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**Petroleum and Liquid Petroleum Products -
Measurement of Level and Temperature in Storage
Tanks by Automatic Methods - Part 2: Measurement of
Level in Marine Vessels**

石油和液体石油产品 储罐中液位和温度自动测量法

第 2 部分：油船舱中的液位测量

(ISO 4266-2:2002, MOD)

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Petroleum and Liquid Petroleum Products - Measurement of Level and Temperature in Storage Tanks by Automatic Methods - Part 2: Measurement of Level in Marine Vessels

1 Scope

This Part of GB/T 21451 provides the accuracy, installation, calibration and inspection guidance for immersive and non-immersive automatic level gauge (ALG), which is adopted for the measurement of level of petroleum and liquid petroleum products, which are transported in marine vessels and with the Reid vapor pressure of less than 100 kPa.

This Part also provides the guidance for the application of marine ALG in custody transfer metering. However, generally speaking, the consensus of both parties involved in the custody transfer metering is needed.

This Part is inapplicable to the measurement of level in refrigerated marine vessels.

2 Normative References

The following documents are indispensable to the application of this document. In terms of references with a specified date, only versions with a specified date are applicable to this document. In terms of references without a specified date, the latest version (including all the modifications) is applicable to this document.

GB/T 13236 *Petroleum and Liquid Petroleum Products - Equipment for Measurement of Liquid Levels in Storage Tanks - Manual Method* (GB/T 13236-2011, ISO 4512:2000, MOD);

GB/T 13894 *Petroleum and Liquid Petroleum Products - Measurement of Liquid Level in Tank - Manual Method*;

GB/T 21451.5 *Petroleum and Liquid Petroleum Products - Measurement of Level and Temperature in Storage Tanks by Automatic Method - Part 5: Measurement of Temperature in Marine Vessels* (GB/T 21451.5-2019; ISO 4266-5:2002, MOD);

ISO 1998 (all parts) *Petroleum Industry - Terminology*;

ISO 8697:1999 *Crude Petroleum and Petroleum Products - Transfer Accountability - Assessment of On Board Quantity (OBQ) and Quantity Remaining on Board (ROB)*

4.2.9 Mixed air and vapor

Before the measurement of liquid level, retain sufficient time, so that the mixed air or vapor can thoroughly flow out of the liquid.

4.2.10 Swaying of vessels

During lightering, offshore operation, or when vessels are berthed at an open berth, the swaying of vessels will trigger liquid fluctuation in the vessels. Within the shortest period of time, conduct reading for at least 3 times; obtain an average reading. When vessels are dramatically swaying because of the acutely fluctuating waves, within the shortest period of time, conduct reading for at least 5 times.

As a part of the digital display device, some ALGs provide internal screening algorithm. At a certain interval, obtain an average reading of the liquid level. The screening time may be fixated, or, may be accordingly adjusted in accordance with the motion of the vessels.

4.3 The Application of Marine ALG in Custody Transfer Metering

Due to the influencing factors provided in Appendix A and Appendix B, generally speaking, marine ALG cannot be applied to custody transfer metering. However, when there are no other measurement methods that can reliably be used as a substitute, liquid level measurement conducted by marine ALG may also be used for custody transfer metering. However, generally speaking, the consensus of both parties involved in the custody transfer metering will be needed.

5 Accuracy

5.1 Inherent Error of ALG

Inherent error of ALG is error of ALG inspection conducted under the control conditions stipulated by the manufacturer. The accuracy of all ALG liquid level measurement is under the influence of its inherent error.

5.2 Calibration before Installation

Marine ALG used for custody transfer metering shall be calibrated before installation (namely, in factory or laboratory). In at least 3 points within the expected measurement range of ALG, the difference between ALG and certified standard shall be within 3 mm. Certified standard shall be traceable to national primary standards and be equipped with a calibration correction meter. After applying the calibration correction value, its uncertainty shall not exceed 0.5 mm.

NOTE: certified standard refers to reference standard which has a valid verification or calibration certificate. In terms of the uncertainty of certified standard, its metrology

ALG shall be positioned in a location with relatively weak influence from the turbulence and fluctuation of liquid level in marine vessels. In the design of the installation location, consider avoiding the prevention of damages caused by vessel-washing. In terms of mechanical float-type ALG, which cannot endure the fluctuation of liquid level or the operation of vessel-washing, when it is not in service, the function of float storage shall be provided.

In terms of cuboid vessels, ALG shall be positioned in the geometric center of marine vessels. Thus, correction of longitudinal inclination and transverse inclination may be avoided. In terms of marine vessels that contain curved edges, for example, fore and aft side tank, in order to avoid the influence of the curved part at the bottom of marine vessels, ALG shall be installed near the inner bulkhead.

At present, the integration level of marine vessel design and ALG technology restricts the application of ALG in the metering of partially loaded or fully loaded vessels. Therefore, other measurement locations need to be adopted to satisfy the demand of small-volume (on board quantity and quantity remaining on board) metering (see ISO 8697).

6.3 Location of Manual Calibration Checkpoint

In order to accurately compare the manually measured liquid level and the automatically metered liquid level, manual calibration checkpoint shall be positioned near ALG (namely, within 1 m).

6.4 Metering of Inert Marine Vessels

In terms of marine vessels that are connected with inert gas system, the design and installation of ALG shall guarantee that maintenance and calibration are conducted under the condition with no decompression.

7 Onboard Inspection of Marine ALG

7.1 General Requirements

7.1.1 Inspection of operating stability of liquid level sensing element in the dock

After the installation and before the calibration of immersive ALG, inspect liquid level sensing element; make sure that it can freely operate within the whole measuring range. The above inspection shall be slowly conducted, so as to simulate the practical operating condition and avoid damage to ALG.

7.1.2 Consideration of specific ALG technology

Other specific technology that would affect ALG inspection shall be considered. Before the inspection, additional steps might need to be adopted to prepare for ALG. For

7.4.4 ALG adjustment

7.4.4.1 When the difference between the average ALG reading and the average manual measurement reading exceeds 6 mm, ALG shall be re-adjusted or re-set, so as to implement consistency with the value of manual measurement. The above-mentioned setting and the causes for the setting shall be recorded in vessel equipment maintenance record.

7.4.4.2 After the re-adjustment, in accordance with 7.4.3, compare the ALG reading and the manual measurement reading. If the difference between the average ALG reading and the average manual measurement reading is within 6 mm, then, it is unnecessary to adopt any further measures.

7.4.4.3 When ALG cannot be adjusted to a consistent value as the average reading of manual measurement, it may be corrected. The corrected value shall be indicated near ALG digital display equipment and shall be used to correct ALG reading. The condition of such correction shall be recorded in vessel documents.

7.5 Inspection with Alternative Method

As a matter of fact, due to operation restrictions (for example, airtight or restricted measurement requirement), deficiency of correctly positioned points for manual measurement or adverse marine conditions (such as surges and swaying of vessels), it is generally difficult to obtain reliable manual measurement data to inspect ALG. As an alternative method, by comparing ALG measured value with a stable reference height value which is pre-set on marine vessels or ALG still-pipe, onboard inspection may be conducted. The above method and steps might vary with the type of ALG. Hence, the inspection shall be conducted in accordance with ALG manufacturer's requirements.

7.6 ALG Regular Inspection Plan

In terms of vessels which cannot verify ALG accuracy (through the comparison with manual measurement or pre-set reference height value) in accordance with the stipulations, inspection shall be conducted at least once in each quarter.

7.7 Data Storage

ALG inspection record shall be archived and shall be made convenient for the inspection by involved parties. Recorded data shall be kept for at least 1 year or 20 voyages.

8 Data Communication

8.1 Introduction

Appendix A

(informative)

Influencing Factors of Liquid Level Measurement of Marine Vessels

Being irrelevant with the applied ALG, liquid level measurement by marine ALG is under the influence of the following defects:

- a) Small-volume (on board quantity and quantity remaining on board) measurement. It is difficult to use ALG to measure the liquid level of small-volume on board quantity and quantity remaining on board.
- b) Accurate determination of longitudinal inclination and transverse inclination. It is difficult to accurately determine longitudinal inclination and transverse inclination. In addition, the correction of longitudinal inclination and transverse inclination will affect the accuracy of liquid level measurement of marine vessels. Due to swelling, drooping, twisting and bending, the depth of immersion of multiple points might need to be measured. The correction of longitudinal inclination that is suitable for the vessels shall be adopted. If ALG digital display device has the function of correcting longitudinal inclination and transverse inclination, the correction method shall be consistent with ISO 8697.
- c) Influence brought by fluctuation in marine vessels triggered by the swaying of vessels. Due to the fluctuation in marine vessels, the measurement of the average value of liquid level becomes extremely difficult. The indicating value of many ALGs is instant liquid level obtained in a point of measurement. However, manual measurement of liquid level is inclined to the measurement of peak height. Hence, it is difficult to calibrate ALG when there is fluctuation in the vessels. Some ALGs provide an internal screening algorithm through a digital display device; the average value of liquid level reading within a certain period of time may be calculated. The screening time may be fixated, or, may be accordingly adjusted in accordance with the swaying of the vessels.
- d) Dimensional variation of vessels caused by petroleum or water temperature change. The dimensions of marine vessels vary with the changes of petroleum or water temperature, and other factors. Hence, the conversion between liquid level and volume would be affected. The variation of the vertical height of marine vessels will change the reference height, which may further influence the accuracy of liquid level measurement by ALG that is installed on the top deck.
- e) Dimensional variation of vessels caused by swelling or drooping. Swelling or drooping would vary the reference height, which may further influence the accuracy of liquid level measurement by ALG that is installed on the top deck.

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