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Refrigerated hydrocarbon and non-petroleum based liquefied gaseous fuels — General requirements for automatic tank gauges —

Part 1: Automatic tank gauges for liquefied natural gas on board marine carriers and floating storage

Hydrocarbures réfrigérés et combustibles gazeux liquéfiés à base non pétrolière — Exigences générales pour jauges de réservoir automatiques —

Partie 1: Jauges de réservoir automatiques pour gaz naturel liquéfié à bord des transporteurs de cargaison en mer et des stocks flottants

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Contents

Page

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 18132-1 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*, Subcommittee SC 5, *Measurement of refrigerated hydrocarbon and non-petroleum based liquefied gaseous fuels*.

This second edition of ISO 18132-1, together with ISO 18132-3:2011, cancels and replaces ISO 18132-1:2006, which has been technically revised.

ISO 18132 consists of the following parts, under the general title *Refrigerated hydrocarbon and non-petroleum based liquefied gaseous fuels — General requirements for automatic tank gauges*:

— *Part 1: Automatic tank gauges for liquefied natural gas on board marine carriers and floating storage*

— *Part 2: Gauges in refrigerated-type shore tanks*

— *Part 3: Automatic tank gauges for liquefied petroleum and chemical gases on board marine carriers and floating storage*

Introduction

Large quantities of liquefied natural gas (LNG) are transported by LNG carriers and traded by static measurement of the cargo on board by automatic tank measurement. The LNG automatic tank measurement by a custody transfer measurement system (CTMS) involves determination of liquid/vapour interface, i.e. liquid level, average temperatures of liquid and vapour, and vapour pressure. The volumetric quantity of the LNG transferred is calculated with the tank capacity table. The transferred energy content is determined on the basis of this volume, along with the density and heating value of LNG derived from chemical composition of the representative samples.

To ensure accurate quantitative determination of LNG, custody transfer measurement usually takes place on board the LNG carrier and floating storage, not at the shore tanks. Liquid level expressed in innage or ullage is one of the important measurement parameters needed to accurately determine the LNG cargo on board.

Refrigerated hydrocarbon and non-petroleum based liquefied gaseous fuels — General requirements for automatic tank gauges —

Part 1: Automatic tank gauges for liquefied natural gas on board marine carriers and floating storage

1 Scope

This part of ISO 18132 establishes general principles for the accuracy, installation, calibration and verification of automatic tank gauges (ATGs) used for custody transfer measurement of liquefied natural gas (LNG) on board an LNG carrier or floating storage.

The LNG described in this part of ISO 18132 is either fully refrigerated (i.e. at the cryogenic condition), or partially refrigerated, and therefore the fluid is at or near atmospheric pressure.

This part of ISO 18132 also specifies the technical requirements for data collection, transmission and reception. Specific technical requirements for various automatic tank gauges and accuracy limitations are given in the annexes.

2 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms, definitions and abbreviated terms apply.

2.1 Terms and definitions

2.1.1
automatic tank gauge
ATG
instrument that continuously measures liquid height (dip or ullage) in storage tanks

NOTE 1 An automatic tank gauge usually includes a level sensor, a gauge head and associated mounting hardware, and in some cases local display.

NOTE 2 Automatic tank gauges are also known as automatic level gauges (ALGs).

2.1.2
automatic tank gauging system
ATG system
system that includes ATGs at the cargo tanks and control/display unit that processes and displays output signals from the ATG along with any other parameters required to determine the liquid level, i.e. liquid/vapour interface

NOTE The ATG system can also compute the volume of LNG in tanks, using the values of cargo tank temperature and pressure, draft, and tank capacity table.

2.1.3
capacitance-type ATG
ATG that uses electrodes, i.e. coaxial aluminium tubes, vertically assembled in the cargo tanks to detect the dielectric constant of LNG, thereby determining the liquid level

NOTE See Annex C for further descriptions.

2.1.4
custody transfer measurement system
CTMS
system that processes inputs from an ATG system, thermometers, pressure gauges, etc., and provides custody transfer measurement information on board, generating documents with regard to custody transfer of LNG

NOTE The ATG system can be incorporated as part of a CTMS.

2.1.5
float-type ATG
ATG that uses a float to detect the liquid level

NOTE The float is guided by a tape or wire that is connected to a drum or a ratchet in the gauge head, where the level measured is displayed locally and/or remotely. See Annex D for more descriptions.

2.1.6
intrinsic error
inherent error
error of an ATG when it is tested against a reference standard under controlled conditions as specified by the manufacturer

2.1.7
radar-type ATG
microwave-type ATG
ATG that utilizes an antenna to transmit electromagnetic continuous waves toward the liquid in a tank, and to receive electromagnetic waves which are reflected at the surface of the liquid

NOTE See Annex B for further descriptions.

2.2 Abbreviated terms

ATG automatic tank gauge

CTMS custody transfer measurement system

EMC electromagnetic compatibility

FPSO floating production, storage and offloading

FSO floating storage and offloading

IACS international association of classification societies

LNG liquefied natural gas

LPG liquefied petroleum gas

3 General safety precautions

3.1 Compliance with safety regulations, standards, and classification rules

This part of ISO 18132 may involve hazardous materials, operations, and equipment. This part of ISO 18132 does not purport to supersede any safety or operating practices recommended by applicable regulatory agencies and organizations. It is the responsibility of the user of this part of ISO 18132 to establish appropriate health and safety practices and determine the applicability of regulatory limitations prior to use.

3.2 Equipment precautions

3.2.1 General

All electric components of an ATG for use in electrically classified areas shall meet the electrical area classification (see IEC 60079-0). They shall conform to applicable sections of the national and/or international electrical safety standards. All ATGs shall be maintained in safe operating condition and manufacturers' maintenance instructions should be complied with.

3.2.2 Mechanical rigidity

All ATGs shall be capable of withstanding the pressure, temperature, operating, and environmental conditions likely to be encountered in the service.

Where an ATG is installed near a submerged pump or the end of a loading/unloading line in a cargo tank, appropriate measures shall be applied to prevent the ATG from being affected by the vortex or vaporization (i.e. boiling) of cargo caused by the cargo loading or cargo unloading operations.

3.2.3 Gastight design

ATGs shall be designed such that the tank penetration for the ATG is of gastight construction in order to minimize the escape of vapour from the cargo tank. The gauge head or transmitter located on the deck shall be so constructed as to minimize leakage of vapour from the tank.

3.2.4 Compatibility with cargo

All parts of the ATG in contact with the LNG or its vapour shall be chemically compatible with the product, to avoid both product contamination and corrosion of the ATG.

3.2.5 Tolerance against low temperatures

ATGs shall be designed to withstand the low-temperature thermal contraction of their components and of the tanks. Additionally, level measurement errors caused by such thermal contraction shall be compensated for in an appropriate manner.

3.2.6 Type approval

The design and installation of ATGs shall be subject to type approval. Type approval is normally issued after an ATG has been subjected to a specific series of tests.

NOTE Type approval is normally performed by a national measurement organization or class society for environmental considerations (see IACS Unified Requirements E 10).

3.2.7 Use of an ATG in custody transfer service

ATGs, including those which use measurement technologies not listed in this part of ISO 18132, are considered acceptable for use in LNG custody transfer service if they are judged to be compatible with those ATGs in this part of ISO 18132 by the parties to the sales contract of LNG, and approval by national regulations.

4 Design requirements

4.1 General

The following design requirements apply to all types of ATGs on LNG carriers, FPSOs and FSOs. These requirements, which may be in addition to the technical specifications by the ATG manufacturer, should be met where they are applicable.

ATGs, except that of float-type, are normally connected to a computer system designed for processing their output signal, and displaying the level, as well as temperature and other parameters, thus forming a part of an ATG system. Complete design requirements for the ATG system are not specified in this part of ISO 18132.

4.2 Provisions for routine maintenance and verification

All ATGs shall be capable of withstanding vapour from cargo tanks, and allow routine maintenance to be performed without compromising the integrity of the tank. This includes means of verification whereby the ATG accuracy can be checked at high and low tank levels with the tank in service.

ATG shall be equipped with a provision which enables verification of proper functioning of the ATGs at the time of each custody transfer.

4.3 Provision against sudden malfunctions

ATGs shall be designed to minimize the frequency and severity of any malfunction and shall be provided with self-diagnostic features. Electronics essential for the proper functioning of the system should ideally be accessible from the deck and be serviceable with tanks in operation.

4.4 Dynamic response

ATGs shall have sufficient dynamic response to track the liquid level during maximum tank filling or emptying rates. Float-type ATGs are usually installed in a pipe to protect them from surge of LNG in a cargo tank. To ensure equalization of the tank level and that in the pipe, the bottom and top of the pipe shall be open and equipped with sufficient perforations throughout the length.

4.5 Minimum measurable level

Because LNG carriers often retain a tank heel after a discharge, the ATG shall be able to measure levels as near to the bottom of the tank as possible.

4.6 Data filtering and averaging

The ATG system shall be designed to automatically scan, average/filter and display the level in each cargo tank.

A common practice is to use five consecutive readings to compute an averaged liquid level used to consult tank capacity tables for liquid volumes.

Internal filtering algorithms shall be provided in ATG systems to reduce the impact of interferences and also applied to readouts to enable level readings to be averaged over a set number of readings or a defined period of time. Such filters may result in a significant delay, potentially of several minutes, before a reading may be observed.

Filtering and automatic averaging features are recommended because a stable reading may not be available due to the vessel motion and the boiling effect of the cargo. If an automatic averaging feature is not available, multiple consecutive ATG readings corresponding to the high and low level of the wave of the cargo liquid surface shall be taken and the reading averaged for reporting.

4.7 Compensation for variation of cargo temperatures and/or composition

To ensure accurate measuring results, the liquid level obtained by an ATG shall be compensated for any effect of changes in temperature, pressure or cargo properties of the respective cargo components. The compensation is either carried out by the electronics in the ATG system or manually.

In particular, the ATG system shall be designed to compensate for measuring errors caused by thermal contraction/expansion of material used in the ATGs within the measurement function or by other equivalent means, and/or their installation, such as still pipe, supporting wave guides, float tapes or wires. Correction shall also be made for the thermal effects of the tank design/material.

The measurement of pressure and temperature of the vapour in the tank, liquid temperature, or any other relevant parameter should be time correlated with the tank level measurement. The tank liquid temperature should be representative of the liquid contents.

4.8 Sealing, security and unsealing

The ATG or ATG system shall provide means to prevent unauthorized adjustment or tampering. Specifically, an ATG or ATG system used in fiscal or custody transfer application shall provide security to allow sealing of the calibration adjustment. The security may include a physical seal and/or software password(s). Once the ATG or ATG system has been sealed, it shall not be unsealed until the next scheduled inspection.

Should unsealing become necessary for some unavoidable reason, the inspection organization shall be informed of such action prior to unsealing.

4.9 Redundancy

Each cargo tank shall have two ATGs installed. One of the ATGs shall be designated as the primary ATG and the other as secondary ATG. Failure of the primary ATG shall not affect the secondary ATG, or vice versa.

The secondary ATG shall always be in operation. This provides the secondary ATG for comparison to the primary ATG and a means to monitor the primary ATG for malfunction.

NOTE It is recognized that this procedure cannot verify the accuracy of an ATG to ensure it meets the maximum permissible error set forth in this part of ISO 18132. However, crosschecking and tracking the history provide an indication of the performance of the ATGs on the vessel.

4.10 Data communication

The ATG system shall be designed and installed such that its data transmission device and control/display unit:

a) does not compromise the accuracy of the measurement; where there is a local display, this criterion is defined as follows:

   1) for digital signal transmission, there shall be no difference between the local and remote reading;

   2) for analogue signal transmission, the difference between the local reading and remote reading shall agree within 3 mm (the local and remote readout may differ because of data transmission and/or data processing);

b) does not compromise the resolution of the measurement output signal from the level sensor;

c) provides proper security and protection of the measured data to ensure its integrity;

d) provides adequate speed to meet the update time required for the receiving unit/readout.

5 Installation

5.1 General

All ATGs shall be installed in accordance with the manufacturer's instructions and marine classification society requirements.

5.2 Location of installation

ATGs are located near the vertical axis of the tank, in the case of a spherical tank, and near the aft end, in the case of a rectangular tank. Such installations shall have provisions to protect the ATGs from physical damage.

5.3 Protection of tank surface

Where ATGs are installed in membrane tanks, care shall be taken to protect the tank bottom membrane from being damaged during installation.

5.4 Interference of ATGs in a cargo tank

The installation of two or more ATGs in a cargo tank shall not result in interference between the ATGs. This is in addition to the electromagnetic interference described in 3.2.5. Further, cargo tank structural design and other electrical devices within the cargo tank shall not interfere with the ATG measurement.

6 Accuracy

6.1 General

The accuracy of level measurement by an ATG is affected by the inherent (intrinsic) error of the ATG, the error due to installation (e.g. stability, location), the effect of changes in operating conditions, and vessel motion. Accuracy is also subject to the uncertainty associated with manual measurement during calibration.

6.2 Calibration reference

6.2.1 General

The calibration reference shall be traceable to a national metrology institute. The uncertainty of the certified reference should not exceed the tolerance described below, with the calibration correction applied.

6.2.2 Uncertainty of reference standard at factory acceptance test

For testing of the ATG prior to installation on board the vessel, the uncertainty of the reference standard shall be ±1 mm or better, with correction applied.

6.2.3 Uncertainty of reference standard at site acceptance test

For testing of the ATG after installation on board the vessel but prior to placing the tank in service, the uncertainty of the reference standard shall be 0,002 % of the ATG span, or 1 mm, whichever is larger, with correction applied.

6.3 Accuracy requirement

The accuracy of an ATG shall be as follows:

a) intrinsic error (intrinsic accuracy) of the ATG tested prior to installation and in a controlled test environment shall be within ±3 mm;

b) ATG accuracy after installation by the shipyard but prior to placing the tank in service shall be within ±5 mm.

Some existing ATGs may exceed these errors.

NOTE See A.4 for the uncertainty of the calibration reference used.

For ATGs in inventory applications, with the agreement of all parties, intrinsic errors may exceed these errors.