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

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

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

ISO 4266-4:2002

*Partie 4: Mesurage de la température dans les réservoirs à pression
atmosphérique*

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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 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 4266-4 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*, Subcommittee SC 3, *Static petroleum measurement*.

ISO 4266-4, together with ISO 4266-1 to ISO 4266-3 and ISO 4266-5 and 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)*

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

Part 4:

Measurement of temperature in atmospheric tanks

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 atmospheric storage tanks.

This part of ISO 4266 is not applicable to the measurement of temperature in caverns or in refrigerated storage tanks.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 4266. For dated references, subsequent amendments to, or revisions of, any of these publications 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 editions of the normative documents 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*

ISO 4266-1:2002, *Petroleum and liquid petroleum products — Measurement of level and temperature in storage tanks by automatic methods — Part 1: Measurement of level in atmospheric tanks*

ISO 4268:2000, *Petroleum and liquid petroleum products — Temperature measurements — Manual methods*

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 tanks

NOTE An ATT, which may also be known as an automatic tank temperature system, typically includes precision temperature sensors, field-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 Averaging ATT

3.5.1
multiple-point averaging ATT

averaging ATT where the readout equipment selects the individual, spot temperature element(s) that are submerged in the liquid to determine the average temperature of the liquid in the tank

3.5.2
variable-length averaging ATT

averaging ATT consisting of several temperature elements of varying length, with all the elements extending upwards from a position close to the bottom of the tank, and where the readout equipment selects the longest, completely submerged temperature element to determine the average temperature of the liquid in the tank

3.6
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).

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4 Precautions

4.1 Safety precautions

International Standards and government regulations on safety and material-compatibility precautions should be followed when using 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 of the ATT equipment should be capable of withstanding the pressure, temperature, operating and environmental conditions likely to be encountered in service.

4.2.2 ATTs 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 ATT have the same electrical potential as the tank.

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

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

4.2.6 The temperature elements should be located so that the temperature of any sediment deposits or free water bottoms that may be present in the tank is not measured.

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 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.

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

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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. Observance of the accuracy requirements for level and temperature gauging systems gives in ISO 4266-1 and in this part of ISO 4266 will ensure that this is avoided.

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 field transmitters used for fixed, automatic tank temperature measurement are calibrated prior to installation. The transmitters normally do not provide field calibration adjustments.

5.3 Calibration prior to installation

5.3.1 General

ATTs to be used in fiscal/custody transfer applications 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.

NOTE Subclauses 9.2.1, 9.3.1 and 9.4.1 refer to this clause for calibration of an ATT in the field “as a whole” or “as a system”.

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 reference 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.

NOTE See 9.2.1, 9.3.1 and 9.4.1 for calibration of an ATT in the field by components.

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.

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5.3.5 Variable-length ATTs

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

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5.3.6 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 in fiscal/custody transfer applications 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 the 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

- tank mixing;
- multiple sources of supply;
- viscosity of the liquid in the tanks, and
- tank insulation.

NOTE 3 Temperatures in large tanks (i.e. 750 m³ or larger) are often vertically stratified unless the contents are thoroughly mixed. Larger stratification may be expected in high-viscosity petroleum liquids.

NOTE 4 With other level-measurement technologies (e.g. hydrostatic tank gauges which are pressure-based), a single spot temperature may suffice.

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.

When using automatic level gauges (ALGs) which measure the level for fiscal/custody transfer measurement, an ATT should be used which can provide a representative average temperature of the tank contents. In tanks with vertical temperature stratification, the temperature gradient is rarely linear. In circumstances where it has been demonstrated that the operational conditions (e.g. use of tank mixers and/or recirculation of the tank contents) can result in measurements from a single-point temperature sensor being representative (see ISO 4268), such a single-point ATT may be considered adequate. In other circumstances, a multiple-point or other averaging ATT system is recommended.

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 field verification tolerances given below.

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 field verification tolerance (see 9.2.2, 9.3.2 and 9.4.2).

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

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6 Selection of ATTs

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6.1 General

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

- single-point (spot) ATT (see 3.3);
- multiple-point ATT (see 3.4);
- variable-length averaging ATT (see 3.5).

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) available tank entries for new or existing tanks;
- g) requirements for local and remote readout, signal transmission, and cabling.