof floats freely on the surface of the liquid contents except at low levels when the weight of the roof is taken, through its supports, by the tank bottom

[ISO 7507-1]

### 3.14

#### **free-water level**

level of any water and sediment that exist as a separate layer underneath the product

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### 3.15

#### **gross standard volume**

volume of oil, including dissolved water, suspended water and suspended sediment, but excluding free water and bottom sediment, calculated at standard conditions

### 3.16

#### **head mass**

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

### 3.17

#### **heel space**

space inside the tank, below the bottom HTG sensor

### 3.18

#### **HTG reference point**

stable reference point from which the HTG sensor positions are measured

### 3.19

#### **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

### 3.20

#### **in-tank vapour density**

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

### 3.21

#### **observed density**

value obtained at a test temperature which differs from the calibration temperature of the apparatus

[adapted from ISO 3838]

### 3.22

#### **pin height**

lower limit of the critical zone, i.e. the level at which the floating roof or floating blanket rests fully on its legs

### 3.23

#### **product heel mass**

mass of product below the bottom HTG sensor

### 3.24

#### **product heel volume**

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

### 3.25

#### **product mass**

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

### 3.26

#### **product temperature**

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

### 3.27

#### **reference density**

density at the reference temperature

**3.28**

**reference temperature**

temperature to which reference density and standard volumes are referred

**3.29**

**tank average cross-sectional area**

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

**3.30**

**tank lip**

tank bottom plate on the outside of the tank shell

**3.31**

**tank shell**

outer casing of a storage tank that on land is secured to the ground and includes the roof, if it is a **fixed-roof tank** (3.10)

**3.32**

**total heel volume**

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

**3.33**

**total volume**

indicated volume, including all water and sediment without correction for temperature and pressure.

[adapted from ISO 4267-2]

**3.34**

**ullage pressure**

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

**3.35**

**vapour relative density**

ratio of molecular mass of vapour (mixture) to that of air (mixture)

**3.36**

**water volume**

observed volume of free sediment and water, calculated from the free water level and the tank capacity tables

**3.37**

**ullage**

**outage**

capacity of the tank not occupied by the liquid

[ISO 7507-1]

**3.38**

**uncertainties**

unless stated otherwise, all uncertainties, including maximum permissible errors, are assumed to be extended uncertainties with coverage factor  $k = 2$