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Refrigerated hydrocarbon and non-petroleum based liquefied gaseous fuels — General requirements for automatic tank thermometers on board marine carriers and floating storage

Hydrocarbures réfrigérés et combustibles gazeux liquéfiés à base non pétrolière — Exigences générales pour les thermomètres de réservoir automatiques à bord des transporteurs de cargaison en mer et des stocks flottants

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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 8310 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 cancels and replaces the first edition (ISO 8310:1991), which has been technically revised.

Introduction

Large quantities of liquefied natural gas (LNG), liquefied petroleum gas (LPG) and other liquefied gases are usually transported by marine carriers dedicated for these applications and traded based on static measurement on board by automatic tank measurement. Such an automatic tank measurement may be a part of the custody transfer measurement system (CTMS) which involves determination of liquid/vapour interface, i.e. liquid level, average temperatures of liquid and vapour, and vapour pressure. The volumetric quantity of the liquid and gas is then computed with the tank capacity table based on which the delivered quantity in terms of energy content or mass is calculated.

In most cases, shore tank measurement is not used due to the active and dynamic conditions of the shore tank operations. In the absence of other means of acceptable measurement, custody transfer measurement usually takes place on board the carrier or floating production storage offshore (FPSO) and floating storage offshore (FSO). Liquid cargo density is very sensitive to temperature; therefore, obtaining accurate temperature readings is extremely important. For example, a change of 0,2 °C for liquid methane cargo results in a change in density of approximately 0,07 %.

This International Standard also discusses use of automatic tank thermometers on board marine vessels for other volatile, non-petroleum liquids in fully refrigerated conditions. Many of these non-petroleum liquids, such as di-methyl ether (DME) are measured in a similar manner to that used for fully refrigerated LPGs.

Values of temperature in this International Standard are in terms of the International Temperature Scale of 1990, ITS-90. Temperatures in degrees Celsius are denoted by the symbol *t*.

Refrigerated hydrocarbon and non-petroleum based liquefied gaseous fuels — General requirements for automatic tank thermometers on board marine carriers and floating storage

1 Scope

This International Standard specifies the essential requirements and verification procedures for automatic tank thermometers (ATTs) consisting of platinum resistance thermometers (PRT) and an indicating device used for custody transfer measurement of liquefied natural gas, liquefied petroleum and chemical gases on board ships. Temperature detectors other than PRT are considered acceptable for use in the custody transfer service of liquefied gases if they meet the performance requirements of this International Standard and are approved by national regulations.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60751, *Industrial platinum resistance thermometers and platinum temperature sensors*

3 Terms and definitions

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

3.1
automatic tank gauge
ATG
automatic level gauge
ALG
instrument that automatically measures and displays liquid levels or ullages in one or more tanks, either continuously, periodically or on demand

3.2
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

3.3
automatic tank thermometer
ATT
automatic tank temperature system
instrument that continuously measures temperature in cargo tanks

NOTE 1 An ATT typically includes temperature sensors, such as PRTs, field-mounted transmitters for electronic signal transmission, and indicating device(s).

NOTE 2 ATTs on liquefied gas carriers are usually multiple-point ATTs which consist of three or more temperature sensors, such as PRTs, to measure the temperatures at selected heights in the cargo tank.

3.4
custody transfer measurement system
CTMS
system that processes inputs from an ATG system, an ATT, pressure gauges, etc. and provides custody transfer measurement information on board, generating documents with regard to custody transfer of liquefied gases

NOTE An ATT can be incorporated as part of a CTMS.

3.5
gas dangerous space or zone
space or zone defined by the *International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk* (IGC Code)

3.6
indicating device
displaying device
set of components of a measuring instrument intended to indicate the measured value

3.7
inherent error
intrinsic error
error of a gauge when it is tested against a reference standard under controlled conditions as specified by the manufacturer

3.8
nominal resistance
expected resistance R_0 of a PRT at 0 °C, declared by the manufacturer and shown in the thermometer marking, usually rounded to the nearest ohm

3.9
nominal temperature/resistance relationship
relationship between temperature and resistance of a nominal PRT

3.10
platinum resistance thermometer
PRT
resistance temperature detector
RTD
temperature-responsive device consisting of one or more sensing platinum resistors within a protective sheath, internal connecting wires and external terminals to permit connection of electrical measurement instruments

3.11
uncertainty
non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used

4 Safety precautions

4.1 General

Nothing contained in this International Standard is intended to supersede any regulatory requirements or recommended operating practices issued by organizations such as the International Maritime Organization (IMO), International Chamber of Shipping (ICS), Oil Companies International Marine Forum (OCIMF), International Association of Classification Societies (IACS) and individual operating companies, nor is this International Standard intended to conflict with any safety or environmental considerations, local regulations, or the specific provisions of any contract.

4.2 Equipment precautions

4.2.1 General

All electric components of an ATT for use in electrically classified areas shall meet the electrical area classification. They shall conform to applicable sections of the national and/or international electrical safety standards. All ATTs shall be maintained in a safe operating condition and manufacturers' maintenance instructions should be complied with.

4.2.2 Mechanical rigidity

All ATTs shall be capable of withstanding the pressure, temperature, dynamic loads generated from rolling/pitching, and sloshing from environmental conditions likely to be encountered in the service.

Where a PRT 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 ATT from being affected by the vortex or vaporization, i.e. boiling, of cargo caused by cargo loading or cargo unloading operations. In addition, all PRTs shall be mounted such that they are not affected by the spray of liquefied gas whenever the spray nozzles are in operation.

4.2.3 Gastight design

All parts of ATTs exposed to a gas dangerous space or zone shall be of gastight construction.

4.2.4 Compatibility with cargo

All parts of the ATT in contact with liquefied gases or their vapour shall be chemically compatible with the product, to avoid both product contamination and corrosion of the ATT.

4.2.5 Tolerance against low temperatures

ATTs shall be designed to measure the low temperatures encountered in refrigerated liquefied gas service. They shall also be designed to withstand the low-temperature thermal contraction of their components and of the tanks. Additionally, change in the height of PRT in the tanks by such thermal contraction shall be compensated for in an appropriate manner.

4.2.6 Type approval

The design and installation of ATTs shall be subject to the approval of a national metrology institute (NMI) or class society. For electrical considerations, refer to IACS Unified Requirements E10[10]. Type approval is normally issued after an ATT has been subjected to a specific series of tests.

5 Design requirements

5.1 General

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

5.2 Temperature sensors

Temperature sensors used for custody transfer measurement of liquefied gases on board ships shall be either three- or four-wire type PRTs as described in IEC 60751. The relationship of temperature and resistance of the PRTs is described by a temperature/resistance relationship (see Annex A).

Each PRT shall be subject to the following routine production tests:

a) insulation resistance at ambient temperature;

b) sheath integrity test;

c) dimensional test;

d) tolerance acceptance test.

NOTE See IEC 60751 for the details of the routine production test.

The manufacturer shall calibrate each PRT and establish its nominal resistance (R_0) and constants A, B and C in the temperature/resistance relationship.

Identification such as the serial number should be clearly and indelibly marked on each PRT.

5.3 Indicating device

Indicating devices with analogue inputs shall have a high-impedance input circuit so as to minimize error.

5.4 Installation

The number of PRTs in a tank depends on the capacity and the height of the tank; however, IGC Code requires a minimum of three. In the case of large LNG carriers, there may be five or more PRTs in each tank with each PRT supported by a secondary PRT mounted adjacent to the primary PRT (see 5.12).

At least one PRT shall be located above the maximum fill height so as to remain in the vapour space. The lowest PRT shall be located near the bottom of the tank so as to measure the temperature of the heel.

The indicating device of an ATT shall be installed in a location free from temperature variations, which can cause measurement errors. The indicating device may be integrated into the CTMS.

5.5 Provisions for routine maintenance and verification

Except for those components within the cargo tank itself, all parts of an ATT shall allow routine maintenance to be performed without compromising the integrity of the tank. This includes means of verification whereby the accuracy of an indicating device can be checked.

5.6 Provision against sudden malfunctions

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

5.7 Dynamic response

ATTs shall have sufficient dynamic response to track the temperature of liquid and gas in the tanks.

5.8 Measurable range

ATTs shall have sufficient measurable range in accordance with the intended cargoes to be loaded.

5.9 Data processing and reporting

An ATT or CTMS may calculate and report:

a) the average liquid temperature in each cargo tank;

b) the average vapour temperature in each cargo tank;

c) the average liquid temperature throughout all cargo tanks;

d) the average vapour temperature throughout all cargo tanks.

5.10 Compensation for variation of cargo temperatures

To ensure accurate discrimination of the liquid and vapour phases, the height of each PRT shall be compensated for any effect of thermal contraction/expansion of material used in a thermowell or protecting tube. The compensation may be carried out by the electronics in the ATT system or manually.

5.11 Sealing, security and unsealing

The ATTs shall be equipped with a means of preventing unauthorized adjustment or tampering. Specifically, ATTs used in fiscal or custody transfer applications shall provide security to allow sealing of the calibration adjustment. The security may include a physical seal and/or software password(s). Once the ATT 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.

5.12 Redundancy

Usually, liquefied petroleum and chemical gas carriers are equipped with one set of PRTs per tank.

Where a higher degree of reliability is desired, it is common practice to install two sets of PRTs in each cargo tank. One set shall be designated as the primary PRTs and the other as the secondary PRTs. In such a case:

a) each PRT shall be supported by a secondary PRT mounted adjacent to the primary PRT;

b) failure of a primary PRT shall not affect the secondary PRT, or vice versa;

c) secondary PRTs shall always be in operation; this provides a secondary PRT for comparison to the primary PRT and a means of monitoring the primary PRT for malfunction.

5.13 Data communication

The ATT system shall be designed and installed such that its data transmission device and indicating device:

a) does not compromise the accuracy of the measurement;

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

c) provides adequate update speed.

6 Calibration and accuracy verification

6.1 General

The manufacturer of an ATT shall calibrate the ATT to meet the specification before it is shipped from the factory (see 6.3). The ATT is then calibrated by the manufacturer or its authorized service representative after it is installed (see 6.4) and periodically (see 6.5), with the results normally verified by a qualified third party.

The accuracy of temperature measurement by an ATT is affected by the inherent error of the ATT equipment, the error due to installation (e.g. stability, location, etc.) and the effect of changes in operating conditions. Accuracy is also subject to the uncertainty associated with the calibration. Chronological change of characteristics of a PRT is negligibly small in relation to the life of the ship.