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Petroleum and liquid petroleum products — Measurement of level and temperature in storage tanks by automatic methods —

Part 1: Measurement of level in atmospheric tanks

Pétrole et produits pétroliers liquides — Mesurage du niveau et de la température dans les réservoirs de stockage par méthodes automatiques —

Partie 1: Mesurage du niveau dans les réservoirs à pression atmosphérique

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Foreword

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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 document 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).

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

This second edition cancels and replaces the first edition (ISO 4266-1:2002), which has been technically revised.

The main changes are as follows:

— it has been specified in the scope that this document includes fiscal/custody transfer applications;

— in 4.3.2, it has been clarified that temperatures should be measured and recorded simultaneously with the level;

— in 6.5.7, the perforation distance on still-well's from 300 mm to 150 mm has been updated.

A list of all parts in the ISO 4266 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Petroleum and liquid petroleum products — Measurement of level and temperature in storage tanks by automatic methods —

Part 1: Measurement of level in atmospheric tanks

1 Scope

This document gives requirements and guidance on the accuracy, installation, commissioning, calibration and verification of automatic level gauges (ALGs). It applies to ALGs which are both intrusive and non-intrusive types, in fiscal/custody transfer applications for measuring the level of petroleum and petroleum products having a Reid vapour pressure less than 100 kPa, stored in atmospheric storage tanks.

This document is not applicable to the measurement of level in refrigerated storage tanks with ALG equipment.

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1998 (all parts) and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
automatic level gauge
ALG
automatic tank gauge
ATG
instrument that continuously measures liquid height [*dip* (3.2) or *ullage* (3.10)] in storage tanks

3.2
dip
innage
vertical distance between the *dipping datum plate* (3.3) and the liquid level

3.3
dipping datum plate
dipping datum point
dip-plate
horizontal metal plate located directly below the *gauging reference point* (3.5) to provide a fixed contact surface from which manual liquid-depth measurements are made

3.4
gauge-hatch
gauging access point
dip-hatch
opening in the top of a tank through which gauging and sampling operations may be carried out

3.5
gauging reference point
reference gauge point
point clearly defined on the *gauge hatch* (3.4) directly above the *dipping datum plate* (3.3) to indicate the position (and upper datum) from which manual dipping or ullaging should be carried out

3.6
innage-based automatic level gauge
automatic level gauge (3.1) designed and installed to measure the liquid dip, with an integral reference point at or close to the tank bottom, referenced to the *dipping datum plate* (3.3)

3.7
intrusive automatic level gauge
automatic level gauge (3.1) where the level-sensing device intrudes within the tank and makes physical contact with the liquid

EXAMPLE Float and servo-operated-type automatic level gauge.

3.8
non-intrusive automatic level gauge
automatic level gauge (3.1) where the level-sensing device may intrude within the tank, but does not make physical contact with the liquid

EXAMPLE Microwave or radar-type automatic level gauge.

3.9
still-well
still-pipe
vertical, perforated pipe built into a tank to reduce measurement errors arising from liquid turbulence, surface flow or agitation of the liquid

3.10
ullage
outage
distance between the liquid level and the *gauging reference point* (3.5), measured along the vertical measurement axis

3.11
ullage-based automatic level gauges
automatic level gauge (3.1) designed and installed to measure the *ullage* (3.10) distance from the upper automatic level gauge reference point to the liquid surface

4 Precautions

4.1 Safety precautions

International standards and government regulations on safety and material-compatibility precautions can apply when using ALG equipment. In addition, the manufacturer's recommendations on the use and installation of the equipment should be followed. It is presupposed that all regulations covering entry into hazardous areas are observed.

4.2 Equipment precautions

4.2.1 All of the ALG equipment should be capable of withstanding the pressure, temperature, operating and environmental conditions likely to be encountered in service.

4.2.2 ALGs should be certified for use in the hazardous-area classification appropriate to their installation.

4.2.3 Measures should be taken to ensure that all exposed metal parts of the ALG have the same electrical potential as the tank.

4.2.4 All ALG equipment should be maintained in safe operating condition and the manufacturer's maintenance instructions should be complied with.

NOTE 1 The design and installation of ALGs can be subject to the approval of a national measurement organization, who normally have issued a type approval for the design of the ALG regarding the particular service for which it is to be employed. Type approval is normally issued after an ALG has been subjected to a specific series of tests and is subject to the ALG being installed in an approved manner.

NOTE 2 Type-approval tests can include the following: visual inspection, performance, vibration, humidity, dry heat, inclination, fluctuations in power supplies, insulation, resistance, electromagnetic compatibility, and high voltage.

4.3 General precautions

4.3.1 The general precautions given in 4.3.2 to 4.3.8 apply to all types of ALGs and should be observed where applicable.

4.3.2 Tank temperatures should be measured at the same time as the tank level is measured. The tank temperature should be representative of the tank contents. For more details on temperature measurement, refer to ISO 4266-4.

4.3.3 Levels measured for bulk transfer should be recorded promptly when they are taken.

4.3.4 Whenever determinations of the contents of a tank are made before the movement of a bulk quantity of liquid (opening gauge) and after the movement of a bulk quantity of liquid (closing gauge), the same general procedures should be used to measure the tank level.

4.3.5 All parts of the ALG in contact with the product or its vapour should be chemically compatible with the product, to avoid both product contamination and corrosion of the ALG.

4.3.6 ALGs should have a sufficient dynamic response to track the liquid level during maximum tank filling or emptying rates.

4.3.7 Following the transfer of the product, the tank should be allowed to settle before the tank level is measured.

4.3.8 ALGs should provide security to prevent unauthorized adjustment or tampering. ALGs used in fiscal/custody transfer applications should provide facilities to allow sealing for calibration adjustment.

5 Accuracy

5.1 Intrinsic error of ALGs

The level measurement accuracy of all ALGs is affected by the intrinsic error of the ALG, i.e. the error of the ALGs when tested under controlled conditions as specified by the manufacturers.

5.2 Calibration prior to installation

The reading of the ALG to be used in a fiscal/custody transfer application should agree with a certified reference (e.g. a certified gauge tape) within ±1 mm over the entire range of the ALG. It is presupposed that the certified reference is traceable to national standards. The certified reference should be provided with a calibration correction table.

NOTE Metrology requirements for uncertainty of the calibration reference can be more stringent.

5.3 Error caused by installation and operating conditions

The total error of the ALG in a fiscal/custody conditions transfer application should not be affected by more than ±3 mm due to installation, variation of operating conditions and variation of physical and electrical properties of the liquid and/or vapour, provided these conditions are within the limits specified by the ALG manufacturer.

The accuracy of measurements using ullage-based ALGs is limited by vertical movement of the gauging reference point used to calibrate the ALG or vertical movement of the ALG top mounting point during tank transfers. The accuracy can be affected by tank-shell bulging due to liquid head stress. Any vertical movement of the gauging reference point due to liquid head stress of the tank shell can be compensated by a correction in the ALG.

The accuracy of measurements using innage-based ALGs can be limited by any vertical movement of the dipping datum plate used to calibrate the ALG, or vertical movement of the ALG bottom mounting point during tank transfers.

Volume measurements using tanks are limited by the following installed accuracy limitations, regardless of the ALGs used. These limitations can have a significant effect on the overall accuracy of both manual level gauging and of all types of automatic level gauges, and/or on the accuracy of the quantity of the content in the tank. These limitations include:

a) Tank capacity table accuracy (including the effect of tank tilt and hydrostatic pressure).

b) Bottom movement.

c) Encrustation of the tank shell.

d) Expansion of the tank diameter due to temperature.

e) Random and systematic errors in level, density, and temperature measurements.

f) Operational procedures used in the transfer.

g) Minimum difference between opening and closing levels (parcel size).

5.4 Overall accuracy

5.4.1 General

The overall accuracy of level measurement by ALGs, as installed, is limited by the intrinsic error of the ALG equipment, the effect of installation methods, and the effect of the operating conditions.

NOTE Depending on the overall accuracy of the ALG as installed ("installed accuracy"), ALGs can be used for fiscal/custody transfer purposes. The use of ALGs in fiscal/custody transfer applications requires the highest possible accuracy. The use of ALGs for other (i.e. stock control or for plant or terminal operations) purposes often permits a lower degree of accuracy.

5.4.2 Use of ALGs for fiscal/custody transfer purposes

The ALG should meet the calibration tolerance prior to installation (see 5.2).

The ALG should meet the field verification tolerance (see 7.4.3.3), as well the effects of installation methods and changes in operating conditions (see 5.3).

The remote readout, if used, should meet the recommendations of this document (see Clause 9).

6 Installation of ALGs

6.1 General

6.2 to 6.5 outline recommendations for the installation of ALGs.

6.2 Mounting location

The mounting location of an ALG can affect the installed accuracy. For fiscal/custody transfer accuracy, the ALG mounting location should be stable, with minimal vertical movement under all practical operating conditions, which can arise, for example, due to changes in liquid head, vapour pressure and loading of the roof or gauging platform (see 6.5.)

6.3 Manufacturer's requirements

The ALG and level transmitter shall be installed and wired according to the manufacturer's instructions.

6.4 Installation

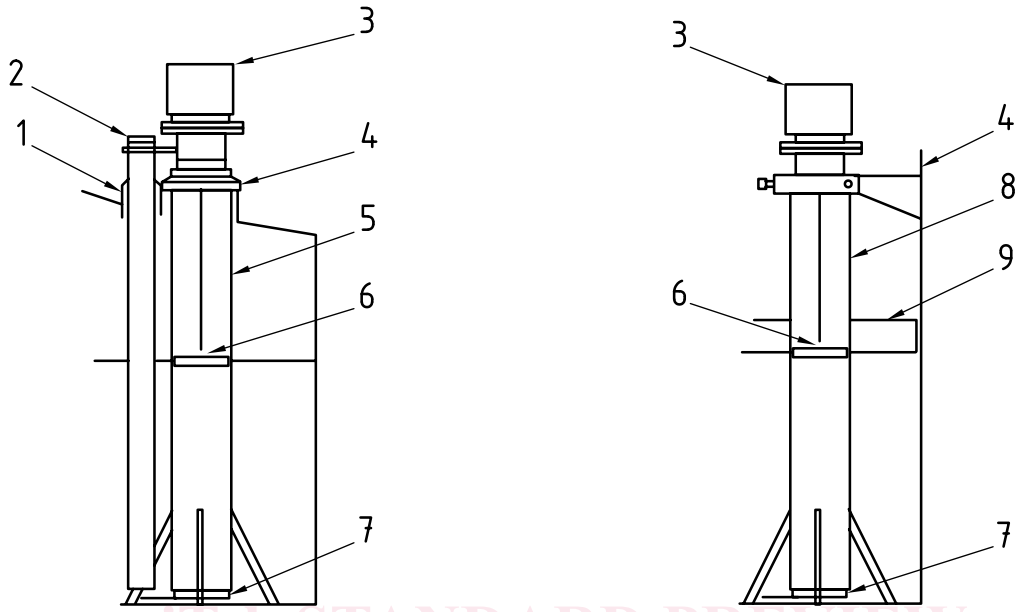
6.4.1 For fiscal/custody transfer accuracy, an ullage ALG should be mounted on a properly supported, perforated still-well, as illustrated in Figures 1 and 2.

6.4.2 As an alternative, an ullage-based ALG may be mounted on the roof or on a "gallows" supported from the top course of the shell. The ALG's calculation procedure for liquid level should include a means which compensates or corrects for movement of the ALG with respect to the gauging reference point (due to liquid height and temperature). Various types of "gallows" designs are used. An example of this type of installation is shown in Figure 3. Installation of some other ullage-based ALGs can involve a mounting attached to the outside of the tank shell near the tank bottom. An example of this type of installation is shown in Figure 4.

NOTE An ALG can include a programme to compensate or correct for the movement of the ALG due to liquid height and temperature.

6.4.3 Innage-based ALGs should be mounted at a stable location at the tank bottom where any effects due to liquid turbulence and/or tank bottom movement are minimized. An example of this type of installation is shown in Figure 5.

6.4.4 Where possible, the ALG should be located in close proximity to the manual gauge-hatch and should be accessible from the gauger's platform so that the ALG's accuracy can be easily verified by manual gauging. The ALG mounting and the gauging reference point of the manual gauging hatch should be rigidly connected to avoid errors due to differential and unpredictable movement.



a) Installation of top-mounted ALG on fixed-roof tanks with still-well

b) Installation of top-mounted ALG on external floating-roof tanks or on internal floating-roof tanks with still-well

Key

1 flexible weather seal
2 separate still-well (see note 1)
3 automatic level gauge (ALG) attached to top of still-well
4 perforated still-well sliding guide
5 perforated still-well (see notes 1 and 5)
6 level-detecting element (see note 2)
7 datum plate (see note 4)
8 perforated still-well (see notes 1 and 3)
9 pontoon

NOTE 1 Separate still-well(s) for manual gauging and temperature measurement can be installed adjacent to the ALG still-well.

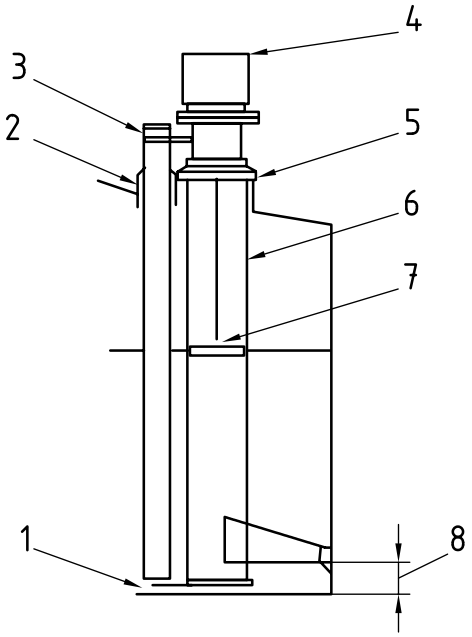
NOTE 2 The installations shown in Figure 2 a) and b) are typical for some intrusive ALGs. Non-intrusive top-mounted ALGs can be installed in a similar way.

NOTE 3 Local environmental restrictions can require the use of non-perforated still-well(s) on external floating-roof (EFR) tanks, but this can result in serious gauging errors and have safety implications (risk of tank overflow) in certain circumstances (see 6.5.7).

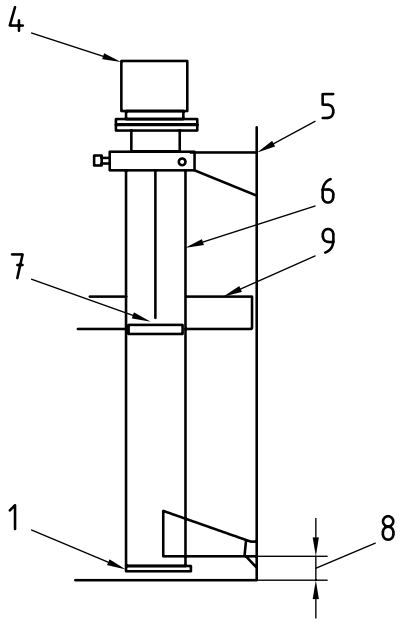
NOTE 4 It is expected that the datum plate is mounted on the tank bottom located below the still-well, or attached to the still-well (as shown).

NOTE 5 An ALG can also be mounted on the stable section of the roof of a fixed-roof tank (not shown in this figure).

Figure 1 — Example of an ALG (intrusive or non-intrusive) mounted on a still-well supported by the tank bottom



a) Installation of top-mounted ALG on fixed-roof tanks with still-well



b) Installation of top-mounted ALG on external floating-roof tanks or on internal floating-roof tanks with still-well

Key

1 datum plate (see note 5)
2 still-well sliding guide and weather seal
3 separate still-well (see note 1)
4 automatic level gauge (ALG) attached to top of still-well
5 still-well sliding guide
6 perforated still-well (see notes 1 and 3)
7 level-detecting element (see note 2)
8 support bracket (see note 4)
9 pontoon

NOTE 1 Separate still-wells for manual gauging and temperature measurement can be installed adjacent to the ALG still-well.

NOTE 2 The installations shown in Figure 2 a) and b) are typical for some intrusive ALGs. Non-intrusive, top-mounted level ALGs can be installed in a similar way.

NOTE 3 Local environmental restrictions can require the use of non-perforated still-well(s) on external floating-roof (EFR) tanks, but this can result in serious gauging errors and have safety implications (risk of tank overflow) in certain circumstances (see 6.5.7).

NOTE 4 It is expected that the support bracket is as close to the tank bottom as practical, typically 250 mm or less from the bottom.

NOTE 5 It is expected that the datum plate is attached to the still-well (as shown), or on the tank bottom plate.

NOTE 6 An ALG can also be mounted on the stable section of the roof of a fixed-roof tank (not shown in this figure).

NOTE 7 In order to minimize the vertical movement of the still-well due to hydrostatic deformation of the tank shell, it is expected that the support bracket design decouples the still-well from the tank shell.

Figure 2 — Example of an ALG (intrusive or non-intrusive) mounted on a still-well that is supported by a bracket hinged to the lower tank shell