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RECOMMENDATION

OIML R 85

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Automatic level gauges for measuring the level of liquid in fixed storage tanks

Part 1: Metrological and technical requirements - Tests
Part 2: Test report format

Jaugeurs automatiques pour le mesurage des niveaux de liquide dans les réservoirs de stockage fixes

Partie 1: Exigences métrologiques et techniques - Essais
Partie 2: Format du rapport d'essai

OIML R 85 Edition 1998 (E)

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Contents

Foreword

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Automatic level gauges for measuring the level of liquid in fixed storage tanks

Part 1 - Metrological and technical requirements - Tests

1 Scope

This Recommendation prescribes the metrological and technical requirements and test procedures for automatic level gauges for measuring the level of liquid in stationary storage tanks, at atmospheric pressure or under pressure and with or without cooling or heating.

Tank level measurements may be used in conjunction with tank calibration tables for the determination of liquid volume received from, delivered to or contained in stationary storage tanks.

2 Terminology

Terms conform to the *International Vocabulary of Basic and General Terms in Metrology* (VIM, Second edition, 1993) and to the *Vocabulary of Legal Metrology* (VML, 1978 edition).

In addition, for the purpose of this Recommendation, the following definitions apply (see page 45 for an alphabetic list of these terms).

2.1 Automatic level gauge

An instrument intended to measure automatically the level of the liquid contained in a tank with respect to a fixed reference (see Figure 1).

Note: The words "automatic level gauge" are frequently replaced by the acronym "ALG" throughout this document.

2.2 Electronic automatic level gauge

An automatic level gauge using electronic means and/or equipped with electronic devices.

Note: For the purpose of this Recommendation ancillary equipment, in so far as it is subject to metrological control, is considered to be part of the ALG.

2.3 Liquid level detecting element

An element that senses the presence of the liquid surface and gives information on its level directly or via a transmitter to an indicating device.

2.4 Movable liquid level detecting element

A liquid level detecting element that follows the vertical movement of the liquid surface.

2.5 Static liquid level detecting element

A liquid level detecting element that senses the liquid surface from a stationary position.

2.6 Correction detector

A detecting element that measures a relevant property of the liquid and/or the medium above the liquid level for the purpose of applying a correction to the liquid level measurement, depending on the measuring principle of the ALG.

2.7 Indicating device

A part of the ALG that indicates, displays or prints the measuring result.

Note: For the application of this Recommendation the meaning of "indicating device" is larger than the general OIML meaning (a printing device is considered as such).

2.8 Checking facility

A facility incorporated in an electronic automatic level gauge that enables significant faults to be detected and acted upon.

2.9 Dip plate

A horizontal plate located along the vertical axis descending from the upper reference point, providing a fixed contact surface from which manual liquid depth measurements are made.

Note: The term "datum plate" is synonymous.

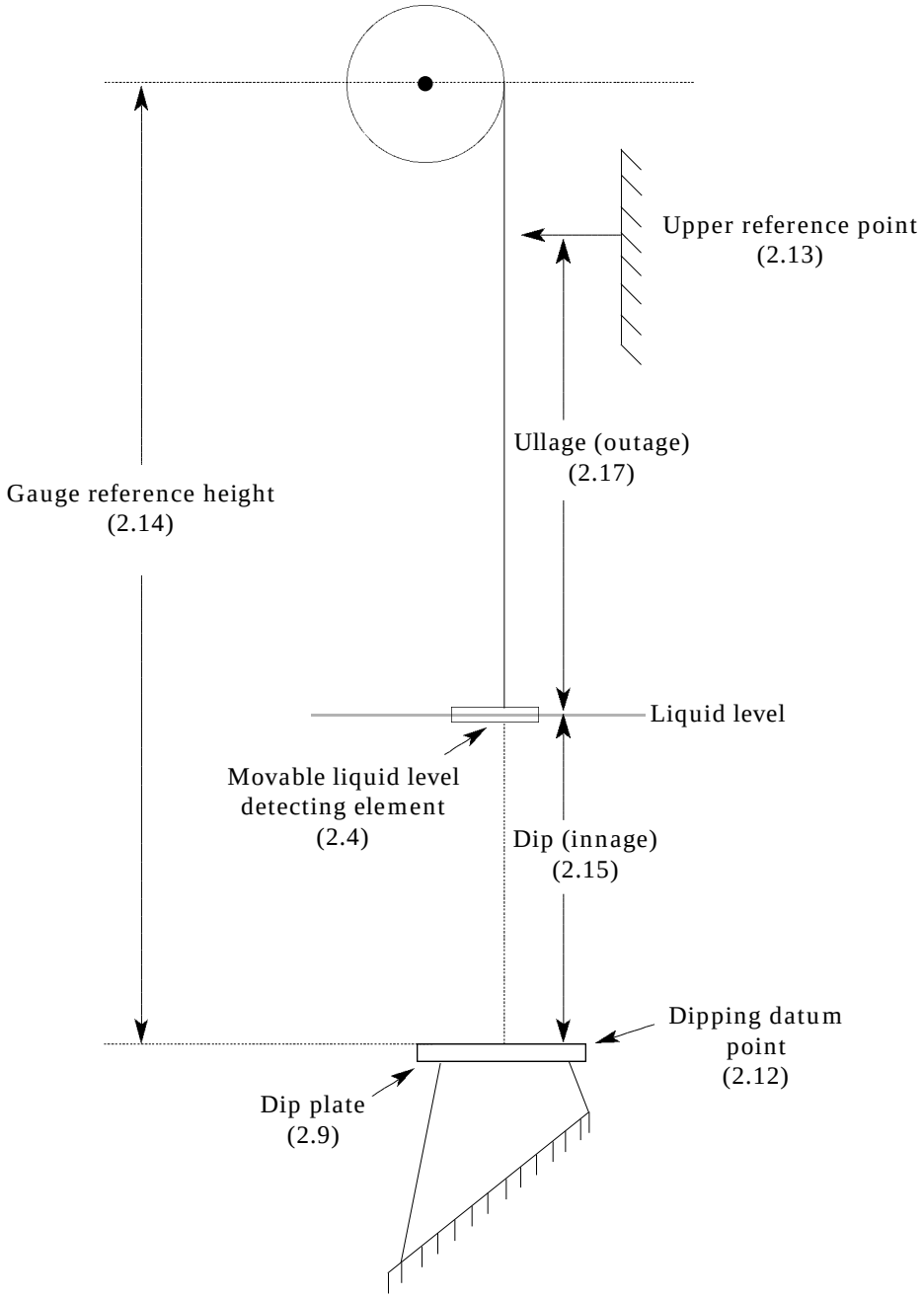

Figure 1

Some of the principal elements of an ALG, shown here with a movable liquid level detecting element

2.10 Datum plate

See “Dip plate”.

2.11 Principal gauge hatch

The gauge hatch which has been designated for the principal measurements and is situated at a convenient, accessible and stable position.

2.12 Dipping datum point

The intersection of the vertical measurement axis with the upper surface of the dip plate, or with the bottom surface of the tank if a dip plate is not provided. It constitutes the origin for the measurement of liquid levels (zero reference or dipping reference point).

2.13 Upper reference point

A point clearly marked on the principal gauge hatch located along the vertical axis ascending from the dipping datum point to indicate the reference position to which ullage is measured.

2.14 Gauge reference height

The vertical distance between the dipping datum point and the point from which the ALG determines the level.

2.15 Dip

The vertical distance between the dipping datum point and the liquid level.

Note: The term “innage” is synonymous.

2.16 Innage

See “Dip”.

2.17 Ullage

The distance between the liquid level and the upper reference point, measured along the vertical measurement axis.

Note: The term “outage” is synonymous.

2.18 Outage

See “Ullage”.

2.19 Tank calibration certificate

A document which contains the tank calibration table together with all the other necessary requirements and information, e.g. smallest measurable volume [(*)].

2.20 Tank calibration table

A table which shows the relation between the height of the liquid level and the volume contained in the tank at that level under specified conditions.

2.21 Rated operating conditions

The conditions of use, giving the range of values of influence quantities for which the metrological characteristics are intended to lie within the specified permissible errors [adapted from VIM 5.5].

2.22 Reference conditions

A set of specified values of influence factors fixed to ensure valid intercomparisons of the results of measurements [adapted from VIM 5.7].

2.23 Influence quantity

A quantity which is not the subject of the measurement but which influences the value of the measurand or the indication of the ALG [adapted from VIM 2.7].

2.24 Influence factor

An influence quantity having a value within the specified rated operating conditions of the ALG.

2.25 Disturbance

An influence quantity having a value within specified limits, but outside the specified rated operating conditions of the ALG.

2.26 Performance

The ability of the ALG to accomplish the intended functions.

(*) See OIML R 71 *Fixed storage tanks* (General requirements)

2.27 Durability

The ability of the ALG to maintain its performance characteristics over a period of use.

2.28 Error (of indication)

The indication of an ALG minus a true value of the corresponding input quantity [VIM 5.20].

2.29 Intrinsic error

The error of an ALG determined under reference conditions [VIM 5.24].

2.30 Initial intrinsic error

The intrinsic error of an ALG as determined prior to performance tests and durability evaluations.

2.31 Fault

The difference between the error of indication and the intrinsic error of an ALG.

Note: Principally a fault is the result of an undesired change of data contained in or flowing through an electronic ALG.

2.32 Significant fault

A fault greater than the value specified in line C of Table 1 (see 3.4.2).

The following faults are considered not to be significant, even when they exceed the value defined above:

(a) faults arising from simultaneous and mutually independent causes in the ALG itself or in its checking facilities;

(b) faults implying the impossibility to perform any measurement;

(c) transitory faults being momentary variations in the indication, which cannot be interpreted, memorized or transmitted as a measurement result;

(d) faults giving rise to variations in the measurement results so serious that they are bound to be noticed by all those interested in the result of the measurement.

2.33 Test

A series of operations intended to verify the compliance of the equipment under test with certain requirements.

2.34 Performance test

A test intended to verify whether the equipment under test is able to accomplish its intended functions.

2.35 EUT

The equipment under test.

3 Metrological requirements

3.1 Constituents of an automatic level gauge

An ALG comprises at least a liquid-level detecting element, a transmitter and an indicating device.

3.2 Materials

All materials used in ALG's shall be of good quality and shall be suitable for their application.

3.3 Indicating device

3.3.1 The authorized units of measurement are those of the International System of Units (SI). If, in any country, units of measurement outside the SI are authorized, the legal units of measurement of that country may be used. In international trade, the officially agreed equivalents between these units of measurement and those of the SI shall be applied.

Indications of the dip or, if applicable, the ullage shall be in legal units of length and shall be accompanied by the name or symbol of the unit. Indication of information that is not subject to metrological control is allowed, provided that it cannot be confused with metrological information.

3.3.2 The scale interval shall not exceed 1 mm.

3.3.3 For an analogue indication, the distance between successive marks on the scale shall be no less than 1 mm.

3.3.4 An ALG may have more than one indicating device. National regulations may require an output for a connection to a local indicating device on the tank.

3.3.5 An additional indicating device may be common to a number of ALG's.

3.3.6 A remote indication shall be unambiguously identified with respect to the ALG it belongs to.

3.3.7 For metrological purposes, an indication of the dip or of the ullage, depending on the measuring principle of the ALG, shall be available on demand.

3.3.8 Subclauses 3.3.1 through 3.3.6 are applicable to printing devices, as appropriate.

3.4 Maximum permissible errors

3.4.1 Accuracy classes

The ALG's are classified according to their accuracy in the Classes 2 and 3. Class 3 is only applicable for tanks containing refrigerated (hydrocarbon) fluids. Class 2 is applicable for all other tanks within the scope of this Recommendation.

3.4.2 The maximum permissible errors, positive and negative, under rated operating conditions to be applied for the relevant indications as referred to in 3.4.2.1 and in the situations of 3.4.2.2 shall be taken from the values of Table 1. The values in lines A and B are relative values of the corresponding indications and the values in lines C and D are absolute values.

Table 1

	Accuracy class	
	2	3
A	0.02 %	0.03 %
B	0.04 %	0.06 %
C	2 mm	3 mm
D	3 mm	4 mm

3.4.2.1 The maximum permissible errors of Table 1 apply to:

- the indication of a dip or an ullage according to the measuring principle of the ALG;
- the indication of a difference between any two levels measured in one direction of operation.

The hysteresis error when changing the direction of the movement of the level shall not exceed:

- 2 mm for ALG's of accuracy class 2;
- 3 mm for ALG's of accuracy class 3.

3.4.2.2 Lines A and C apply to the ALG itself, before being installed on the tank, for pattern approval and for initial verification. The maximum permissible error is the greater value of:

- the absolute value calculated from line A for the corresponding indication;
- the absolute value of line C.

Lines B and D apply to the ALG after installation on the storage tank, for initial and subsequent verification. The maximum permissible error is the greater value of:

- the absolute value calculated from line B for the corresponding indication;
- the absolute value of line D.

3.4.2.3 National regulations may prescribe that the provision of the first indent of 3.4.2.1 is applicable to the indication of a dip.

3.4.3 The discrimination of the ALG itself shall be such that the indication changes at least 1 mm at the occurrence of a change in the level of:

- 2 mm for an ALG of accuracy class 2;
- 3 mm for an ALG of accuracy class 3.

3.4.4 If an ALG gives more than one indication and/or printout, each indication shall comply with the applicable maximum permissible error of 3.4.2. In addition, the difference between any two of them shall not be greater than 1 mm under stable level conditions.

3.5 Field of operation

3.5.1 The field of operation is determined by the following characteristics:

- the minimum and maximum temperatures of the liquid;
- the minimum and maximum pressures of the liquid;
- the characteristics of the liquid and of the medium above the liquid;
- the minimum and maximum densities of the liquid and of the medium above the liquid;
- the maximum and minimum capacities of the ALG.

3.6 Special conditions

National regulations may allow the use of an ALG under conditions outside the rated operating conditions provided that the necessary corrections of the measured value are made.

3.7 Ancillary devices

Ancillary devices (e.g. overfill alarm, etc.) shall not affect the measurement results and shall have no characteristics that facilitate fraudulent use.

3.8 Markings

3.8.1 ALG's shall be legibly and clearly marked with the following information:

- name of the manufacturer or trademark;
- serial number and year of manufacture;
- pattern approval mark;
- accuracy class designation;
- ranges defining the field of operation;
- any information required in the pattern approval certificate.

3.8.2 The descriptive markings shall be indelible and of a size, shape and clarity allowing easy reading under operating conditions of the ALG. They shall be grouped together in a clearly visible place on the ALG itself or on a data plate fixed to it.

3.9 Verification marks

ALG's shall have a place for the verification marks which is visible and allows easy application of the marks. It shall be impossible to remove the marks without damaging them.

3.10 Sealing

It shall be possible to seal the data plate mentioned in 3.8.2 bearing the markings unless this plate cannot be removed without being destroyed.

Sealing means shall be provided for those parts that can affect the accuracy of the measurement and which are not intended to be accessible by the user.

4 Technical requirements specific for ALG's with movable detecting element

4.1 Suspension mechanism

In order to facilitate checks on the mechanism of the gauge, and when applicable, the ALG shall be provided with means allowing to impart on request a movement to the working parts of the gauge.

4.2 Static position

If the level detecting element can be statically positioned above or below the liquid level, it shall be made unambiguously clear that the indication is not presenting an actual measurement.

5 Installation requirements

5.1 General

5.1.1 ALG's shall be installed in such a way that the requirements of subclauses 3.7 through 3.10 are fulfilled.

The indication shall be easily accessible and legible.

5.1.2 Except in the case of tanks under high pressure, ALG's must be equipped and installed in such a way that they may be easily verified when mounted on the tank.

5.1.3 An ALG shall indicate the innage (dip), either continuously or on demand.

5.1.4 If certain regions of liquid level exist in the tank where the ALG indications cannot be used in combination with the tank calibration table, the displayed values in these regions shall be clearly identified or these regions shall be clearly marked on the tank calibration table.

5.1.5 The liquid level detecting element shall be in close proximity to the principal gauge hatch if present. It shall be installed in such a way that the correct operation of the liquid level detecting device cannot be obstructed by obstacles.

5.1.6 The liquid level detecting element shall be placed so that no mutual interference can take place during manual gauging, sampling or other operations.

5.1.7 The liquid level detecting element shall be installed in such a way that the influence of eddies, currents, turbulence, foam, asymmetrical heating, wind and other effects on level detection shall be negligible. If applicable, adequate protection shall be provided.

5.1.8 The ALG shall be installed on the tank in such a way that the variation of the gauge reference length due to movement of the tank shell, bottom or roof is minimized or is compensated for.

5.1.9 Under reference conditions the gauge reference length shall not vary by more than 0.02 % due to changes in liquid head, vapor pressure and loading of roof or platform or may be compensated for(*).

In particular:

- ALG's located on top of the tank shall be mounted on a support pipe of adequate construction if the upper part of the tank shell is lowered by more than 0.02 % of the tank height when completely filling the tank with liquid of a density of 1 000 kg/m^3 or of the upper density of the field of operation, whichever is greater.
- The support pipe shall be fixed in such a way that its vertical movement with reference to the dipping datum point is less than 0.02 % of the measured dip.

5.1.10 If provided, the correction detector shall be situated in such a way that a reliable value is obtained of the properties intended to be measured. If necessary, more than one detector shall be installed in order to obtain a correct average value.

5.1.11 The thermal expansion of the tank shell or, if applicable, the support pipe, shall be such that the total deviation for a temperature change of 10 °C will fall within the maximum permissible errors for the installed ALG, or if necessary compensated for. (Note: this requirement may be verified by calculation). If temperature sensing elements are used to apply corrections to the indication they shall be mounted in such a way that a correct average temperature is obtained. See ISO DIS 4266 and 4268 [1,2].

5.2 Installation requirements specific for ALG's with movable liquid detecting element

ALG's located at eye level shall be attached to a stable point on the tank shell or to the ground by a rigid gauge-head support bracket. Tape conduits shall be aligned to avoid the tape touching the conduit. Conduit brackets shall allow independent tank shell movement (see note to 5.1.9).

6 Additional requirements for electronic automatic level gauges

6.1 General

6.1.1 An electronic ALG shall be designed and manufactured in such a way that, when it is exposed to disturbances, either:

(a) significant faults do not occur, or
(b) significant faults are detected and acted upon.

If a significant fault is detected, a visual or audible indication shall automatically occur and shall continue until the user takes action or the fault is corrected.

The choice whether (a) or (b) is applied is left to the manufacturer.

(*) The effect of filling of some tanks with a liquid can be determined with the formulae given in Annex C (which is only informative) or be carefully determined empirically. The compensation should be limited to the elastic deformation of the tank or the support pipe.

6.1.2 The provisions of 6.1.1 shall be met durably in accordance with the intended use of the instrument.

6.1.3 The provisions in 6.1.1 (a) and (b) may be applied separately to:

(a) each individual cause of significant fault, and/or
(b) each part of the electronic ALG.

6.1.4 A pattern of an electronic instrument is presumed to comply with the requirements in 6.1.1 and 6.1.2 if it passes the tests specified in Annexes A and B.

6.2 Checking facilities

Electronic ALG's shall be provided with the checking facilities specified below.

6.2.1 It shall be possible to determine the presence and correct functioning of the checking facilities.

6.2.2 If the failure of an indicator display element can cause a false indication then the instrument shall have a display test facility which on demand will show all relevant signs of the indicator display in their active and non-active states for a sufficient time to be easily observed by the operator.

6.2.3 At the beginning and at the end of the measurement operation all data storage components shall be checked automatically to verify that the values of all permanently memorized instructions are correct, by such means as:

- summing up of all instruction and data codes and comparing the sum with a fixed value;
- line and column parity bits (LRC and VRC, ISO 2111, [3]);
- cyclic redundancy check (CRC 16, ISO 2111);
- double storage of data, both in the same code;
- double storage of data, second in inverse or shifted coding; or
- storage of data in "safe coding", for example protected by check sum, line and parity bits.

However, it is not mandatory that this check is carried out more frequently than once per minute if the measurement operation occurs automatically.

6.2.4 All relevant measurement data shall be checked for correct value whenever they are transferred or stored internally or transmitted to peripheral equipment by interface, by such means as: parity bit, check sum, independent double storage or other handshake-routine with retransmission.

Note: The use of parity bit alone is not sufficient in case of storing or reading metrological data for an electronic ALG.

7 Metrological controls

7.1 Pattern approval

7.1.1 Application for pattern approval

The application for pattern approval shall include the required number of instruments (generally from 1 to 3) and the following information and documents:

- metrological characteristics including a definition of the field of operation, reference values etc.;
- drawings of general arrangement and details of metrological interest such as interlocks, safeguards, restrictions, limits etc.;
- a short functional description of the instrument;
- a short technical description including, if necessary, schematic diagrams of the method of operation in particular for internal processing and exchange via interface of data and instructions;
- manner of installation;
- all other information of metrological interest.

7.1.2 Pattern evaluation

The submitted documents shall be examined to verify compliance with the requirements of this Recommendation.

Suitable spot-checks shall be performed to establish confidence that the functions are performed correctly in accordance with the submitted documents.

The instruments shall be submitted to the testing procedures of Annex A, and those of Annex B if applicable. Where reference has been made to International Standards and Publications, these should be consulted before conducting the tests.

If testing of the complete instrument is not possible, tests may, as agreed by the approving authority and the applicant, be performed:

- on a simulated set-up;
- on modules or main devices separately.

The approving authority may, in special cases, require the applicant to supply test equipment and personnel to perform the tests.

The pattern evaluation shall generally be carried out in the laboratory of the authority. However it may be feasible to perform tests on other premises. The approving authority may require up to three instruments to be installed on-site for tests under working conditions and an endurance test of three months on an installed instrument. For these tests on site attention should be paid to the characteristics of the liquids that are likely to be measured.

7.2 Initial verification

Initial verification shall be carried out in two stages, as follows.

7.2.1 For the examination and testing of the ALG before installation on the tank (preliminary examination):

- the ALG shall be checked for conformity with the approved pattern. Tests have to be done on accuracy, discrimination and hysteresis (see A.1.2 through A.1.4) to verify compliance with the requirements of clauses 3 and 4. Tests shall be carried out within the conditions of the field of operation.

7.2.2 For the examination of installation and adjustment of the ALG on the tank:

- check that the requirements of 3.3.6, 3.4.4 and 5 are met;
- check that the conditions of the tank match with the characteristics of the field of operation specified according to 3.5.1.

The actual operating conditions shall be checked. If national regulations allow the use of an ALG under conditions outside the rated operating conditions (see 3.6) all necessary information to make the required corrections shall be given to the user.

The ALG shall be adjusted carefully to the correct level with reference to the reference conditions and actual conditions at the moment of adjustment.

The test method shall be in compliance with Annex D. The instrument shall remain within the maximum permissible errors specified for ALG's installed on tanks.

7.2.3 The instrument shall be stamped and sealed in accordance with national regulations.

7.3 Subsequent verification

7.3.1 Periodic verification with a period of validity of 1 year is recommended.

7.3.2 The ALG shall be inspected and examined to establish that it is in correct working order.

7.3.3 Subsequent verification shall be carried out according to 7.2.2.

7.4 Tests

A description of test methods and equipment is given in Annex D.

ANNEX A

TESTING PROCEDURES FOR AUTOMATIC LEVEL GAUGES

(Mandatory)

A.1 Performance tests

A.1.1 General

These tests are carried out on instruments before being installed on a tank.

The equipment under test shall be clean and free of moisture. It shall be mounted and put into operation in accordance with the manufacturer's specifications before the test is started. The EUT shall be in normal operation throughout the test. The EUT shall be thoroughly checked after the termination of each test and sufficient time shall be allowed for recovery.

Tests shall be performed under normal test conditions. When the effect of one factor is being evaluated, all other factors are to be held relatively constant, at a value close to the reference conditions. Reference conditions for this purpose are: 20 °C ± 5 °C, ambient atmospheric pressure, 60 % ± 15 % relative humidity, nominal voltage. The electromagnetic environment of the laboratory shall not influence the test results.

The temperature is considered to be constant when the difference between the extreme temperatures noted during the test does not exceed 5 °C, and the rate of change does not exceed 5 °C per hour.

When subjected to the effect of influence factors as provided for in A.2, the instrument shall continue to operate correctly and the indications shall be within the maximum permissible errors.

A.1.2 Accuracy

Constitute levels rising from zero to a value close to the measuring range and similarly descending. When determining the initial intrinsic error, at least 10 levels shall be selected and for other determinations at least 3 levels shall be selected. From the indications of the ALG the error of the ALG level measurement and of all level differences shall be evaluated by comparison with a certified standard.

A.1.3 Discrimination

Constitute three different levels, equally distributed over the measuring range, rising and descending. From a stable position, the level shall be changed in the same direction with the value of subclause 3.4.3 according to the accuracy class. The change of the indication is noted.

A.1.4 Hysteresis

This test shall be performed at three different levels, equally distributed between the first point of verification and the limit of the measuring range, upper or lower height according to the movement of the ALG.

Starting from a value close to zero, raise the level over a distance of at least 1/5 of the measuring range, allow stabilization and read the indication. Then raise the level further over 1/10 of the measuring range and after that lower the level until the first stabilized level is reached. Again allow stabilization and read the indication. Carry out this sequence two more times, now starting from the previous stabilized level.

Repeat these measurements starting from a value close to the measuring range and proceed inverting the direction of the movements. Evaluate the error.

A.1.5 Instruments with more than one indicating device

If the instrument has more than one indicating device, the indications of the various devices shall be compared during the performance tests and shall comply with 3.4.4.

A.2 Influence factor tests

These tests are intended to ensure that the instrument will perform as intended within the rated operating conditions. These tests are mandatory for any ALG (electronic or not).

A.2.1 Static temperatures

The test consists of exposing the equipment under test (EUT) to constant temperatures for a 2 hour period after the EUT has reached temperature stability.

For the high temperature, 55 °C shall be taken as a general rule, except for devices used indoors for which 40 °C shall be taken, and for special cases(*).

For the low temperature, – 25 °C shall be taken, except for devices used indoors for which + 5 °C shall be taken, and for special cases(**).

The following tests shall be carried out after the two hour period:

- accuracy test according to A.1.2 at three levels: high, middle and low levels;
- discrimination test according to A.1.3 at one level, anywhere within the measuring range;
- hysteresis test according to A.1.4 at one level, anywhere within the measuring range.

The tests shall be carried out in the following sequence:

- at the reference temperature;
- at the specified high temperature;
- at the specified low temperature;
- at the reference temperature.

The change of temperatures shall not exceed 1 °C/min during heating and cooling.

The absolute humidity of the test atmosphere shall not exceed 0.020 kg/m^3, unless the operation manual gives different specifications.

Reference to IEC Publications: see Bibliography [4].

A.2.2 Damp heat, steady state (not applicable to devices used indoors)

This test may be omitted if the damp heat, cyclic test (A.2.3) is extended to 6 cycles.

The test consists of exposing the EUT to a constant temperature of 40 °C and a constant relative humidity of 93 % for a period of 4 days. The handling of the EUT shall be such that no condensation of water occurs on the EUT.

During the 4th day the following tests shall be carried out:

- accuracy test according to A.1.2 at three levels: high, middle and low levels;
- discrimination test according to A.1.3 at one level, anywhere within the measuring range;
- hysteresis test according to A.1.4 at one level, anywhere within the measuring range.

Reference to IEC Publications: see Bibliography [5].

A.2.3 Damp heat, cyclic (not applicable to devices used indoors)

The test consists of exposing the EUT to 2 cycles of temperature variation between 25 °C and 55 °C, maintaining the relative humidity above 95 % during the temperature change and low temperature phases, and at 93 % ± 3 % at the upper temperature phases. Condensation should occur on the EUT during the temperature rise.

During the last phase of low temperature the following tests shall be carried out:

- accuracy test according to A.1.2 at three levels: high, middle and low levels;
- discrimination test according to A.1.3 at one level, anywhere within the measuring range;
- hysteresis test according to A.1.4 at one level, anywhere within the measuring range.

Reference to IEC Publications: see Bibliography [6].

A.2.4 Power voltage variation

a) AC power supply

The test consists of exposing the EUT to a power supply voltage which varies between 110 % of V and 85 % of V, where V is the value marked on the instrument; if a range of voltages (V_{min}, V_{max}) is marked then the test shall be performed at V_{max} + 10 % and V_{min} – 15 %.

(*) For applications in areas where the temperature considerably exceeds 55 °C by solar radiation the test shall be carried out at 85 °C if no measures are taken to avoid such radiation (for example, by insulation or by screening the radiation) at the installation of the ALG.

(**) For application in areas with low temperatures the test shall be carried out at –40 °C.

The frequency variation lies between + 2 % and – 2 % of the nominal frequency of the power network.

Where an instrument is powered by a three phase supply, the voltage variations shall apply for each phase successively.

b) DC power supply

The test consists of exposing the EUT to the limits of the specified power supply conditions.

After stabilization in the stated supply conditions, tests shall be performed on accuracy, discrimination and hysteresis.

All functions shall operate as designed.

ANNEX B

ADDITIONAL TESTS FOR ELECTRONIC INSTRUMENTS

(Mandatory)

B.1 General

The tests shall be performed under constant environmental conditions as mentioned in A.1.1.

Energize the EUT for a time period sufficiently long to reach stability.

Tests shall be performed while the instrument is set to measure a fixed level.

The instrument shall be considered to comply with 6.1 if the difference between the level indication due to the disturbance and the indication without the disturbance either does not exceed 2 mm or the instrument detects and reacts to a significant fault.

B.2 Disturbance tests

B.2.1 Short time power reductions

A test generator capable of reducing the amplitude of one or more half cycles (at zero crossings) of the AC mains voltage shall be used. The test generator shall be adjusted before connecting the EUT. The mains voltage reductions shall be repeated ten times with an interval of at least 10 seconds.

Test severity:	Reduction	100 %	50 %
	Number of half cycles	1	2

B.2.2 Bursts

The test consists of exposing the EUT to specified bursts of voltage spikes.

The test set-up, instrumentation and procedure shall be in compliance with IEC Publication 61000-4-4. See Bibliography [7].

The test shall be applied separately to:

- power supply lines, using the coupling network in common mode and in differential mode interference;
- I/O circuits and communication lines, using the capacitive coupling clamp.

Test severity: level 2

Open circuit output test voltage for:

- power supply lines: 1 kV;
- I/O signal, data and control lines: 0.5 kV.

At least 10 positive and 10 negative, randomly phased bursts shall be applied in each mode as appropriate.

B.2.3 Electrostatic discharge

The test consists of exposing the EUT to specified, direct and indirect, electrostatic discharges. The test set-up, generator and procedure shall be in compliance with IEC Publication 61000-4-2. See Bibliography [8].

For direct discharges the air discharge shall be used where the contact discharge method cannot be applied.

At least 10 direct and 10 indirect discharges shall be applied. The time interval between successive discharges shall be at least 10 seconds.

Test severity: level 4

DC voltage up to and including 8 kV for contact discharges and 15 kV for air discharges.

Indirect discharges: up to and including 8 kV.

It is necessary to consult the referenced IEC Publications before conducting any test.

B.2.4 Radiated, radio frequency, electromagnetic fields

The test consists of exposing the EUT to specified electromagnetic fields in the frequency band of 26 MHz up to and including 1000 MHz.

The test set-up, equipment and procedure shall be in compliance with IEC Publication 61000-4-3. See Bibliography [9]. For tests in the frequency band 26 MHz–80 MHz the alternative method of IEC Publication 61000-4-6 is recommended. See Bibliography [10].

Test severity: level 3

Field strength: 10 V/m.

ANNEX C

DEFORMATION OF TANKS

(Informative)

(See note to 5.1.9)

C.1 Vertical cylindrical tanks

For a vertical cylindrical tank the relative reduction in height of the tank (lowering of the upper part of the tank shell) due to complete filling with a liquid whose density is ρ (kg/m^3) can be calculated(*) using the formula below, where:

$\frac{\Delta H}{H}$ = relative reduction in height (%)

H = height of the tank (m)

D = diameter of the tank (m)

g = gravitational acceleration (m/s^2)

E = modulus of elasticity (N/m^2)

μ = Poisson ratio (non-dimensional)

h_n = height of the nth course from the bottom (m)

w_n = thickness of the nth course from the bottom (mm)

(See also Figure 2).

Note: The Poisson ratio μ is the lateral contraction divided by the elongation (e.g. $\mu_{steel} = 3.3$).

C.2 Horizontal cylindrical tanks

For a horizontal cylindrical tank the effect of complete filling with a liquid can be calculated using formulae which will be developed by ISO/TC 28/SC 3/WG 1.

C.3 Spherical and prismoidal tanks

For spherical and prismoidal tanks the effect of complete filling with a liquid can be calculated using formulae which will be developed by ISO/TC 28/SC 5/WG 1.

$$\frac{\Delta H}{H} = \frac{D\rho g}{4\mu E}\left[\frac{H}{w_1} + \frac{(H-h_1)^2}{H}\left(\frac{1}{w_2} - \frac{1}{w_1}\right) + \frac{(H-h_1-h_2)^2}{H}\left(\frac{1}{w_3} - \frac{1}{w_2}\right) + \right.$$

$$\left. \ldots\ \ldots + \frac{(H-(h_1+h_2+\ldots+h_{n-1}))^2}{H}\left(\frac{1}{w_n} - \frac{1}{w_{n-1}}\right)\right]$$

(*) Sometimes the real behavior of tanks differs from the formula. In field tests some tanks have shown no measurable reduction while others have shown significant variations.

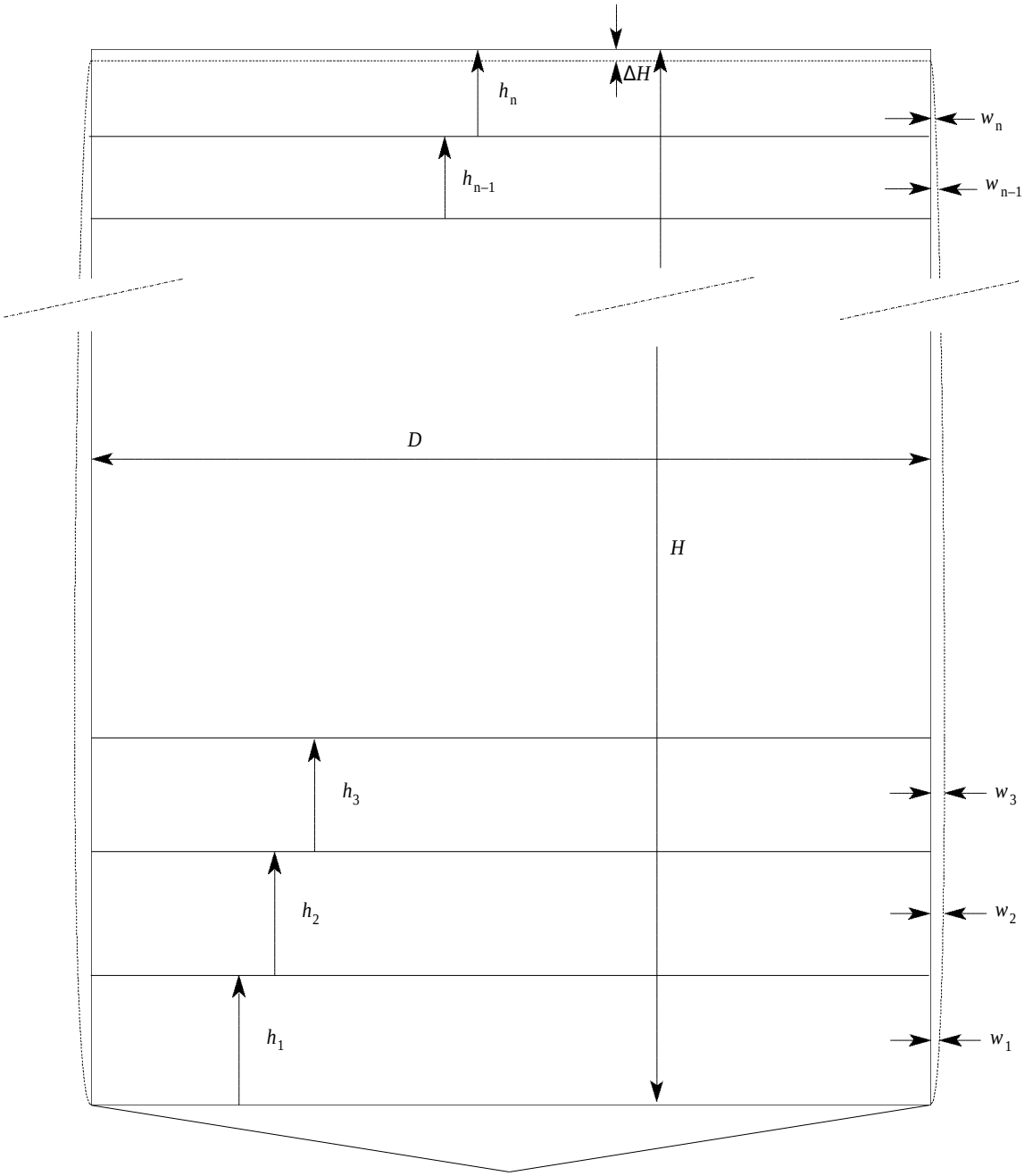

Figure 2 Deformation of tanks

ANNEX D

EQUIPMENT AND TEST METHODS

(Mandatory)

Equipment:

- a certified measuring tape with correction table in compliance with ISO DIS 4512 [11];
- a certified temperature sensing element with an accuracy within 0.1 °C.

Test methods:

- in dipping in accordance with ISO DIS 4512 [11] and ISO DIS 4266 [1];
- the total reference height measurement at installation in accordance with ISO DIS 7507-1 [12].

Automatic level gauges for measuring the level of liquid in fixed storage tanks

Part 2: Test report format

ANNEX E

Note: This *Test report format* is informative with regard to the implementation of this Recommendation in national regulations; however, in the framework of the *OIML Certificate System for Measuring Instruments*, use of the *Test report format* is mandatory.

This *Test report format* presents a standardized format for the results of the various tests and examinations to which a pattern of an automatic level gauge shall be submitted with a view to its approval.

It is recommended that all metrology services or laboratories evaluating patterns of automatic level gauges according to OIML R 85 or to national or regional regulations based on OIML R 85 use this *Test report format*, directly or after translation into a language other than English or French.

It is also recommended that this *Test report format* in English or in French (or in both languages) be transmitted by the country performing the tests to the relevant authorities of another country, under bi- or multi-lateral cooperation agreements.

General information concerning the pattern

Manufacturer’s trade mark/corporate name	
Type	electronic / non-electronic
Liquid level detecting element	static / movable
Model number	
Serial number	
Pattern approval sign	
Accuracy class designation	

Applicant	
Representative	
Address	
Reference	
Date of application	

Test laboratory	
Application number	
Test started at date	Test finished at date

Summary of tests

Serial number: ..... Observer: .....

Date/time: .....

Subclause	Test	+	−	Remarks	Page
E.1	Constituents (3.1)				
E.2	Materials (3.2)				
E.3	Indicating device (3.3)				
E.4	Printers (3.3.8)				
E.5	Field of operation (3.5.1)				
E.6	Special conditions (3.6)				
E.7	Ancillary devices (3.7)				
E.8	Markings (3.8.1)				
E.9	Verification marks (3.9)				
E.10	Sealing (3.10)				
E.11.1	Accuracy (A.1.2)				
E.11.2	Discrimination (A.1.3)				
E.11.3	Hysteresis (A.1.4)				
E.12.1	Static temperatures (A.2.1)				
E.12.1.1	Reference temperature				
	Accuracy				
	Discrimination				
	Hysteresis				
E.12.1.2	High temperature				
	Accuracy				
	Discrimination				
	Hysteresis				
E.12.1.3	Low temperature				
	Accuracy				
	Discrimination				
	Hysteresis				
E.12.1.4	Reference temperature				
	Accuracy				
	Discrimination				
	Hysteresis				
E.12.2	Damp heat, steady state (A.2.2)				
	Accuracy				
	Discrimination				
	Hysteresis				

Subclause	Test	+	−	Remarks	Page
E.12.3	Damp heat, cyclic (A.2.3)				
	Accuracy				
	Discrimination				
	Hysteresis				
E.12.4	Power voltage and frequency variation (A.2.4)				
E.12.4.1	High voltage				
	Accuracy				
	Discrimination				
	Hysteresis				
E.12.4.2	Low voltage				
	Accuracy				
	Discrimination				
	Hysteresis				
E.12.4.3	High frequency				
	Accuracy				
	Discrimination				
	Hysteresis				
E.12.4.4	Low frequency				
	Accuracy				
	Discrimination				
	Hysteresis				
	Electronic instruments				
E.13.1	Short time power reductions (B.2.1)				
E.13.2	Bursts (B.2.2)				
E.13.3	Electrostatic discharge (B.2.3)				
E.13.4	Radiated, radio frequency, electromagnetic fields (B.2.4)				

OVERALL RESULT	

Remarks:

E.1 Constituents (3.1)

Detecting element	
Transmitter	
Correction detector	
Indicating device(s)	
Printer	
Ancillary devices	
Checking facilities	

E.2 Materials (3.2)

E.3 Indicating device (3.3)

Subclause	Performance tests and requirements of OIML R 85	Remarks	+	–
3.3.1	Unit of measurement	SI		
3.3.1	Default display of	dip/ullage		
3.3.1	Symbol or name of unit present			
3.3.1	Display additional information possible? Non confusing?			
3.3.2	Scale interval (mm)	analogue/digital		
3.3.3	Scale spacing (analogue only) (mm)			
3.3.4	Number of indicating devices			
3.3.5	Common indicating device			
3.3.6	Remote indication duly identified			
3.3.7	Both dip and ullage available			

Remarks:

E.4 Printer (3.3.8)

Subclause	Performance tests and requirements of OIML R 85	Remarks	+	–
3.3.1	Unit of measurement	SI		
3.3.1	Default display of	dip/ullage		
3.3.1	Symbol or name of unit present			
3.3.1	Display additional information possible? Non confusing?			
3.3.2	Scale interval (mm)	analogue/digital		
3.3.3	Scale spacing (analogue only) (mm)			
3.3.4	Number of printers			
3.3.5	Common printer			
3.3.6	Remote printer duly identified			
3.3.7	Both dip and ullage available			

E.5 Field of operation (3.5.1)

Liquid temperature extreme values	
Pressure extreme values	
Liquid characteristics	
Liquid density extreme values	
Medium characteristics	
Medium density extreme values	

E.6 Special conditions (3.6)

Remarks:

E.7 Ancillary devices (3.7)

Description	Remarks	+	–

E.8 Markings (3.8.1)

	Marking	+	–
Location of the markings			
Name of the manufacturer			
Serial number			
Pattern approval sign			
Accuracy class designation			
Ranges defining the field of operation (ref. 3.5.1)			
Additional information (if required)			

E.9 Verification marks (3.9)

	Remarks	+	–
Location			
Fit for easy application			
Impossible to remove without damage			

E.10 Sealing (3.10)

	Remarks	+	–
Data plate			
Other components			
Impossible to remove without damage			

Remarks:

E.11 Performance tests

E.11.1 Accuracy (A.1.2)

Serial number:	Accuracy class:	Observer:
Temperature C	Begin:	End:
Relative humidity % RH		
Pressure hPa		
Date/time:		

Observations in mm: upwards

Level	Indication	Error	Diff.	mpe	+	−

Maximum differences mm

Levels	Diff.	mpe	Levels	Diff.	mpe	+	−

Remarks:

E.11.1 Accuracy (*cont'd*)

Observations in mm: downwards

Level	Indication	Error	Diff.	mpe	+	−

Maximum differences mm

Levels	Diff.	mpe	Levels	Diff.	mpe	+	−

Remarks:

E.11.2 Discrimination (A.1.3)

Discrimination	Level	Indication	Level change	Indication change	+	−
Upwards						
Downwards						

E.11.3 Hysteresis (A.1.4)

Upwards	Level 1	Level 2	Level 3	Maximum hysteresis	mpe	+	−
Level up				/	/	/	/
Indication				/	/	/	/
Level down				/	/	/	/
Indication				/	/	/	/
Hysteresis							

Downwards	Level 1	Level 2	Level 3	Maximum hysteresis	mpe	+	−
Level down				/	/	/	/
Indication				/	/	/	/
Level up				/	/	/	/
Indication				/	/	/	/
Hysteresis							

Remarks:

E.12 Influence factor tests

E.12.1 Static temperatures (A.2.1)

Serial number:	Accuracy class:	Observer:
Pressure hPa	Begin:	End:
Date/time:	Begin:	End:

E.12.1.1 Reference temperature

Accuracy

Time:	Temperature:	Humidity:					
	Level	Indication	Error	Diff.	mpe	+	−
Upwards							
Downwards							
Time:	Temperature:	Humidity:					

Discrimination

	Begin	Time:	Temperature:	Humidity:		
	Level	Indication	Level change	Indication change	+	−
Upwards						
Downwards						
	End	Time:	Temperature:	Humidity:		

Hysteresis

	Begin	Time:	Temperature:		Humidity:
Upwards	Level	Hysteresis	mpe	+	−
Level up					
Indication					
Level down					
Indication					
Downwards	Level	Hysteresis	mpe	+	−
Level down					
Indication					
Level up					
Indication					
	End	Time:	Temperature:		Humidity:

Remarks:

E.12.1.2 High temperature

Accuracy

Time:	Temperature:	Humidity:					
	Level	Indication	Error	Diff.	mpe	+	−
Upwards							
Downwards							
Time:	Temperature:	Humidity:					

Discrimination

	Begin	Time:	Temperature:	Humidity:		
	Level	Indication	Level change	Indication change	+	−
Upwards						
Downwards						
	End	Time:	Temperature:	Humidity:		

Hysteresis

	Begin	Time:	Temperature:		Humidity:
Upwards	Level	Hysteresis	mpe	+	−
Level up					
Indication					
Level down					
Indication					
Downwards	Level	Hysteresis	mpe	+	−
Level down					
Indication					
Level up					
Indication					
	End	Time:	Temperature:		Humidity:

Remarks:

E.12.1.3 Low temperature

Accuracy

Time:	Temperature:	Humidity:					
	Level	Indication	Error	Diff.	mpe	+	−
Upwards							
Downwards							
Time:	Temperature:	Humidity:					

Discrimination

	Begin	Time:	Temperature:	Humidity:		
	Level	Indication	Level change	Indication change	+	−
Upwards						
Downwards						
	End	Time:	Temperature:	Humidity:		

Hysteresis

	Begin	Time:	Temperature:		Humidity:
Upwards	Level	Hysteresis	mpe	+	−
Level up					
Indication					
Level down					
Indication					
Downwards	Level	Hysteresis	mpe	+	−
Level down					
Indication					
Level up					
Indication					
	End	Time:	Temperature:		Humidity:

Remarks:

E.12.1.4 Reference temperature

Accuracy

Time:	Temperature:	Humidity:					
	Level	Indication	Error	Diff.	mpe	+	−
Upwards							
Downwards							
Time:	Temperature:	Humidity:					

Discrimination

	Begin	Time:	Temperature:	Humidity:		
	Level	Indication	Level change	Indication change	+	−
Upwards						
Downwards						
	End	Time:	Temperature:	Humidity:		

Hysteresis

	Begin	Time:	Temperature:		Humidity:
Upwards	Level	Hysteresis	mpe	+	−
Level up					
Indication					
Level down					
Indication					
Downwards	Level	Hysteresis	mpe	+	−
Level down					
Indication					
Level up					
Indication					
	End	Time:	Temperature:		Humidity:

Remarks:

E.12.2 Damp heat, steady state (A.2.2)

Exposure of the EUT		
Temperature C	Begin:	End:
Relative humidity % RH		
Pressure hPa		
Date/time:		

Accuracy

Time:	Temperature:	Humidity:					
	Level	Indication	Error	Diff.	mpe	+	−
Upwards							
Downwards							
Time:	Temperature:	Humidity:					

Discrimination

	Begin	Time:	Temperature:	Humidity:		
	Level	Indication	Level change	Indication change	+	−
Upwards						
Downwards						
	End	Time:	Temperature:	Humidity:		

Hysteresis

	Begin	Time:	Temperature:		Humidity:
Upwards	Level	Hysteresis	mpe	+	−
Level up					
Indication					
Level down					
Indication					
Downwards	Level	Hysteresis	mpe	+	−
Level down					
Indication					
Level up					
Indication					
	End	Time:	Temperature:		Humidity:

Remarks:

E.12.3 Damp heat, cyclic (A.2.3)

E.12.3.1 Exposure

Cycle no.	Time	Temp. low C	Humidity % RH	Time	Temp. high C	Humidity % RH
1						
2						
3						
4						
5						
6						

E.12.3.2 Test

Accuracy

Time:	Temperature:	Humidity:					
	Level	Indication	Error	Diff.	mpe	+	−
Upwards							
Downwards							
Time:	Temperature:	Humidity:					

Discrimination

	Begin	Time:	Temperature:	Humidity:		
	Level	Indication	Level change	Indication change	+	−
Upwards						
Downwards						
	End	Time:	Temperature:	Humidity:		

Hysteresis

	Begin	Time:	Temperature:		Humidity:
Upwards	Level	Hysteresis	mpe	+	−
Level up					
Indication					
Level down					
Indication					
Downwards	Level	Hysteresis	mpe	+	−
Level down					
Indication					
Level up					
Indication					
	End	Time:	Temperature:		Humidity:

Remarks:

E.12.4 Power voltage and frequency variation (A.2.4)

Power supply: AC/DC

Marked value: V

Nominal frequency: ..... Hz

E.12.4.1 High voltage: V

Accuracy

Time:	Temperature:	Humidity:					
	Level	Indication	Error	Diff.	mpe	+	−
Upwards							
Downwards							
Time:	Temperature:	Humidity:					

Discrimination

	Begin	Time:	Temperature:	Humidity:		
	Level	Indication	Level change	Indication change	+	−
Upwards						
Downwards						
	End	Time:	Temperature:	Humidity:		

Hysteresis

	Begin	Time:	Temperature:		Humidity:
Upwards	Level	Hysteresis	mpe	+	−
Level up					
Indication					
Level down					
Indication					
Downwards	Level	Hysteresis	mpe	+	−
Level down					
Indication					
Level up					
Indication					
	End	Time:	Temperature:		Humidity:

Remarks:

E.12.4.2 Low voltage: V

Accuracy

Time:	Temperature:	Humidity:					
	Level	Indication	Error	Diff.	mpe	+	−
Upwards							
Downwards							
Time:	Temperature:	Humidity:					

Discrimination

	Begin	Time:	Temperature:	Humidity:		
	Level	Indication	Level change	Indication change	+	−
Upwards						
Downwards						
	End	Time:	Temperature:	Humidity:		

Hysteresis

	Begin	Time:	Temperature:		Humidity:
Upwards	Level	Hysteresis	mpe	+	−
Level up					
Indication					
Level down					
Indication					
Downwards	Level	Hysteresis	mpe	+	−
Level down					
Indication					
Level up					
Indication					
	End	Time:	Temperature:		Humidity:

Remarks:

E.12.4.3 High frequency: ..... Hz

Accuracy

Time:	Temperature:	Humidity:					
	Level	Indication	Error	Diff.	mpe	+	−
Upwards							
Downwards							
Time:	Temperature:	Humidity:					

Discrimination

	Begin	Time:	Temperature:	Humidity:		
	Level	Indication	Level change	Indication change	+	−
Upwards						
Downwards						
	End	Time:	Temperature:	Humidity:		

Hysteresis

	Begin	Time:	Temperature:		Humidity:
Upwards	Level	Hysteresis	mpe	+	−
Level up					
Indication					
Level down					
Indication					
Downwards	Level	Hysteresis	mpe	+	−
Level down					
Indication					
Level up					
Indication					
	End	Time:	Temperature:		Humidity:

Remarks:

E.12.4.4 Low frequency: ..... Hz

Accuracy

Time:	Temperature:	Humidity:					
	Level	Indication	Error	Diff.	mpe	+	−
Upwards							
Downwards							
Time:	Temperature:	Humidity:					

Discrimination

	Begin	Time:	Temperature:	Humidity:		
	Level	Indication	Level change	Indication change	+	−
Upwards						
Downwards						
	End	Time:	Temperature:	Humidity:		

Hysteresis

	Begin	Time:	Temperature:		Humidity:
Upwards	Level	Hysteresis	mpe	+	−
Level up					
Indication					
Level down					
Indication					
Downwards	Level	Hysteresis	mpe	+	−
Level down					
Indication					
Level up					
Indication					
	End	Time:	Temperature:		Humidity:

Remarks:

E.13 Additional tests for electronic instruments

E.13.1 Short time power reductions (B.2.1)

Serial number:	Accuracy class:	Observer:
Temperature C	Begin:	End:
Relative humidity % RH		
Pressure hPa		
Date/time:		

Level mm	(1) Indication mm	Reduction %	(2) Indication mm	(2-1) Fault mm	+	−
		100				
		50				

Remarks:

E.13.2 Bursts (B.2.2)

Serial number:	Accuracy class:	Observer:
Temperature C	Begin:	End:
Relative humidity % RH		
Pressure hPa		
Date/time:		

	Level	Indication
Initial measurement		
Final measurement		

Line under test (Description)	Severity kV	Polarity +/−	Exposure time s	Indication	Fault	+	−

Remarks:

E.13.3 Electrostatic discharge (B.2.3)

Serial number:	Accuracy class:	Observer:
Temperature C	Begin:	End:
Relative humidity % RH		
Pressure hPa		
Date/time:		

	Level	Indication
Initial measurement		
Final measurement		

Air/contact discharge applied on:	Severity kV	Polarity +/−	Number of discharges	Indication	Fault	+	−

Remarks:

E.13.4 Radiated, radio frequency, electromagnetic fields (B.2.4)

Serial number:	Accuracy class:	Observer:
Temperature C	Begin:	End:
Relative humidity % RH		
Pressure hPa		
Date/time:		

	Level	Indication
Initial measurement		
Final measurement		

Frequency MHz	Field strength V/m	Indication	Fault	+	–

Remarks:

BIBLIOGRAPHY

Full titles of International Standards referred to in the text of this Recommendation.

[1] ISO DIS 4266

Petroleum and liquid petroleum products - Direct measurement of temperature and level in storage tanks - Automatic methods.

[2] ISO DIS 4268

Petroleum and liquid petroleum products - Temperature measurement - Excluding averaging thermometers.

[3] ISO 2111 (1985)

Data communication - Basic mode control procedures - Code independent information transfer.

[4] IEC 60068-2-1 (1990)

Basic environmental testing procedures, Part 2: Tests, Test Ad: Cold, for heat dissipating equipment under test (EUT), with gradual change of temperature. Plus Supplement A (1976).

IEC 60068-2-2 (1974)

Basic environmental testing procedures, Part 2: Tests, Test Bd: Dry heat, for heat dissipating equipment under test (EUT) with gradual change of temperature.

IEC 60068-3-1 (1974)

Background information, Section 1: Cold and dry heat tests. Plus Supplement (1978).

[5] IEC 60068-2-3 (1969)

Basic environmental testing procedures, Part 2: Tests, Test Ca: Damp heat, steady state.

IEC 60068-2-28 (1990)

Guidance for damp heat tests.

[6] IEC 60068-2-30 (1980)

Basic environmental testing procedures, Part 2: Tests, Test Db: Damp heat, cyclic (12 h + 12 h cycle), test variant 1.

IEC 60068-2-28 (1990)

Guidance for damp heat tests.

[7] IEC 61000-4-4 (1995)

Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test.

[8] IEC 61000-4-2 (1995)

Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques - Section 2: Electrostatic discharge immunity test.

[9] IEC 61000-4-3 (1995)

Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques - Section 3: Radiated, radio- frequency, electromagnetic field immunity test.

[10] IEC 61000-4-6 (1996)

Electromagnetic compatibility (EMC). Part 4: Testing and measurement techniques - Section 6: Immunity to conducted disturbances induced by radio-frequency fields.

[11] ISO DIS 4512

Petroleum and liquid petroleum products - Equipment -Tank gauging and calibration - Manual methods.

[12] ISO 7507 (1993)

Petroleum and liquid petroleum products - Volumetric calibration of vertical cylindrical tanks.

Part 1: Strapping method.
Part 2: Optical reference line method.
Part 3: Optical triangulation method.
Part 4: Electro-optical distance ranging internal method.

International Vocabulary of Basic and General Terms in Metrology (VIM), Second edition, 1993.

Vocabulary of Legal Metrology (VML), 1978 (being revised).

ALPHABETICAL LIST OF DEFINED TERMS

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130, rue Général-de-Gaulle, 10000 Troyes