

Guide for

Selection, specification, installation, operation and maintenance of automatic liquid level and temperature measuring instruments on petroleum storage tanks

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee PTI/12, Petroleum measurement and sampling, upon which the following bodies were represented:

- Department of Trade and Industry (National Engineering Laboratory)
- Department of Trade and Industry (Oil and Gas Office)
- Institute of Petroleum
- Salvage Association

The following body was also represented in the drafting of the standard, through subcommittees and panels:

- GAMBICA (BEAMA Ltd)

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National foreword

This British Standard has been prepared by Technical Committee PRI/12. It is identical with ISO 4266:1994 *Petroleum and liquid petroleum products — Direct measurement of temperature and level in storage tanks — Automatic methods*, published by the International Organization for Standardization (ISO). ISO 4266 was prepared by Subcommittee 3, Static petroleum measurement, of Technical Committee 28, Petroleum products and lubricants, in which the United Kingdom participated.

A previous British Standard, BS 3792:1964 was withdrawn in 1989 because it was obsolete.

Cross-references

International standard	Corresponding British Standard
ISO 3838:1983	BS 4699:1985 <i>Methods for the determination of density or relative density of petroleum and petroleum products (pycnometer methods)</i> (Identical) BS 7723 <i>Methods for calibration of vertical cylindrical tanks for petroleum and liquid petroleum products</i>
ISO 7507-1:1993	Part 1:1994 <i>Strapping method</i> (Identical)
ISO 8310:1991	BS 7575:1992 <i>Specification for resistance thermometers and thermocouples for the measurement of temperature in tanks containing refrigerated light hydrocarbon fluids</i> (Identical)

The Technical Committee has reviewed the provisions of IEC 79-0:1983 (with Amendment No. 1:1987) to which normative reference is made in the text, and has decided that it is acceptable for use in conjunction with this standard.

The reference to ISO 8309:1991 is for information only, and does not affect the validity of this standard.

CAUTION. Attention is drawn to the Health and Safety at Work etc. Act 1974, and the need for ensuring that the guidance given in this British Standard is used with suitable precautions.

The guidance given in this British Standard is intended to be used by appropriately qualified and experienced persons or other suitable trained and/or supervised personnel. Normal safety precautions should be observed in the use of the guidance. With respect to the various safety codes and regulations referred to in 4.2 the user should be familiar with the relevant UK regulations, which should be observed.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 20, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

1.1 This International Standard gives guidance on the selection, specification, installation, operation and maintenance of mechanical and servo-operated automatic tank gauging systems measuring level and temperature in petroleum storage tanks which are at or near atmospheric temperature and pressure, or used under pressure, or for the storage of heated liquid petroleum products.

This International Standard does not apply to tank gauging systems using other sensing principles, such as radar and optical methods.

NOTE 1 Automatic level gauges may be used with either manual or automatic temperature measurement and automatic temperature measurement may be used with either manual or automatic level gauging.

The provisions of this International Standard are intended to ensure a sufficiently high degree of accuracy to meet the requirements of normal commercial operation.

This International Standard does not apply to level and temperature measurement systems for refrigerated hydrocarbon liquids, for which reference should be made to ISO 8309 and ISO 8310.

1.2 The provisions of this International Standard are intended to meet the requirements of accuracy necessary for custody transfer purposes. However, automatic level gauges are widely used for monitoring the movements of oil to and from storage tanks for stock control, for which a lower standard of accuracy may be acceptable.

1.3 The user of automatic tank gauging systems should consult the system manufacturer for details of any specific requirements not covered in this International Standard.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards. IEC 79-0:1983, *Electrical apparatus for explosive gas atmospheres — Part 0: General requirements, (with Amendment No. 1:1987)*.

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1

accuracy

degree of closeness with which the indication of gauging equipment approaches the true value of the quantity measured

3.2

analog signal

representation of the proportional value of a variable in the form of a physically measurable quantity

3.3

anchor weight

weight to which the detecting element guide wires are attached to hold them taut and plumb

3.4

bottom guide-wire anchor

bar, welded to the tank bottom, to which the detecting element guide wires are attached

3.5

automatic level gauge

instrument that continuously measures liquid depths or ullages in storage tanks

3.6 automatic temperature-measuring system

System that continuously measures the temperature of the contents of a storage tank.

3.6.1

electrical resistance spot thermometer

thermometer that measures the temperature of a liquid at a particular point in a tank by electrical resistance

3.6.2

electrical resistance averaging thermometer

thermometer that measures the average temperature of a liquid over the whole or a large part of its depth or at discrete intervals throughout its depth

3.7

calibration

process or procedures of setting gauges or instruments so as to bring their reading into agreement with the true value of measurement

3.8

condensate reservoir

device situated at the base of a gauge to collect and drain off condensate formed within the tape conduit

**3.9
density**

mass of a substance divided by its volume
(see ISO 3838)

**3.10
detecting element**

that part of the measuring equipment which responds to a specific property (e.g. liquid surface encounter or temperature) of the substance presented to it

**3.11
digital signal**

representation of the value of a variable in the form of a series of individually distinct pulses or states

3.12 dip

Depth of a liquid in a tank.

NOTE 2 The term “innage” is synonymous (see ISO 7507-1).

**3.12.1
dip-hatch**

opening in the top of a tank through which dipping and sampling operations are carried out
(see ISO 7507-1)

**3.12.2
dip-tape**

graduated steel tape used for measuring the depth of oil or water in a tank, either directly by dipping or indirectly by ullaging (see ISO 7507-1)

**3.12.3
dip-tube**

vertical pipe built into a tank for manual gauging

**3.13
displacer**

surface-detecting element which is suspended from a level gauge and moves in a vertical direction to follow the change in liquid level. The displacer has a higher mass than the liquid it displaces

**3.14
error**

difference between a computed or measured quantity and its true value

**3.15
fixed-roof tank**

vertical cylindrical storage vessel with a cone- or dome-shaped roof, of either the non-pressure (freely-vented) type or the low-pressure type

**3.16
float**

detecting element floating on the surface of a liquid in a tank which moves in a vertical direction to follow the change in liquid level

**3.17
floating cover (screen)**

lightweight cover of either metal or plastics material designed to float on the surface of a liquid in a tank

NOTE 3 The cover rests upon the liquid surface. The device is used to retard evaporation of volatile products in a tank (see ISO 7507-1).

**3.18
floating-roof tank**

tank in which the roof floats freely on the surface of its contents only in the vertical direction; the roof is restrained from rotation in the horizontal plane

**3.19
gauge head**

housing of the liquid level measuring element, which may include the local indicator, transmitter and associated equipment

**3.20
gauge well**

vertical cylindrical structure built into the roof of a floating-roof tank to contain and guide the detecting element

**3.21
guide pole**

vertical tube used in floating-roof tanks to prevent rotation of the roof

the guide pole may also be used as the still pipe (3.34), the support pipe (3.35) or the dip-tube (3.12.3)

**3.22
guide wire**

spring-tensioned solid wire or flexible cable used to guide the travel of an automatic gauge float

**3.23
indicator**

device which indicates the value of the measurement being made by the gauging equipment

**3.24
non-pressure tank**

storage tank designed for operation at atmospheric pressure

**3.25
operation checker**

externally operated device sometimes incorporated in a mechanical level gauge by which a sudden movement may be imparted to the tape in order to ensure that it moves freely

3.26**pressure tank**

storage tank designed for operation at pressures above atmospheric

pressure tanks are divided into two main classes:

- a) low-pressure tanks, used for volatile products which are liquid at ambient temperatures;
- b) high-pressure tanks, used for liquids which are normally in the vapour phase at ambient temperature and atmospheric pressure.

3.27**receiver**

system which receives signals from a transmitter

3.28**remote transmission and telemetering systems**

separate or integral systems used in conjunction with level or temperature measuring devices to transmit local data readings to some point other than the point of measurement

such systems usually comprise a transmitter to convert the readings into a form suitable for transmission to a receiver which presents the readings at a remote location

3.29**resistance thermometer (RTD)**

temperature-sensing element constructed from material whose electrical resistance changes with temperature in a predictable manner

3.30**sampling hatch**

any hatch used for sampling; often the dip-hatch

3.31**seal unit**

device that seals the gauge assembly from tank vapours

3.32**sensitivity**

minimum change in the measured parameter required to produce a movement of the indicator

3.33**servo-mechanism**

externally powered mechanism which is controlled by the detecting element

3.34**still pipe; still well**

vertical pipe built into a tank to contain the liquid level-detecting element in order to reduce measurement errors arising from liquid turbulence, surface flow or agitation of the liquid

3.35**support pipe**

still pipe used to support an automatic tank gauge near or by the bottom of the tank or from the lower part of the tank shell

3.36**tank shell**

cylindrical part of a storage tank

3.37**tape; measuring wire**

element connecting the liquid level-detecting element of a direct-detecting automatic level gauge with the gauge head mechanism

3.38**thermowell**

tube installed in a tank to house the resistance thermometer or any other temperature-measuring device

if vertical, the thermowell may be a perforated pipe

3.39**ullage**

- 1) Capacity of a tank not occupied by the liquid.
- 2) Distance between the surface of a liquid in a tank and some fixed reference point on the top of a tank.

NOTE 4 The term "outage" is synonymous (see ISO 7507-1).

3.40**ullage lip**

marine term for the reference point on the dip-hatch from which manual measurements are made

3.41**ullage plug**

marine term for the manual dip-hatch usually fitted with a heavy-duty cover

3.42**ullage reference point**

point clearly marked on the dip-hatch, or on a plate suitably located above or below the dip-hatch, and situated above the maximum level in the tank to indicate the point from which measurements of ullage are taken

3.43**upper reference point**

point clearly defined on the dip-hatch directly above the dip-point to indicate the position at which dipping or ullaging shall be carried out (see ISO 7507-1)

NOTE 5 If the upper edge of the dip-tube is level, this may be taken as the reference plane.

4 Precautions for installation and operation

4.1 General precautions

4.1.1 Regardless of the equipment used for the measurement of liquid depth and/or temperature, it is recommended that the following general precautions be observed, where applicable.

- a) Temperature measurements should be made at the same time as the level measurement.
- b) These readings should be recorded at the time they are taken.
- c) When determinations of the contents of a tank are made both before and after movement of a bulk quantity of liquid, the same general procedure should be followed in each case.
- d) All materials in contact with the product or its vapour should be chemically compatible with the product so that the product is not contaminated nor the equipment affected.
- e) Equipment installed in ships should be environmentally tested in accordance with the requirements of the appropriate approval body.

4.1.2 It is recommended that, for critical applications for LPG spheres, two level gauges be fitted, the primary gauge for indication and the secondary gauge for alarm, although both should be available for indication if required. They should be permanently installed and, if a remote control room is provided, both should be wired back to it (see also 8.1.2).

4.2 Safety precautions

4.2.1 The safety precautions given below constitute good practice, but the list is not necessarily comprehensive. It is recommended that the list be read in conjunction with the appropriate safety code. These precautions should be taken whenever they do not conflict with national or other regulations which should, in any case, always be followed.

4.2.2 All automatic level- and temperature-measuring equipment should be capable of withstanding the pressure, temperature and environmental conditions specified for the tank design.

4.2.3 All electrical components used in connection with automatic gauging equipment situated in a classified area should be appropriate to the classification of the area and should conform to the standards laid down in recognized codes (for example IEC 79-0).

4.2.4 All metal parts of gauging equipment mounted on tanks should be firmly connected to an electrical earth, so that the resistance is not greater than the value specified in the local safety code.

A float should be bonded to the tank by means of the tape, because the guide wires do not provide adequate bonding or grounding of the float since the sliding contact could be intermittent. The bonding should not affect the free movement of the float.

Where intrinsically safe equipment is employed, the earth for such equipment is normally kept separate from other earths.

4.2.5 All regulations covering entry into hazardous areas should be rigorously observed.

Before a tank which has contained hydrocarbon liquids or toxic material is entered, a gas-free certificate and work permit should be obtained.

The standard regulations regarding entry into tanks which have contained leaded fuels should be meticulously observed.

4.2.6 Plant and equipment should be adequately maintained, and it is recommended that a regular inspection be made by a competent person.

4.2.7 If radioactive materials are used, any applicable regulations covering the handling of these materials should be observed.

4.2.8 Floating-roof tanks are preferably gauged from the platform, but in exceptional circumstances it may be necessary to descend to the roof. Toxic and flammable vapours may accumulate above the roof, and if it is necessary for a gauger to descend to the roof he should at all times be kept under observation by another operator from the top platform. It is essential that the gauger be equipped with a safety-line and harness, and both the gauger and the observer should put on breathing apparatus before the gauger descends on to the roof in the following circumstances:

- a) if the product in the tank contains hydrogen sulphide or volatile mercaptans;
- b) if the roof is at rest on its supports or is not fully floating;
- c) if the roof is out-of-round or when the roof-seal is known to be faulty;
- d) in any other circumstances if vapours may be present in dangerous concentrations.

4.2.9 Rotating shafts may enter part of the gauge installation which is effectively connected to the vapour space. If an electrically energized transmitter is attached to the gauge, there should be a vented space between the gauge and the transmitter.

4.2.10 All conductors entering zone 0 areas (see IEC 79-0) should be protected against flashover, which could occur during lightning storms.