BS EN 13352:2012

BSI Standards Publication

Specification for the performance of automatic tank contents gauges

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National foreword

This British Standard is the UK implementation of EN 13352:2012. It supersedes BS EN 13352:2002, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PVE/393/5, Tank contents gauges for petroleum liquids.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Specification for the performance of automatic tank contents gauges

Spécification de performance des jauges automatiques de niveau de réservoir

Anforderungen an automatische Tankfüllstandmessgeräte

This European Standard was approved by CEN on 28 January 2012.

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Foreword

This document (EN 13352:2012) has been prepared by Technical Committee CEN/TC 393 “Equipment for storage tanks and for filling stations”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2012, and conflicting national standards shall be withdrawn at the latest by September 2012.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 13352:2002.

The main changes with respect to the previous edition are listed below:

— test liquid changed;

— requirement concerning the compatibility of the materials in contact with fuels (including ethanol blends and biodiesel) and/or their vapour added;

— test equipment modified;

— test procedures modified to reduce the number of tests without affect the overall performances; some procedures are performed in climatic chamber;

— some notes about the performance of water indication added that may be affected if the fuel to monitor is an ethanol blend;

— information concerning environmental aspects included.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

The principal function of a tank gauge is to measure the level of liquid contained in a storage tank without the need to access the tank and take manual dip readings. The gauge measures liquid parameters, which can include height, mass, temperature, density and pressure. These can then be used to determine the tank's content. Methods of establishing tank's content, e.g. direct volume measurement, are not addressed in this standard.

The increasing need for continuous inventory control for security, effective site operation and environmental protection has made the use of tank gauges a practical solution for any tank installation. In addition, in the case of volatile products, the advent of vapour emission control makes access to the tank for dipping purposes increasingly difficult.

Automatic tank gauging systems are devices which can interface with other measuring equipment and can be capable of providing one or more of the following functions:

Basic gauging

Where the gauge is used solely to confirm that there is sufficient ullage to accept delivery of a quantity of product into the tank or where the gauge is used solely to measure the liquid contents of the tank.

Inventory control

Where the tank contents information is used for stock accounting purposes. This can be transferred manually or, where the gauge forms part of an integrated system, automatically.

Automatic reconciliation

Where the tank contents information is used together with measured additions to and depletions from the storage tanks contents in a defined time period to identify possible discrepancies.

Automatic Calibration

Where the tank level information in connection with refuel volume is used to calculate tank calibration data.

1 Scope

This European Standard specifies the minimum performance requirements for various classes of automatic tank gauges which are limited to static tanks of shop fabricated manufacture both metallic and non metallic, underground and above ground which do not exceed 5 m in height.

It is applicable to gauges for fuels (products) which are flammable, having a flash point up to but not exceeding 100 °C, stored at premises (e.g. filling stations) at which fuel is dispensed for use in vehicles and other forms of transportation. This European Standard applies to gauges suitable for use at ambient temperatures and subject to normal operational pressure variations.

Gauging of liquefied gases are not covered by this standard.

This European Standard relates to the measurement of product level, measurement of product temperature and detection of the presence of free water. The detection of free water may be compromised for Alcohol blended fuels.

NOTE 1 This standard is not intended to cover safety functionalities (i.e. overfill prevention, leak detection, etc.). Further Standards apply.

NOTE 2 This standard is not intended to cover legal metrology requirements.

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.

EN 228, *Automotive fuels — Unleaded petrol — Requirements and test methods*

EN 590:2009+A1:2010, *Automotive fuels — Diesel — Requirements and test methods*

EN 14214, *Automotive fuels — Fatty acid methyl esters (FAME) for diesel engines — Requirements and test methods*

EN 15376, *Automotive fuels — Ethanol as a blending component for petrol — Requirements and test methods*

EN 60296, *Fluids for electrotechnical applications — Unused mineral insulating oils for transformers and switchgear (IEC 60296)*

EN ISO/IEC 17025:2005, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:2005)*

3 Terms and definitions

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

3.1
automatic tank gauge (ATG)
device capable, as a minimum, of providing a measurement of the level of liquid contained in a storage tank without the need for manual access into the tank

3.2
ullage
product quantity which can safely be delivered into the tank without running the risk of exceeding the maximum safe filling capacity

3.3
gauge sensor
device which measures one or more of product level, temperature and free water presence

3.4
gauging system
combined system of gauge sensor(s) and associated indicator device(s)

3.5
indicator device
device which receives and displays the output signals from the gauge sensor(s). It may process that data and display, print or transmit information as required

3.6
maximum permissible error (MPE)
extreme values of an error permitted by specifications, regulations etc. for a given measuring instrument

3.7
measuring range (MR)
distance between the upper and lower limits of measurement over which the performance requirements are satisfied

3.8
readability
property of a measuring instrument where the indicating device is constructed in such a way that its indication may be read without ambiguity

3.9
reference level measurement device (RLMD)
certified level measurement device used for verification of the ATG's performance

3.10
reference temperature measurement device (RTMD)
certified temperature measurement device used for verification of the ATG's performance

3.11
repeatability
ability of a measuring instrument to provide closely similar indications for repeated applications of the same measurand under the same conditions of measurement (ISO-Publication)

Note 1 to entry: These conditions include:

— reduction to a minimum of the variations due to the observer;

— the same measurement procedure;

— the same observer;

— the same measuring equipment, used under the same conditions;

— the same location;

— repetition over a short period of time.

Note 2 to entry: Repeatability can be expressed quantitatively in terms of the dispersion characteristics of the indications.

3.12
resolution
smallest difference between indications of a displaying device that can be meaningfully distinguished (ISO-Publication)

Note 1 to entry: For a digital displaying device, this is the change in the indication when the least significant digit changes by one step.

Note 2 to entry: This concept applies also to a recording device.

3.13
consecutive readings
reading taking from the indicator device at intervals of no less than 1 minute, in consideration of the refresh time of the measurement and display cycle

4 General requirements

4.1 Temperature ranges

The components of an automatic tank gauge shall be designed for operation under atmospheric conditions and rated subdivided into the temperature categories according to Table 1.

Table 1 — Temperature category

Temperature category	Temperature range
O	–25 °C to +55 °C
P	–5 °C to +45 °C
U	–5 °C to +30 °C
I	+5 °C to +40 °C

NOTE The temperature category are intended to cover Over-ground, Underground, Indoor and Protected environments.

4.2 Variations in the properties of stored products

The performance requirements for ATGs according to 5.1 and 5.2 shall be satisfied when using one or more of the following test liquids:

— Type 1 Diesel according to EN 590:2009+A1:2010;

— Type 2 Transformer oil according to EN 60296.

NOTE 1 The above test liquids have defined ranges of variations in their physical properties.

NOTE 2 The above test liquids cover also the characteristics of gasoline and bio-fuels (including bio-diesel and ethanol-gasoline blends) for level and temperature measurements only.

4.3 Humidity

For all classes of gauging system, the performance shall be unaffected by humidity, i.e. the gauge sensors shall operate in conditions of 95 % non-condensing humidity.

4.4 Characteristics of the materials

All materials that may be in permanent contact with fuels or their vapours during the normal use of the probe shall comply with the requirements of Annex E for all fuels as appropriate. The tests shall be performed only for fuels foreseen by the manufacturer for that type of probe.

NOTE The type of fuels for which the probe is intended to be used may be determined by the literature accomplishing the probe or by a manufacturer statement. In absence of such information, tests are performed for each test fluid.

5 Performance requirements

5.1 Level measurement

Gauging systems shall be classified as one of three classes, A, B or C, satisfying the performance requirements for level measurement according to Table 2 over their entire measuring range and operating temperature range.

Table 2 — Level measurement performance requirements

Class	Maximum permissible error (MPE)	Repeatability
A	± 1 mm	0,5 mm
B	± 2 mm	1 mm
C	± 1 % of measuring range	0,5 % of measuring range

The method of type testing for level measurement is given in Clause 9.

5.2 Temperature measurement

Where average product temperature measurement is provided, the performance requirements for temperature measurement according to Table 3 shall be satisfied.

Table 3 — Temperature measurement performance requirements

Class	Maximum permissible error ° C
A	± 1,0
B	± 2,0
C	Not prescribed

The method of type testing for temperature measurement is given in Clause 9.

5.3 Water detection

Where water detection is provided, this facility shall:

5.3.1 Detect a minimum free water level of 30 mm when the probe has been installed on the bottom of the tank.

5.3.2 Indicate the presence of free water within 1 min of the free water reaching the level specified in 5.3.1 (response time).

5.3.3 Cease to indicate the presence of free water within 5 min of the free water dropping below the level specified in 5.3.1 (recovery time).

5.3.4 Activate an alarm within 1 min on detecting the presence of free water at a pre-set level.

NOTE To prevent false alarms during deliveries it is permitted to disable water detection.

The method of type testing for free water detection is given in Clause 10.

5.4 Essential information

The information available for display, printing or transmission by the indicator device shall include:

a) the identification of the tank (for multiple tank systems);

b) product identification (for multiple tank systems);

c) the level and an indication of the volume of product in the tank and/or ullage with an indicated resolution according to Table 4;

d) the date and time of the reading (if printed);

e) indication of water present (if water detection fitted);

f) high water alarm (if water detection fitted);

g) sensor disconnection indication;

h) visual indication of power on.

Table 4 — Required resolution for level measurement and volume indication

Class	Level measurement resolution	Volume indication resolution
A	0,1 mm	1 l
B	0,2 mm	1 l
C	0,1 %	0,1 %

The correct provision of essential information shall be verified through the type approval test procedure described in Clause 8.

NOTE 1 With a multiple tank system, a single indicator device for the gauge sensors can be provided in which case it should be capable of being switched between tanks or should switch automatically between tanks and should then indicate clearly to which tank the information shown refers.

NOTE 2 To achieve accurate volume measurement, an accurate tank capacity table is required. Suggested methods for generating tank capacity tables are referenced in Annex B (informative).

5.5 Indicator device

The display of information shall be stable to within the corresponding MPE for the class of measurement performance (A, B or C) over a range of environmental temperature for the indicator device. The manufacturer shall specify this range either as category O or category I, according to 4.1.

5.6 Manufacturers instructions

Instructions shall be provided by the manufacturer for the safe installation, accurate positioning of the gauge sensor, operation and maintenance of the automatic tank gauging system.

NOTE See Annex B (informative) for further information.

5.7 Classification and designation

5.7.1 Gauge sensors shall be designated according to the following classifications as established by the relevant test methods:

a) Class of measurement performance (class A, B or C in accordance with Table 2 and Table 3);

b) the temperature range over which this class of performance is achieved (category O, P or U according to 4.1);

c) water detection performance (W represents compliance according to 5.3).

These classifications shall be designated each by a single letter or numeral according to the following syntax:

a)	b)	c)
{A}	{O}	
{B}	{P}	[W]
{C}	{U}	

Items bracketed { } are required. One option from each classification shall be given.

Items bracketed [ ] are optional.

For example, a sensor achieving class of performance B, over the temperature range of category U and capable of water detection would be designated BUW.

These designations shall not be affixed other than to sensors within the range of tank sizes specified by manufacturer for which approval has been obtained.

5.7.2 Indicator devices (where separate from the sensor) shall be designated according to the following classifications as established by the relevant test methods:

a) measurement performance (class A, B or C in accordance with Table2 and Table 3);

b) the temperature range over which this class of performance is achieved (category O or I according to 4.1).

These classifications shall be designated each by a single letter according to the following syntax:

a)	b)
{A}	{O}
{B}	{I}
{C}	

Items bracketed { } are required. One option from each classification shall be given.

For example, an indicator unit achieving class of performance B, over the temperature range of category I would be designated BI.

6 Test methods

6.1 Sampling

The gauging system to be tested shall consist of one sample of the ATG including gauge sensors which cover the longest gauge sensor length for which they will obtain approval.

6.2 Test sequence

Prior to testing, the manufacturer shall state the class of measurement performance against which the gauging system is to be assessed. For each gauge sensor contained in the gauging system to be tested, the manufacturer shall also state the temperature category, the measuring range and whether water detection is provided. For each indicator device (if separate from the gauge sensors) the manufacturer shall also state the relevant temperature category.

The device under test shall be the subject of three tests, the test parameter bands in each case being selected according to the relevant ranges as stated by the manufacturer.

These tests shall be conducted in the following order:

— test for the provision of essential information, according to Clause 8.

— test for level and temperature measurement performance, according to Clause 9.

— test for water detection capability, according to Clause 10, if relevant.

6.3 Test report

The results of the three tests according to 6.2 shall be compiled into a test report in accordance with 5.10 of EN ISO/IEC 17025:2005. This report shall include at least the following information:

a) identification of the ATG and details of the length of the sensor tested, stating the approval apply to all sensor lengths up to the length of the sensor tested;

b) date of manufacture of the product;

c) dates for the beginning and end of each test;

d) reference to this standard and the test methods used;

e) any variants of any test method;

f) the class of measurement performance assessed;

g) types of test liquid used;

h) temperature category applied to gauge sensor(s);

i) temperature category applied to indicator device (if relevant);

j) whether water detection capability was tested;

k) results for each test stating "Pass" or listing failures by exception in each case.

7 Marking and labelling

Each gauge sensor and/or indicator device shall be clearly and indelibly marked by the manufacturer either directly on the product or by an adhesive label with the following information:

— manufacturer's name, trade mark or identification mark;

— year of manufacture or serial number or batch number;

— number of this European Standard, EN 13352, followed by designation as defined in 5.7;

— mandatory marking, when required.

The essential characteristics, the recognition and observance of which will ensure that electrical equipment will be used safely and in the application for which it was made, shall be marked on the equipment or, if this is not possible, on an accompanying notice.

8 Test of provision of essential information

8.1 Test objective

To prove the availability of the essential information as listed in 5.4. Availability shall be verified either by the information being displayed or printed on the indicator device or being transmitted to a remote indicator device, display or printer (dependent upon the system design).

8.2 Evaluation

When the equipment is operated in accordance with the manufacturer's instructions, each item of essential information is available from either the indicator device or from the remote indicator device, display or printer to which it is transmitted.

Textual information shall be readable in the language selected to communicate the information. Similarly, any icons or indications utilised shall be readable. Audible alarms are supplementary to the communication of the warning by visual means.

8.3 Test equipment

The manufacturer shall supply a gauging system. Where the indicator device does not provide all of the essential information, the manufacturer shall also supply additional devices as necessary to provide any missing items. For a multiple gauging system a minimum of two sensors shall be supplied.

8.4 Test method

The system shall be installed and commissioned in accordance with the manufacturer's instructions. Each item of essential information shall be obtained from the indicator device or display or printer, either locally or remotely, in accordance with the manufacturer's instructions. The high water alarm and sensor loss alarm shall be simulated by creating the appropriate conditions.

8.5 Test result

From the recorded results, it shall be verified that each item of essential information is available as listed in 5.4.

9 Test for level and temperature performance

9.1 Test objective

The aim of the type test is to classify the performance capabilities of the ATG in product level and temperature measurement in accordance with the performance requirements of one of the three classes specified in 5.1 and 5.2. Tests shall be performed to determine:

i) the maximum error in product level measurement;

ii) the repeatability of product level measurement;

iii) the maximum error in temperature measurement.

Tests shall be carried out over the rated temperature ranges of both gauge sensor and indicator device, to verify that the rated class of performance is maintained across these ranges.

9.2 Evaluation

The performance values produced by the ATG under test shall be analysed and compared with the minimum performance specifications for the three classes, A, B and C. The ATG will have passed the test for a specific class if each of its performance values are equal to or better than those specified for that class.

9.3 Test equipment

9.3.1 Test vessel

A vessel suitable for mounting the ATG, RTMD and RLMD mentioned below.

NOTE Special care should be taken with the mounting of the RLMD, as its mounting position should not change due to environmental temperature variations.

9.3.2 Secondary vessel

If a secondary vessel is used, it shall have at least the same capacity as the test vessel, together with a pump and hoses suitable for the transfer of liquid to and from the test vessel.

9.3.3 Reference level measurement device (RLMD)

The RLMD shall have performance values 3 times better than the values according to Table 2 for ATG class A.

9.3.4 Reference temperature measurement devices (RTMD)

The RTMD shall have performance values 3 times better than the values according to Table 3 for ATG class A. The device shall consist of a vertical array of temperature sensors over the height of the test vessel with a spacing of (30 ± 1) cm between the temperature sensors.

9.3.5 Monitoring devices

A temperature measurement device for monitoring the ambient temperature in the area where the ATG is undergoing tests.

9.3.6 ATG

For an automatic tank level gauge under test where a readout of level is not normally displayed, special provision shall be made for the purposes of testing. For the test of temperature performance, it is possible to use a separate gauge sensor with a shorter length (i.e. 0,8 m) which is mountable in a standard environmental chamber.

9.3.7 Environmental chamber

An environmental chamber to mount ATG, the reference level measurement device (RLMD) and reference temperature measurement devices (RTMD) and/or the indicating device while being connected to the gauge sensors. The temperature of the chamber shall be controllable with an accuracy of ± 1 K over a range of −25 °C to +55 °C. The chamber shall be fitted with suitable means for reading the display of the indicator device while chamber and indicator device are functioning.

9.3.8 Temperature stabilisation

The test vessel is considered stabilised at a given temperature when the difference between the readings from any of the submerged sensors of the RTMD is no more than ± 0,2 K, over a 10 min period.

9.4 Test method

9.4.1 Test schedule

The type testing procedure for level and temperature measurement shall consist of the following steps:

— preparation of the test which includes the installation and commissioning of the ATG under test;

— a trial run to verify that ATG is operating correctly;

— MPE test A for level in which measurements are taken to verify the performance of the ATG in relation to the maximum permissible level error as stated in Clause 5. The test shall be performed under reference conditions (room temperature) for different levels;

— MPE test B for level and temperature in which measurements are taken to verify the performance of the ATG in relation to the maximum permissible level and temperature error as stated in Clause 5. The test shall be performed using variable temperatures in the test liquid at medium level. This test may be done with a short gauge;

— the repeatability test for level in which measurements are taken to verify the performance of the ATG in relation to the repeatability as stated in Clause 5. The test shall be performed under reference conditions (room temperature) for different levels of the test liquid;

— the stability test in which measurements are taken to verify the performance of the indication device in relation to the maximum permissible level error as stated in Clause 5. The test shall be performed using variable temperatures.

The test schedule is summarised in Table 5.

Table 5 — Test schedule summary

No	Test	Level	Temperature
1	preparation	not applicable	9.4.2
2	trial run	60 % MR	room temp.
3	MPE Test A (L)	Variable	room temp. (20 ± 1) °C
4	MPE Test B	Fix	variable
5	repeatability test (L)	between 30 % and 60 % MR	(20 ± 1) °C
6	stability test	60 % MR	variable

9.4.2 Preparation

The gauge sensor under test shall be mounted in the test vessel in accordance with the manufacturer's installation instructions. The manufacturer's installation materials should be used whenever possible. The gauge sensor under test is connected to the indicator device under test, which is situated in ambient laboratory conditions. Power shall then be applied to the ATG and the ATG shall be commissioned in accordance with the manufacturer's instructions.

After installation and commissioning, the test vessel shall be filled with the test liquid to its maximum level. Three consecutive level readings are taken from the RLMD and the ATG's level reading is set equal to that of the RLMD.

The environmental monitoring devices shall be installed in the vicinity of the ATG's components such that the environmental conditions can be monitored. The monitors are used throughout the duration of the tests to ensure that all tests are conducted within a temperature range of +15 °C to +35 °C, humidity range of 25 % to 75 % non condensing and a pressure range of 860 mbar to 1 060 mbar.

9.4.3 Trial run

The purpose of the trial run is to establish that the ATG is operating correctly. With the ATG under test fully operational, the test vessel is filled with the test liquid to a level of 60 % of the ATG's measuring range. The product level test vessel is then left to stabilise until the reading of the RLMD is stable to within 1/3 of the level-MPE under test. After stabilisation, three consecutive level readings are taken from both the RLMD and ATG. The sets of readings for the RLMD and ATG are individually averaged. The average level reading for the ATG, when compared to the averaged level reading of the RLMD, shall be within the band of the maximum permissible error ATG for the class in question plus the maximum permissible error of the RLMD.

The test vessel shall be then further left to stabilise at room temperature. After stabilisation, three consecutive temperature readings shall be taken from both the RTMD and ATG. The sets of readings for the RTMD and ATG are individually averaged. The average temperature reading for the ATG, when compared to the averaged temperature reading of the RTMD, shall be within the band of the maximum permissible error ATG for the class in question plus the maximum permissible error of the RTMD.

9.4.4 MPE test A for level

9.4.4.1 General

The measuring range of the ATG, as specified by the manufacturer, is divided into 12 bands according to Table 6.

Table 6 — Definition of level measurement bands

Band	Range
Band no. 1	0^{+1}_{0} % of the ATG's measuring range
Band no. 2	5 % to 10 % of the ATG's measuring range
Band no. 3	11 % to 20 % of the ATG's measuring range
Band no. 4	21 % to 30 % of the ATG's measuring range
Band no. 5	31 % to 40 % of the ATG's measuring range
Band no. 6	41 % to 50 % of the ATG's measuring range
Band no. 7	51 % to 60 % of the ATG's measuring range
Band no. 8	61 % to 70 % of the ATG's measuring range
Band no. 9	71 % to 80 % of the ATG's measuring range
Band no. 10	81 % to 90 % of the ATG's measuring range
Band no. 11	91 % to 95 % of the ATG's measuring range
Band no. 12	100^{+1}_{0} % of the ATG's measuring range

Two measurements shall be performed at a test level randomly selected within each band. One measurement is performed when filling the tank, the other is performed when emptying the tank. The test consists of one filling/emptying cycle during which the test liquid is kept at a room temperature and stable within (± 1) °C.

Individual sensor temperatures will be recorded throughout the test to ensure that stratification does not exceed 3 K.

The level measurements shall be made using the following procedure:

9.4.4.2 Filling

The first part of a cycle shall consist of the recording of the environmental parameters as measured by the environmental monitors. Also the test liquid used for the cycle shall be recorded plus the average product temperature as measured by the RTMD.

Starting with an empty tank, pump the test liquid into the test vessel until a level within band no. 1 is reached. The test vessel shall be then left to stabilise until the reading of the RLMD is stable to within one third of the MPE under test. If the reading of the ATG is not stable within the MPE under test, during 1 min, the device has failed the test.

If the level is stable, record three consecutive level readings of both the ATG and the RLMD. Average the three readings for the ATG and record it as $L_{\mathrm{F1.}}$ Average the three readings for the RLMD and record it as R_{F1}.

Pump the test liquid into the test vessel until level within band no. 2 is reached. The test vessel shall be then left to stabilise until the reading of the RLMD is stable to within one third of the MPE under test. If the reading of the ATG is not stable within the MPE under test, during 1 min, the device has failed the test. The average product temperature shall be recorded after stabilisation of the level.

If the level is stable, record three consecutive level readings of both the ATG and the RLMD. Average the three readings for the ATG and record it as $L_{F2.}$ Average the three readings for the RLMD and record it as R_{F2}.

The filling, stabilisation and recording cycle shall be repeated until measurements have been made within bands 3 to 12 resulting in measurements L_{F3} to L_{F12} and R_{F3} to R_{F12}.

9.4.4.3 Emptying

With a stable level within band 12, record three consecutive level readings of both the ATG and the RLMD. Average the three readings for the ATG and record it as $L_{E1.}$ Average the three readings for the RLMD and record it as R_{E1}.

Withdraw the test liquid from the test vessel again until a level within band no. 11 is reached. The test vessel shall then be left to stabilise until the reading of the RLMD is stable to within one third of the MPE under test. If the reading of the ATG is not stable within the MPE under test, during 1 min, the device has failed the test. The average product temperature shall be recorded after stabilisation of the level.

If the level is stable, record three consecutive level readings of both the ATG and the RLMD. Average the three readings for the ATG and record it as $L_{E2.}$ Average the three readings for the RLMD and record it as R_{E2}.

Withdraw the test liquid from the test vessel until a level within band no. 10 is reached. The test vessel shall then be left to stabilise until the reading of the RLMD is stable to within one third of the MPE under test. If the reading of the ATG is not stable within the MPE under test, during 1 min, the device has failed the test. The average product temperature shall be recorded after stabilisation of the level.

If the level is stable, record three consecutive level readings of both the ATG and the RLMD. Average the three readings for the ATG and record it as $L_{E3.}$ Average the three readings for the RLMD and record it as R_{E3}.

The emptying, stabilisation and recording cycle shall be repeated until measurements have been made within bands 9 to 1 resulting in measurements L_{E9} to L_{E1} and R_{E9} to R_{E1}.

After the final measurement has been performed, the environmental parameters shall be recorded again. In case one of these environmental parameters exceeds the conditions specified in 9.4.2, the test cycle shall be invalid and shall be performed again.

NOTE The above procedure describes a regular empty $\rightarrow$ full $\rightarrow$ empty cycle, resulting in two readings for each band, one reading during the filling and one reading during the emptying of the test vessel. These readings can also be obtained starting from any level in the test vessel. Alternative starting points can therefore be used, as long as the procedure results in measurements during filling and emptying of the test vessel.

9.4.5 MPE test B for level and temperature

9.4.5.1 General

The temperature range according to 4.1 shall be divided into 4 bands according to Table 7.

Table 7 — Definition of temperature measurement bands

Band	Temperature range		
	Category U	Category P	Category O
Band no. 1	–5 °C to 0 °C	–5 °C to 0 °C	–25 °C to –20 °C
Band no. 2	+5 °C to +10 °C	+5 °C to +10 °C	+5 °C to +10 °C
Band no. 3	+15°C to +20 °C	+20 °C to +25 °C	+30 °C to +35 °C
Band no. 4	+25 °C to +30 °C	+40 °C to +45 °C	+50 C to +55 °C

Both level and temperature measurements shall be performed at a test temperature randomly selected within each band for the temperature range in question at a fixed level of test liquid which value is equal to the midpoint of measuring range of the ATG under test. ATG

9.4.5.2 Test procedure

Record the environmental parameters as measured by the environmental monitors.

Starting with an empty tank, pump the test liquid into the test vessel until the tank is filled to the midpoint of the ATG's level measuring range. The test vessel shall then be left to stabilise, until the reading of the RLMD is stable to within one third of the MPE under test and a stable temperature point is reached.

When both level and temperature are stable, record three consecutive temperature readings of both the ATG and the RTMD. Average the three temperature readings for the ATG and record it as $T_{A1.}$ Average the three temperature readings for the RTMD and record it as RT_{A1}.

Record three consecutive level readings of both the ATG and the RLMD. Average the three level readings for the ATG and record it as $L_{A1.}$ Average the three level readings for the RLMD and record it as RL_{A1}.

Heat or cool the test liquid until a stable temperature within next band is reached.

If the temperature is stable, record three consecutive temperature readings of both the ATG and the RTMD. At the same time record three consecutive level readings of both the ATG and the RLMD.

Average the three temperature readings for the ATG and record it according to band (as T_{A1}, T_{A2}, T_{A3}, T_{A4}). Average the three temperature readings for the RTMD and record it according to band (as RT_{A1}, RT_{A2}, RT_{A3}, RT_{A4}).

Average the three level readings for the ATG and record it according to band (as L_{A1}, L_{A2}, L_{A3}, L_{A4}).
Average the three level readings for the RLMD and record it according to band (as RL_{A1}, RL_{A2}, RL_{A3}, RL_{A4}).

Follow same procedure for each band

After the final measurement has been performed, the environmental parameters shall be recorded again. In case one of these environmental parameters exceed the conditions specified in 9.4.2, the test cycle shall be invalid and shall be performed again.

9.4.6 Repeatability test for level

9.4.6.1 General

The repeatability test shall be performed with the test vessel filled to a level between 30 % and 60 % of the ATG's measuring range. The test shall consist of a number of small additions and withdrawals of product with

the product level returning to it's previous value. After each addition/withdrawal, readings of the ATG shall be recorded. These tests shall be performed at a stable room temperature (± 1) °C.

9.4.6.2 Test procedure

The first part of a cycle shall consist of the recording of the environmental parameters as measured by the environmental monitors. Fill the test vessel to a level between 30 % and 60 % of the ATG's measuring range. The test vessel shall be then left to stabilise until the reading of the RLMD is stable to within one third of the MPE under test. If the reading of the ATG is not stable within the MPE under test, within 1 min, the device has failed the test.

When the level is stable, record three consecutive level readings of both the ATG and the RLMD. Average the three readings for the ATG and record it as $L_{S.}$ Average the three readings for the RLMD and record it as R.

Slowly fill the test vessel until the RLMD shows a level that is 5,0 cm higher than the recorded level R, with a tolerance of ± 0,5 cm. Withdraw the test liquid slowly from the test vessel, until the RLMD shows a level equal to R as previously recorded within one third of the MPE.

Let the test vessel stabilise until the reading of the RLMD is stable to within one third of the MPE under test. If the reading of the ATG is not stable within the MPE under test, within 1 min, the device has failed the test. When the level is stable, record three consecutive level readings for the ATG. Average the three readings for the ATG and record it as L_1.

Slowly withdraw the test liquid from the test vessel until the RLMD shows a level that shall be 5,0 cm lower than the recorded level R, with a tolerance of ± 0,5 cm. Slowly fill the test vessel with the test liquid until the RLMD shows a level equal to R as previously recorded, within one third of the MPE.

Let the test vessel stabilise until the reading of the RLMD is stable to within one third of the MPE under test. If the reading of the ATG is not stable within the MPE under test, within 1 min, the device has failed the test. When the level is stable, record three consecutive level readings for the ATG. Average the three readings for the ATG and record it as L_2.

Slowly fill the test vessel until the RLMD shows a level that shall be 5,0 cm higher than the recorded level R, with a tolerance of ± 0,5 cm. Withdraw the test liquid slowly from the test vessel, until the RLMD shows a level equal to R as previously recorded within one third of the MPE.

Let the test vessel stabilise until the reading of the RLMD is stable to within one third of the MPE under test. If the reading of the ATG is not stable within the MPE under test, within 1 min, the device has failed the test. When the level is stable, record three consecutive level readings for the ATG. Average the three readings for the ATG and record it as L_3.

Slowly withdraw the test liquid from the test vessel until the RLMD shows a level that shall be 5,0 cm lower than the recorded level R, with a tolerance of ± 0,5 cm. Slowly fill the test vessel with the test liquid until the RLMD shows a level equal to R as previously recorded, within one third of the MPE.

Let the test vessel stabilise until the reading of the RLMD is stable to within one third of the MPE under test. If the reading of the ATG is not stable within the MPE under test, within 1 min, the device has failed the test. When the level is stable, record three consecutive level readings for the ATG. Average the three readings for the ATG and record it as L_4.

Repeat the "filling → emptying → recording" and "emptying → filling → recording" three more times, resulting in ATG readings L_5 ... L_{10}.

After the final measurement has been performed, the environmental parameters are recorded again. In case one of these parameters exceeds the conditions specified in 9.4.2, the test cycle shall be invalid and shall be performed again. The test shall also be invalid when the temperature of the test liquid has moved more than 1 °C outside the temperature fixed according to 9.4.6.1.

9.4.7 Test of the temperature category of the indicator device unit

9.4.7.1 General

The stability test shall be performed with the test vessel filled at a fixed level of 60 % of the ATG's measuring range and the test liquid in the vessel kept at a constant room temperature ± 1 °C. The indicator device shall be placed in an environmental chamber whose temperature shall be changed in fixed steps across one of the temperature ranges according to 4.1, according to whether the indicator device is rated for temperature category O, temperature category P or temperature category I.

Table 8 defines the test temperatures for the three categories.

Table 8 — Test temperatures for the stability test

No	Category O	Category P	Category I
T_L	–25 °C	–5 °C	+5 °C
T_A	20 °C	20 °C	20 °C
T_H	+55 °C	+45 °C	+40 °C

The test shall consist of a cycle in which the temperature in the environmental chamber shall be raised from the lowest to the highest environmental chamber temperature during which level and temperature measurements shall be made for an ATG of class A or B. Only level measurements shall be made for an ATG of class C.

9.4.7.2 Test procedure

The first part of the test shall consist of the recording of the environmental parameters as measured by the environmental monitors.

Fill the test vessel at a level of 60 % of the ATG's measuring range. The test vessel shall be then left to stabilise until the reading of the RLMD is stable to within one third of the MPE under test and a stable room temperature within ± 1 °C is reached.

Adjust the temperature in the environmental chamber to the first test temperature T_I according to the values in Table 8 for categories O, P or I.

When the temperature in the environmental chamber has reached the first test temperature, record three consecutive temperature readings of both the ATG and the RTMD. Average the three temperature readings for the ATG and record it as $T_{M1.}$ Average the three temperature readings for the RTMD and record it as RT_{M1}.

Record three consecutive level readings of both the ATG and the RLMD. Average the three level readings for the ATG and record it as $L_{M1.}$ Average the three level readings for the RLMD and record it as RL_{M1}.

Adjust the temperature in the environmental chamber to the second test temperature T_A according to the values in Table 8 for categories O, P or I.

When the temperature in the environmental chamber has reached the second test temperature, record three consecutive temperature readings of both the ATG and the RTMD. Average the three temperature readings for the ATG and record it as $T_{M2.}$ Average the three temperature readings for the RTMD and record it as RT_{M2}.

Record three consecutive level readings of both the ATG and the RLMD. Average the three level readings for the ATG and record it as $L_{M2.}$ Average the three level readings for the RLMD and record it as RL_{M2}.

Adjust the temperature in the environmental chamber to the last test temperature T_H according to the values in Table 8 for categories O, P or I.

When the temperature in the environmental chamber has reached the last test temperature, record three consecutive temperature readings of both the ATG and the RTMD. Average the three temperature readings for the ATG and record it as $T_{M3.}$ Average the three temperature readings for the RTMD and record it as RT_{M3}.

Record three consecutive level readings of both the ATG and the RLMD. Average the three level readings for the ATG and record it as $L_{M3.}$ Average the three level readings for the RLMD and record it as RL_{M3}.

After the final measurement has been performed, the environmental parameters shall be recorded again. In case one of these environmental parameters exceed the conditions specified in 9.4.2, the test cycle shall be invalid and will have to be performed again.

9.5 Test results and analysis

9.5.1 General

The results of the individual tests shall be analysed in accordance with the procedure according to 9.5.2 to 9.5.7. The results of these analyses shall be a classification of the ATG, according to 9.5.8.

9.5.2 MPE test A for level

The procedure for the maximum permissible error test, according to 9.4.4 shall result in the measurements according to Table 9 for each of the test liquids:

Table 9 — Results MPE test A for level

	Filling		**Emptying**	
Band no	**ATG**	**RLMD**	**ATG**	**RLMD**
1	L_{F1}	R_{F1}	L_{E1}	R_{E1}
2	L_{F2}	R_{F2}	L_{E2}	R_{E2}
3	L_{F3}	R_{F3}	L_{E3}	R_{E3}
4	L_{F4}	R_{F4}	L_{E4}	R_{E4}
5	L_{F5}	R_{F5}	L_{E5}	R_{E5}
6	L_{F6}	R_{F6}	L_{E6}	R_{E6}
7	L_{F7}	R_{F7}	L_{E7}	R_{E7}
8	L_{F8}	R_{F8}	L_{E8}	R_{E8}
9	L_{F9}	R_{F9}	L_{E9}	R_{E9}
10	L_{F10}	R_{F10}	L_{E10}	R_{E10}
11	L_{F11}	R_{F11}	L_{E11}	R_{E11}
12	L_{F12}	R_{F12}	L_{E12}	R_{E12}

The results shall be analysed, according to the following procedure:

a) Calculate the differences between the reading from the RLMD and the ATG for all twenty-four measurements, i.e. R_{FN} - L_{FN} and R_{EN} - L_{EN} in which N ranges from 1 to 12.

b) Calculate the average of all the absolute calculated differences for the classes A to C (see Table 2):

— for all class: avg[abs(R_{FN} - L_{FN}) and abs(R_{EN} - L_{EN})] in which N ranges from 1 to 12;

c) The ATG is deemed to have passed the maximum permissible error test when, for each of the 12 bands:

— for class A, the average of the calculated differences is less than, or equal to, MPE(a) + [MPE(a) * 1/3];

— for class B, the average of the calculated differences is less than, or equal to, MPE(b) + [MPE(a) * 1/3];

— for class C, the average of the calculated differences is less than, or equal to, MPE(c) + [MPE(a) * 1/3].

— For all classes, no single measurement can be outside the required MPE by more than 50 % of the MPE for that class plus [MPE(a) * 1/3].

9.5.3 MPE test B for temperature

The test procedure, according to 9.4.5, shall result in the measurements according to Table 10.

Table 10 — Results MPE test B for temperature

Band	ATG	RTMD
Band 1	T_{A1}	RT_{A1}
Band 2	T_{A2}	RT_{A2}
Band 3	T_{A3}	RT_{A3}
Band 4	T_{A4}	RT_{A4}

The test results shall be analysed, according to the following procedure:

a) Calculate the differences between the reading from the RTMD and the ATG for the measurements performed. That is:

— RT_{AN} - T_{AN} in which N ranges from 1 to 4;

b) Calculate the average of all the absolute calculated differences for the classes A or B (see Table 3).

For all classes: avg[abs(RT_{AN} - T_{AN})] for all N ranges from 1 to 4.

c) Compare the average of the absolute calculated differences with the maximum permissible error for the types A to B (see Table 3). The ATG is deemed to have passed the maximum permissible error test if:

— for class A, the average of the calculated differences is less than, or equal to, MPE(a) + [MPE(a) * 1/3];

— for class B, the average of the calculated differences is less than, or equal to, MPE(b) + [MPE(a) * 1/3].

— For all classes, no single measurement can be outside the required MPE by more than 50 % of the MPE for that class plus [MPE(a) * 1/3].

9.5.4 MPE test B for level

The test procedure, according to 9.4.5, shall result in the measurements according to Table 11.

Table 11 — Results MPE test B for level

Band	ATG	RLMD
Band 1	L_{A1}	RL_{A1}
Band 2	L_{A2}	RL_{A2}
Band 3	L_{A3}	RL_{A3}
Band 4	L_{A4}	RL_{A4}

The test results shall be analysed, according to the following procedure:

a) Calculate the differences between the reading from the RLMD and the ATG for the measurements performed. That is:

— RL_{AN} - L_{AN} in which N ranges from 1 to 4;

b) Calculate the average of all the absolute calculated differences for the classes A to C (see Table 2).

For all classes: avg[abs(RL_{AN} - L_{AN})] for all N ranges from 1 to 4.

c) The ATG is deemed to have passed the maximum permissible error test when:

— for class A, the average of the calculated differences is less than, or equal to, MPE(a) + [MPE(a) * 1/3];

— for class B, the average of the calculated differences is less than, or equal to, MPE(b) + [MPE(a) * 1/3];

— for class C, the average of the calculated differences is less than, or equal to, MPE(c) + [MPE(a) * 1/3]

— For all classes, no single measurement can be outside the required MPE by more than 50 % of the MPE for that class plus [MPE(a) * 1/3].

9.5.5 Repeatability test for level

The procedure for the repeatability test, according to 9.4.6, shall result in the measurements according to Table 12.

Table 12 — Results of the repeatability test

Cycle	Device	Recorded measurement
Initial filling	**RLMD**	R
	ATG	L_S
Filling + emptying	ATG	L_1
Emptying + filling	ATG	L_2
Filling + emptying	ATG	L_3
Emptying + filling	ATG	L_4
Filling + emptying	ATG	L_5
Emptying + filling	ATG	L_6
Filling + emptying	ATG	L_7
Emptying + filling	ATG	L_8
Filling + emptying	ATG	L_9
Emptying + filling	ATG	L_{10}

The results shall be analysed according to the following procedure:

a) Calculate the differences between the initial reading from ATG and each subsequent reading after the filling/emptying and emptying/filling cycles (i. e. L_S - L_N in which N ranges from 1 to 10).

b) Calculate the average of the absolute calculated differences:

— for all classes A: avg[abs(L_S - L_N)], in all N ranges from 1 to 10;

c) Compare the average of the absolute calculated differences with the maximum permissible error for the types A to C (see Table 2). The ATG is deemed to have passed the repeatability test when:

— for class A, the average of the calculated differences is less than, or equal to, Rep-(a) + [Rep(a) * 1/3];

— for class B, the average of the calculated differences is less than, or equal to, Rep(b) + [Rep(a) * 1/3];

— for class C, the average of the calculated differences is less than, or equal to, Rep(c) + [Rep(a) * 1/3].

— For all classes, no single measurement can be outside the required Rep by more than 50 % of the Rep for that class plus [Rep(a) * 1/3].

9.5.6 Test of the temperature category of the liquid level measurement

The test procedure, according to 9.4.7, shall result in the level measurements according to Table 13.

Table 13 — Level measurement results of the stability test

No	All Categories (O, P and I)	
	ATG	RLMD
T_1	L_{M1}	RL_{M1}
T_2	L_{M2}	RL_{M2}
T_3	L_{M3}	RL_{M3}

The test results shall be analysed, for each test temperature, according to the following procedure:

a) Calculate the differences between the reading from the RLMD and the ATG for the measurements performed at each test temperature. That is:

   — RL_{MN} - L_{MN} for all categories in which N ranges from 1 to 3;

b) Calculate the average of the absolute calculated differences.

   — for all classes avg[abs(RL_{MN} - L_{MN})] in which N ranges from 1 to 3;

c) Compare the average of the absolute calculated differences with the maximum permissible error for the types A to C (see Table 2). The ATG is deemed to have passed the stability test for level when:

For type A:

— the average of the calculated differences is less than, or equal to, MPE(a) + [MPE(a) * 1/3] for all categories;

For type B:

— the average of the calculated differences is less than, or equal to, MPE(b) + [MPE(a) * 1/3] for all categories;

For type C:

— the average of the calculated differences is less than, or equal to, MPE(c) + [MPE(a) * 1/3] for all categories;

— for all classes, no single measurement can be outside the required MPE by no more than 50 % of the MPE for that class plus [MPE(a) * 1/3].

d) The results shall be recorded.

The test procedure, as described in 9.4.7, results in the temperature measurements according to Table 14.

Table 14 — Temperature measurement results

No	All Categories (O, P and I)	
	ATG	**RTMD**
T_1	T_{M1}	RT_{M1}
T_2	T_{M2}	RT_{M2}
T_3	T_{M3}	RT_{M3}

The test results shall be analysed, for each test temperature, according to the following procedure:

a) Calculate the differences between the reading from the RTMD and the ATG for the measurements performed at each test temperature. That is:

— for all categories RT_{MN} - T_{MN} in which N ranges from 1 to 3.

b) Calculate the average of the absolute calculated differences.

— for all categories avg[abs(RT_{MN} - T_{MN})] in which N ranges from 1 to 3.

c) Compare the average of the absolute calculated differences with the maximum permissible error for the types A and B (see Table 2). The ATG is deemed to have passed the stability test for temperature when:

For type A:

— the average of the calculated differences is less than, or equal to, MPE(a) + [MPE(a) * 1/3] for all categories;

For type B:

— the average of the calculated differences is less than, or equal to, MPE(b) + [MPE(a) * 1/3] for all categories;

— For all classes, no single measurement can be outside the required MPE by no more than 50 % of the MPE for that class plus [MPE(a) * 1/3].

d) The results shall be recorded.

9.5.7 Classification of the ATG

On the basis of the results of the analysis performed according to 9.5.2 to 9.5.6 the ATG can be classified as follows:

Class A The ATG has passed the maximum permissible error tests for level and temperature plus the repeatability test for level, with results corresponding with class A.

Class B The ATG has passed the maximum permissible error tests for level and temperature plus the repeatability test for level, with results corresponding with class B.

Class C The ATG has passed the maximum permissible error test and repeatability test for level, with results corresponding with class C.

Failed The ATG has failed classification when it has failed any of the maximum permissible error tests on level and temperature plus the repeatability test.

10 Test for water detection capability

10.1 Test objective

This test aims to prove the functionality of water detection using the test liquid. Manufacturer instructions should provide information about applicability with any other fuels including bio-fuels and alcohol blends. Tests are performed to identify that the performance requirements listed in 5.3 are satisfied.

10.2 Evaluation

Tests will be deemed to have been passed where:

— The presence of water is not indicated when no water is present.

— The presence of water is indicated within 1 min when water is introduced into the test system to a level of $\left(30\ ^{+2}_{0}\right)$ mm in the continuous presence of stored liquid.

— The water indicating condition is cancelled within 5 min following removal of the presence of water but in the continuous presence of stored liquid.

— An alarm is activated within 1 min when water is introduced into the test system to a level of (45 ± 2) mm and the alarm level has been preset to 35 mm.

10.3 Test equipment

— A test vessel suitable to contain the bottom of the probe with a minimum depth of 0,3 m. One or more fittings shall be provided in the floor of the vessel for the introduction of liquid. A means to measure the liquid interface level with an accuracy of ± 0,5 mm shall be provided.

NOTE 1 I.e. the test vessel may be a flat-bottomed vertical cylinder, having a horizontal cross-sectional area of (0,1 ± 0,002) m^2 (a liquid depth of 0,01 m corresponds to a volume of 1 l) and a minimum depth of 0,3 m.

— Suitable quantities of each fluid for qualification.

— A suitable equipment to introduce liquids into the test vessel.

— A stop clock having a time indication in steps of 1 s to a minimum total of 10 minutes.

NOTE 2 Alternatively it is possible to use a test vessel with a fix level of 50 mm water on bottom topped with 150 mm medium. To simulate the in- and de-creased water levels the probe moved up and down with a vertically adjustable probe support to the different test levels. The means to measure both the liquid interface level and the vertically adjustable probe support with an accuracy of ± 0,5 mm is provided.

10.4 Test

10.4.1 Preparation

The gauge sensor under test shall be fixed in its normal orientation so as to be in contact with the floor of the test vessel but away from any ports for the introduction or extraction of liquid. The manufacturer's fittings should be used wherever possible. The sensor under test shall be connected to the indicator device under test which shall be subject to ambient laboratory conditions where temperature, relative humidity and air pressure shall be maintained within the following ranges:

Temperature: 15 °C to 35 °C

Relative humidity: 25 % to 75 % (non-condensing)

Air pressure: 860 mbar to 1 060 mbar

Prior to the tests, the test vessel shall be filled to a level of 150 mm with the test liquid, and the tool for the introduction of the water has to be in place.

Power shall be applied to the gauging system which shall then be initialised according to the manufacturer's operating instructions such that the system shall be fully operational. The configurable water alarm level shall be set to indicate a level of water of 35 mm.

10.4.2 Stabilisation

Prior to each test to be conducted, and with the sensor system fully operational, the equipment shall be allowed to stabilise in ambient laboratory conditions for 30 min.

10.4.3 Test procedure

For the test to be conducted, the following procedure shall be used:

— check the indicator device. If the presence of water is indicated, terminate the test;

— zero the stop clock;

— introduce water into the test vessel to a measured level of $\left(30\ ^{+2}_{0}\right)$ mm in a time no more than 1 min;

— start the stop clock;

— at the moment when the indicator device first indicates the presence of water, by the means specified in the manufacturer's instructions, or if the maximum response time is exceeded, stop the stop clock;

— record the stop clock elapsed time (measured response time);

— zero the stop clock;

— introduce water into the test vessel to a total measured level of (45 ± 2) mm in a time no more than half a minute;

— start the stop clock;

— at the moment when the indicator device first indicates a high water level alarm, by the means specified in the manufacturer's instructions, or if the maximum response time is exceeded, stop the stop clock and cancel the alarm;

— record the stop clock elapsed time (measured alarm time);

— zero the stop clock;

— commence removal of the water;

— at the moment when the vessel is empty of water, stop removal and start the stop clock;

— at the moment when the indicator device first ceases to indicate the presence of water, by the means specified in the manufacturer's instructions, or if the maximum recovery time is exceeded, stop the stop clock;

— record the stop clock elapsed time (measured recovery time).

10.4.4 Test schedule

The test shall be performed three times (prior to each test, if necessary, the level of liquid in the test vessel shall be topped up to 150 mm).

10.5 Test results

For each test in the schedule, the measured response, alarm and recovery times shall be compared to the relevant criteria, according to 10.2, to determine if the test has been passed or failed. If any one criterion in any test is failed, or if at any time the presence of water is indicated when no water is present (other than during the recovery time) the gauging system is deemed to have failed the test schedule, and shall not be qualified for use.

11 Environmental aspects

Environmental aspects should be considered according to Annex D.

Annex A
(informative)

Evaluation of conformity

A.1 General

This annex covers procedures and requirements for the evaluation of conformity of manufactured ATGs with the performance requirements of this standard on the basis of:

a) Manufacturers Declaration:

— the manufacturer (self certification); or

— the purchaser (second party testing); or

— an accredited test house (third party testing).

b) Factory production control as a task for the manufacturer.

c) Continuous surveillance, assessment and approval of factory production control as a task for either:

— an accredited auditor (third party); or

— the purchaser (second party).

A.2 Initial type testing

In order to demonstrate that a gauging system conforms to all the performance requirements laid down in 5.1 to 5.5, a sample from production should be fully tested in accordance with Clause 6 of this standard. The relevant tests should be repeated whenever there is a change in design or production method which can have an effect on any performance requirement.

A.3 Factory production control

In order to ensure conformity subsequent to initial type testing manufacturers should have in place a nationally or internationally recognised system for quality assurance (such as EN ISO 9000) which requires at least the following:

— that the manufacturer should exercise a permanent internal control of production;

— that the manufacturer should establish production test methods intended to confirm the conformity of product to the performance of the type tested sample;

— that the manufacturer should record the results of production control (manufacturer's records). These records should include at least the following:

a) identification of the product tested;

b) the dates of sampling;

c) the test methods applied;

d) the test and inspection results;

e) the date of tests;

f) the identification of the responsible authority within the manufacturer;

g) calibration records.

A.4 Continuous surveillance

Routine inspections should be carried out by the purchaser or accredited auditor at the frequency required by the company's quality system accreditation. During each inspection:

— the manufacturer should make the manufacturer's records available for examination by the second or third party undertaking surveillance;

— the manufacturer should demonstrate that production tests are established which confirm the conformity of product to the performance of the type tested sample in the course of the normal production process;

— the second or third party should undertake verification of the manufacturer's test records;

— the second or third party should verify that the production tests are carried out such that confirmation of product conformity is validated;

— the second or third party should require the manufacturer to undertake appropriate remedial actions if any non-conformities are found;

— the second or third party should, if any major non-conformities are found, undertake a further extraordinary inspection[1)] to verify implementation by the manufacturer of the necessary remedial actions.

1) The timing of the extraordinary inspection should be determined according to the nature of the non-conformities which are to be remedied.

Annex B
(informative)

Gauge sensors installation

B.1 General

The equipment should be installed in accordance with the installation manual supplied by the tank gauge manufacturer.

Installation should be undertaken by suitable skilled, well-trained contractors certified by the manufacturer.

Each sensor should be checked to ensure that it is the correct device for the particular tank (tank number, product grade, sensor length and tank installation fittings), that the tank sensor entry mounting is compatible and installed correctly, and the sensor itself is not damaged.

Installation of a level measuring sensor in an underground or aboveground tank requires specific consideration in respect of:

(i) reference datum points (levels) for tank and sensor;

(ii) safety - Installation in a Hazardous area.

B.2 Reference datum points

B.2.1 General

Prior to installation of a sensor, the physical tank datum levels (tank bottom datum, upper reference datum and tank reference height) can be obtained from the tank calibration tables, tank records, or by physical measurement, (see Figure B.1). The sensor reference datum can then be referenced to the tank capacity (level/volume) table to ensure that the sensor level measurement correctly relates to the table.

The sensor should be installed through a suitable entry on the centre line of the tank. However, if the entry is offset then an offset allowance should be made to the sensor reference datum.

For record purposes, once the mounting flange for the sensor is installed on the entry cover plate, two measurements should be taken:

B.2.2 Difference between horizontal levels of the tank upper reference and the top face of the sensor-mounting flange.

B.2.3 A manual measurement through the sensor-mounting flange to the tank bottom to establish the sensor reference height.

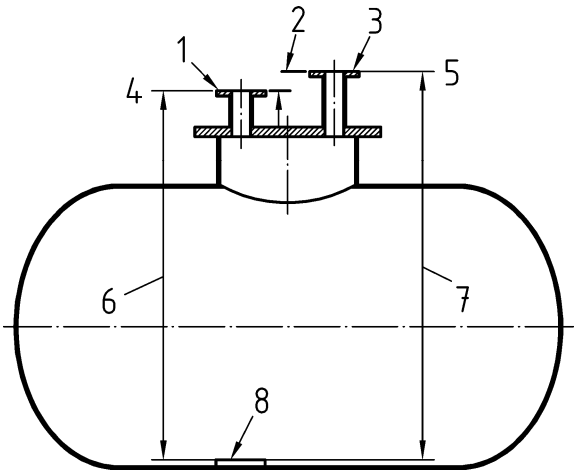
These fundamental dimensions, apart from a cross check on the design of the sensor installation fittings, will be required in the future when verification is required. Should the manual dip entry be used for mounting the sensor, then the tank upper reference point should be maintained and the dimension from this to the sensor reference point accurately measured.

If the sensor has a water detection capability then the following physical checks are required to ensure that water detection is possible below the tank suction level.

B.2.4 The lowest repeatable level of water detection above the bottom of the sensor.

B.2.5 The distance between the bottom of the tank suction pipe and the tank bottom should be verified, plus the distance between the lower end of the sensor and the tank bottom when the sensor is installed.

These checks will ensure correct operation of this facility and the dimensions should be recorded on a tank/sensor installation report.



Key

1 manual dip tape entry
2 measure any offset
3 sensor mounting flange
4 tank upper reference datum
5 sensor reference datum
6 tank reference height
7 sensor reference height
8 tank bottom datum (dip/striker plate or tank bottom if neither fitted)

Figure B.1 — Tank reference datum points

B.3 Safety

The access chamber for the tank manlid can be a hazardous area and hence all safety precautions should be observed by those carrying out the installation before commencing work in the chamber.

To ensure there is no risk of explosion or inhalation of hydrocarbon vapour, it is recommended that a risk assessment is carried out and a safe working procedure established. Reference should be made to local health and safety regulations.

The following points should be considered, but not limited to:

— the access chamber vented to clear residual hydrocarbon vapours prior to access;

— continuous mechanical ventilation of the chamber;

— use of a gas detector;

— presence of a second person;

— use of safety harness;

— use of breathing apparatus.

The cable ducts running between the tank access chamber and the indicator device/operating console can connect a hazardous area to a non-hazardous area. In this case sealing would be required to prevent the possible migration of hydrocarbon vapours. On completion of the cable installation between sensors and the indicator device, all such ducts should be protected against migration of inflammable liquids and their vapours. Final inspection of the installation should include verification of the duct sealing.

The sensor assembly and any associated equipment to be installed in a hazardous area should be suitable for that particular hazardous area. Explosion proof equipment should be correctly installed in accordance with the specified requirements to ensure the safety design is not compromised.

All tank mounted equipment which is not galvanically isolated should be bonded to the tank earth in accordance with the manufacturers installation instructions and applicable Codes of Safe Practice. These earth connections should be tested and verified during final inspection of the installation. Specific requirements for lightning protection should be understood and correctly installed.

B.4 Ingress protection

When any apparatus or wiring is to be installed within the storage tank it should be sealed to IP68.

Any apparatus to be installed within the manhole chamber should be afforded a degree of ingress protection to IP65 according to EN 60529 or better.

The required degrees of protection should be verified by tests in accordance with EN 60529.

Annex C
(informative)

A-deviations

A-deviation : National deviation due to regulations, the alteration of which is for the time being outside the competence of the CEN/CENELEC member.

This European Standard does not fall under any Directive of the EU.

In the relevant CEN/CENELEC countries, this A-deviation is valid instead of the provisions of the European Standard until it has been removed.

Deviation for Sweden

<table>
<tr><th>Clause</th><th>Deviation</th></tr>
<tr><td>4.1

Table 1</td><td>- Regulations and recommendations on open tanks and pipes etc for flammable liquid, SÄIFS 1997:9

In addition to the requirements of this European Standard the following is valid in Sweden:

In Table 1 a temperature category M with the temperature range –40 °C to +50 °C is added.

The following line in Table 1 is amended after the headline:

Table 1 — Temperature category

<table>
<tr><th>Temperature category</th><th>Temperature range</th></tr>
<tr><td>M</td><td>–40 °C to +50 °C</td></tr>
</table>
</td></tr>
</table>

Annex D
(informative)

Environmental Aspects

D.1 Materials should be selected to optimize product durability and lifetime and consideration should be made to avoiding the selection of rare or hazardous materials.

D.2. Consideration should be made to using recycled or reused materials, and to the selection of materials which can then be subsequently recycled.

D.3 The possibility of marking components to aid to their sorting for disposal/recycling at end of life should also be reviewed.

D.4 Packaging design should consider using recycled materials, and materials that need little energy for their manufacture, and should minimize waste.

D.5 Packaging design should consider subsequent reuse and recycling.

D.6 The size and weight of packaging should be minimized whilst protecting the products to minimize waste through damage. Packaging should be designed to optimize capacity of transportation vehicles whilst facilitating safe loading and unloading.

D.7 Test fluids should be used and disposed properly, according to their manufacturer instructions and to the enforced law in respect of environmental protection.

D.8 Test facility, test equipments and tools must be designed to minimize the risk of leak into the ground. The contaminated water used for the tests must be disposed according to the enforced law in respect of environmental protection.

D.9 Consideration should be made to reducing the volume of water required for the operations, for example washing and testing processes. The output water should be of a quality to meet normal drainage requirements.

D.10 Maximum use should be made of high efficiency motors, lighting and displays.

D.11 The design should facilitate the manufacturing of the product and packaging using tools which minimize the generation of noise and vibration.

D.12 Components intended to move in normal use, for example motors and pumping units, should be selected and mounted to minimise noise and vibration.

Table D.1 — Environmental Checklist

Environmental Issue	Stages of the life cycle										All stages
	Acquisition		Production		Use			End-of-Life			
	Raw materials and energy	Pre-manufactured materials and components	Production	Packaging	Use	Maintenance and repair	Use of additional products	Reuse/ Material and Energy Recovery	Incineration without energy recovery	Final disposal	Transportation
Inputs											
Materials	4.2, D.1, D.2	D.1, D.2		D.5	D.1	D.2		4.2,D.2 D.3,D.5	D.2,D.3,D.5	D.2,D.3,D.5	
Water						D.9					
Energy				D.4	D.10						D.6
Land											
Outputs											
Emissions to air	4.2				4.2						
Discharges to water			D.8		D.7,D.8, D.9	D.7, D.9				D.7	
Discharges to soil			D.8		D.7,D.8	D.7				D.7,D.8	
Waste				D.4						D.2,D.3,D.5,D.6, D.7	
Noise, vibration, radiation, heat			D.11	D.11	D.12						
Other relevant aspects											
Risk to the environment from accidents or unintended use					D.8	D.8	D.8				
Customer information											
Comments: Although this standard is not a product standard, equipments, tools and procedures here addressed may affect the environment.											
NOTE The stage of packaging refers to the primary packaging of the products to be tested, materials used for test equipments and tools. Secondary or tertiary packaging for transportation, occurring at some or all stages of the life cycle, is included in the stage of transportation.											

Annex E
(normative)

Compatibility with fuels

E.1 Compatibility tests for materials

Materials shall be selected such that electrolytic corrosion is prevented. This may be achieved by coatings on materials. Materials for probe/sensor body, floats and other components in contact with fuel shall take into consideration that some biofuels act as electrolytes and that copper and aluminium may not be compatible with higher blends of ethanol fuels.

Conformity shall be demonstrated by supplier's declaration which shall specify the materials used and performing the tests in E.2 and E.3.

E.2 Test for parts exposed to fuels vapours

Samples of the materials used for component that are likely to be in contact with the fuel vapours shall be exposed for a minimum of 176 h to the vapours of solvents as listed below:

— methanol;

— ethanol;

— unleaded petrol according to EN 228.

Separate samples shall be used for each solvent.

Where a probe or sensor is intended for use with biodiesel blends above 20 %, separate samples of each materials shall be immersed in 100 % FAME (biodiesel) conforming with EN 14214 for a minimum of 176 h.

The total exposure time shall be made up of one period of (66 ± 2) h and seven periods of (17 ± 1) h, in this order.

Each exposure period shall be followed by a drying period, where the sample is removed from the solvent vapour/fuel and is subjected to forced draft ventilation in fresh air for a minimum period of 6 h.

Inspect the materials and record findings.

Material is compatible if at the end of the test above it has not suffered changes in the characteristics which make it not suitable any more for the foreseen use.

E.3 Test for parts in direct contact with fuels

The component or its representative part shall be tested with a test fluid of unleaded petrol according to EN 228.

In order to demonstrate compatibility with ethanol blended unleaded petrol with an ethanol content between the upper limit of EN 228 and 86 % v/v, the test fluid is a High Blend Ethanol Fuel (HBEF) containing a nominal ratio of 85 % ethanol according to EN 15376 and 15 % unleaded petrol according to EN 228.

In order to demonstrate the compatibility with biodiesel blends with a biodiesel content between the upper limit of EN 590 and up to 100 % v/v the test fluid is 100 % FAME in accordance with EN 14214.

In order to demonstrate compatibility with other fuel types, or to demonstrate suitability up to a limited biofuel blend ratio, the test fluid is the fuel with which the probe are to be used.

Separate samples shall be used for each of the test fluid.

The sample shall be immersed in the test fluid for not less than 1 000 h.

Inspect the materials and record findings.

Material is compatible if at the end of the test above it has not suffered changes in the characteristics which make it not suitable any more for the foreseen use.

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