INTERNATIONAL STANDARD

**ISO 4266-5**

First edition
2002-11-15

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

## Part 5: Measurement of temperature in marine vessels



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

*Partie 5: Mesurage de la température dans les citernes de navire*



Reference number
ISO 4266-5:2002(E)

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.ch
Web www.iso.ch

Printed in Switzerland

# Contents

Page

## Annex

## 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 3.

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 part of ISO 4266 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 4266-5 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*, Subcommittee SC 3, *Static petroleum measurement*.

ISO 4266-5, together with ISO 4266-1 to ISO 4266-4 and also ISO 4266-6, cancels and replaces ISO 4266:1994, which has been technically revised.



ISO 4266 consists of the following parts, under the general title *Petroleum and liquid petroleum products — Measurement of level and temperature in storage tanks by automatic methods*:



— *Part 1: Measurement of level in atmospheric tanks*

— *Part 2: Measurement of level in marine vessels*

— *Part 3: Measurement of level in pressurized storage tanks (non-refrigerated)*

— *Part 4: Measurement of temperature in atmospheric tanks*

— *Part 5: Measurement of temperature in marine vessels*

— *Part 6: Measurement of temperature in pressurized storage tanks (non-refrigerated)*

Annex A of this part of ISO 4266 is for information only.

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

## Part 5:
## Measurement of temperature in marine vessels

## 1 Scope

This part of ISO 4266 gives guidance on the selection, accuracy, installation, commissioning, calibration and verification of automatic tank thermometers (ATTs) in fiscal/custody transfer applications in which the ATT is used for measuring the temperature of petroleum and liquid petroleum products having a Reid vapour pressure less than 100 kPa, stored in cargo tanks on board marine vessels.

This part of ISO 4266 is not applicable to the measurement of temperature in refrigerated storage tanks, or pressurized cargo tanks on board marine vessels.

## 2 Normative reference



The following normative document contains provisions which, through reference in this text, constitute provisions of this part of ISO 4266. For dated references, subsequent amendments to, or revisions of, this publication do not apply. However, parties to agreements based on this part of ISO 4266 are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.



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

## 3 Terms and definitions

For the purposes of this part of ISO 4266, the terms and definitions given in ISO 1998, and the following, apply.

**3.1**
**automatic tank thermometer**
**ATT**
instrument that continuously measures temperature in storage (or cargo) tanks

NOTE A marine ATT, which may also be known as an automatic tank temperature system, typically includes precision temperature sensors, deck-mounted transmitters for electronic signal transmission, and receiving/readout device(s).

**3.2**
**resistance temperature detector**
**RTD**
electrical temperature-sensing element in common use to measure the temperature of the contents of a storage tank

**3.3**
**single-point ATT**
**spot ATT**
ATT that measures the temperature at a particular point in a tank by the spot temperature element

**3.4**
**multiple-point ATT**
ATT consisting of multiple (usually three or more) spot temperature elements to measure the temperature(s) at selected liquid level(s)

NOTE The readout equipment should average the readings from the submerged temperature elements to compute the average temperature of the liquid in the tank and may also display the temperature profile in the tank.

**3.5**
**temperature transmitter**
instrument that typically provides electrical power to the temperature element(s), converts the temperature measured by the element(s) to an electrical or electronic signal, and transmits the signal to a remote readout

NOTE A local readout may be provided. Often, the function of the temperature transmitter is provided by the level transmitter of the automatic level gauge (ALG).

## 4 Precautions

### 4.1 Safety precautions

International Standards, government regulations, classification society rules and ISGOTT regulations on safety and material-compatibility precautions should be followed when using marine ATT equipment. In addition, the manufacturer's recommendations on the use and installation of the equipment should be followed. All regulations covering entry into hazardous areas should be observed.



### 4.2 Equipment precautions



**4.2.1** All marine ATTs should be capable of withstanding the pressure, temperature and other environmental conditions likely to be encountered in marine service. When an ATT is installed in a corrosive service, any parts exposed to the liquid or vapour should be of durable, corrosion-resistant construction to avoid both product contamination and ATT corrosion. All ATTs should be sealed to withstand the vapour pressure of liquid in the tank. ATTs mounted on vessels with an inert gas system (IGS) should be designed to withstand the operating pressure of the IGS.

**4.2.2** All marine ATTs should be specified and installed in accordance with the appropriate national and/or International (IMO, IEC, CENELEC, ISGOTT, ISO, etc.) marine electrical safety standards. ATTs should be certified for use in the hazardous-area classification appropriate to their installation.

**4.2.3** All external metal parts of ATTs mounted on tanks should be firmly connected to an electrical earth, i.e. the ship's hull.

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

### 4.3 General precautions

**4.3.1** The general precautions given in 4.3.2 to 4.3.6 apply to all types of ATTs and should be observed where they are applicable.

**4.3.2** Tank levels should be measured at the same time as the tank temperature is measured.

**4.3.3** Temperatures measured for bulk transfer should be recorded when they are taken, unless the remote readout equipment of the ATT automatically records the temperatures periodically.

**4.3.4** In the case of multiple port loading and/or discharge, the same general procedures should be used to measure a tank temperature before product transfer (opening gauge) and after product transfer (closing gauge).

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

NOTE 1 This protection may require mounting the ATT sensor(s) in a thermowell.

NOTE 2 ATT sensors can be an integral part of the ALG level sensor assembly (e.g. float and tape, pole). Some design (e.g. float and tape) may need the level/temperature sensor assembly to be raised to a "store" position when it is not being used. Note that such ATTs cannot be used during tank washing.

**4.3.6** The design and installation of ATTs may be subject to the approval of the national measurement organization, who will normally have issued a type or pattern approval ("Type Approval") for the design of the ATT for the particular service for which it is to be employed. Type approval is normally issued after an ATT has been subjected to a specific series of tests and is subject to the ATT being installed in an approved manner. Type approval tests may include the following: visual inspection, performance, vibration, humidity, dry heat, inclination, fluctuations in power supplies, insulation, resistance, electromagnetic compatibility and high voltage.

# 5 Accuracy

## 5.1 General

The accuracy of petroleum temperatures taken by the ATTs should be consistent with the accuracy of the levels taken by the automatic level gauging system so that the overall accuracy of the standard volume measurement is not seriously degraded.



## 5.2 Intrinsic error of ATTs

The intrinsic error of the ATT, i.e. the accuracy of the ATTs when tested under controlled conditions as specified by the manufacturers, can be a major component of the uncertainty of the temperature measurement of the ATT as installed. The calibration reference device used to calibrate the ATT should be traceable to appropriate national standards.



NOTE The temperature elements and onboard transmitters used for fixed, automatic tank temperature measurement are calibrated prior to installation. The transmitters normally do not provide on-board calibration adjustments.

## 5.3 Calibration prior to installation

### 5.3.1 General

The ATT can be calibrated/verified either as a system (see 3.1) or by components.

### 5.3.2 ATT calibrated as a system

If verified as a system, the temperature reading of the ATT readout should agree with that of the thermostatically controlled reference bath or oven temperature within 0,25 °C at a minimum of three test temperatures spanning the anticipated working range of the ATT.

### 5.3.3 ATT calibrated by components

If the ATT is verified by components:

a) the temperature equivalent of the measured resistance should agree with the bath temperature within 0,20 °C at each temperature;

b) the temperature transmitter/converter and the ATT readout should be checked using precision resistors or a recently calibrated thermal calibrator. The ATT readout should agree with the temperature equivalent of the resistors or calibrator within 0,15 °C at each temperature.

#### 5.3.4 Multiple-point ATTs

The required accuracy for each spot temperature sensor should be as given in 5.3.2 or 5.3.3, depending on the method used.

#### 5.3.5 Uncertainty of the reference

The uncertainty of the reference should not exceed $\pm$ 0,05 °C.

### 5.4 Error caused by installation and operating conditions

The total error of the ATT for custody transfer service can be affected by the installation and by variations in the operating conditions.

NOTE 1 The accuracy of an ATT depends on the following:

— the number of temperature-sensing elements;

— the location of the temperature-sensing elements.

NOTE 2 The tank content's temperature may be subject to stratification which varies with

— cargo-heating method and/or location of heating coils;

— multiple sources of supply;

— viscosity of the liquid in the tanks;

— tank insulation;

— adjacent tank temperatures, and

— sea water temperature for tanks in contact with the ship's hull and bottom.



NOTE 3 Temperatures in large tanks (i.e. 750 $m^3$ or larger) are often vertically stratified unless the contents are thoroughly mixed. Larger stratification may be expected in high-viscosity petroleum liquids. Temperatures in wing tanks can also be horizontally stratified due to the effect of the sea temperature.

### 5.5 Overall accuracy

#### 5.5.1 General

The overall accuracy of temperature measurement by the ATT, as installed, is limited by the intrinsic error of the ATT equipment (temperature-sensing element, transmitter and readout), the effect of installation methods, and the effect of the operating conditions.

In tanks with vertical temperature stratification, the temperature gradient is rarely linear. An average temperature should be used for fiscal/custody transfer services. The mid-level temperature of the tank contents may not give an accurate average temperature.

#### 5.5.2 Use of ATT for fiscal/custody transfer purposes

An ATT system should be considered suitable for fiscal/custody transfer services, if the ATT system meets the following on-board verification tolerances.

The ATT should meet the calibration tolerances prior to installation (see 5.3).

Including the effects of installation methods and changes in operating conditions, the ATT should meet the on-board verification tolerance (see 9.2.2 and 9.3.2).

The remote readout, if used, should meet the recommendations of this part of ISO 4266 (see clause 10).

# 6 Selection of ATTs

## 6.1 General

Copper or platinum temperature element bulbs, i.e. resistance temperature detectors (RTDs), are normally used for this application. The following types of ATT elements are widely used:

— single-point (spot) ATT (see 3.3);

— multiple-point ATT (see 3.4).

Other types of ATT elements, which provide comparable performance, may be used.

The selection of a suitable ATT should be made based on the following criteria:

a) the accuracy required;

b) the operating conditions which may affect the accuracy (e.g. expected product temperature stratification);

c) the minimum level in the tank at which temperature measurement is required;

d) environmental conditions;

e) number, type and size of the tanks;

f) requirement for local and remote readout, signal transmission, and cabling.



## 6.2 ATTs for fiscal/custody transfer purpose



Tanks using an automatic method to determine temperature in fiscal/custody transfer should preferably be fitted with a multiple-point ATT except when

— the cargo tanks have a capacity less than 159 $m^3$ (1 000 barrels), or the level is less than 3 m;

— the maximum vertical temperature variation is less than 1 °C, and

— manual average temperature measurement is used for fiscal/custody transfer.

NOTE Single-point or spot tank temperature measurement may be used when the temperature of the liquid in the cargo tank is considered to be uniform, or when any temperature stratification in the tank has been shown to be small and acceptable (see ISO 4268).

# 7 Description of ATT equipment — Electrical temperature elements

## 7.1 Resistance temperature detectors

Temperature-measuring equipment commonly used for automatic temperature measurement operates on the basic principle that the electrical resistance of a metal (e.g. copper or platinum) varies with changes of temperature.

Copper or platinum electrical-resistance detectors (RTDs) are normally used for temperature measurement for fiscal/custody transfers because of their high accuracy and stability. The resistance of an RTD is measured by a Wheatstone bridge circuit or other suitable electronic package. The RTD may be a resistance wire wound on a supporting non-conductive core, a thin film type, or other type. The element should be properly encased in a stainless steel enclosure. The electronic circuits should be intrinsically safe as required. The temperature element is suitably contained within a thermowell. The length of the temperature-sensitive portion of a spot element should not exceed 100 mm.