COMMITTEE DRAFT OIML R 85 CD2

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OIML TC8 / SC1 / WG2

Title: Second Committee Draft
Revision OIML International Recommendation R85

Secretariat:
TC8/SC1: Austria/Germany
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[X] discussion at (date and place of meeting): .....

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[ ] vote (P-members only) and comments by

TITLE OF THE CD (English):
Revision OIML R 85
Automatic level gauges for measuring the level of liquid in fixed storage tanks
Part 1: Metrological and technical requirements
Part 2: Metrological Control and tests
Part 3: Test report format

TITLE OF THE CD (French):
Révision OIML R 85
Jaugeurs automatiques pour le mesurage des niveaux de liquide dans les réservoirs de stockage fixes
Partie 1: Exigences métrologiques et techniques
Partie 2: Contrôles métrologiques et essais
Partie 2: Format du rapport d'essai

Original version in: English

Explanatory note

[Will be deleted in the final text]

As part of an inquiry from 4th July 2000 the secretariat of OIML TC8/SC1 (Austria) investigated the need for revision of OIML Recommendation R71, Edition 1985.

From this inquiry it could be concluded that a majority of the voters was in favour for the confirmation of this Recommendation. A revision should not to be necessary. However, further action should be taken considering the inclusion of OIML R71 in the OIML Certificate System.

To submit a category of measuring instruments to the OIML Certificate System, the Recommendation concerned must contain the following elements: metrological requirements, test procedures and a format for the test report. The metrological requirements should already be fixed in the existing Recommendation R71. A working group should be established to develop the test procedures and the test report format.

To establish the working group a TC8/SC1 meeting was held on 30 and 31 October 2003 in Vienna. 6 P-Member countries and 1 O-Member country attended this meeting.

Contrary to the outcome of the inquiry in 2000 the delegates attending the meeting in Vienna advised the P-Members to re-consider there voting and to agree with the terms of reference of a new working group OIML TC8/SC1/WG2, convened by the Netherlands (Mr. Aart Kooiman), i.e.
Revision of OIML R71, in connection with R85;
Revision of OIML R85, and the implementation of automatic calculation of volume and/or converted volume and/or mass.
With respect to R71 the development of test procedures and a test report format would be not necessary. So, only the first verification shall be performed.

On 19 January 2004 the secretariat OIML TC8/SC1 sent out an enquiry to P-, O- and liaison Members of TC8/SC1, as well as BIML, for agreement of the decisions made in Vienna.

On 22 March 2004 the secretariat OIML TC8/SC1 informed the P-, O- and liaison Members of TC8/SC1, as well as BIML, about the outcome of this enquiry. It was agreed by 11 out of 12 votes to accept the terms of reference of OIML TC8/SC1/WG2 “Revision of OIML R71 and R85” and the working group could start work.

The first meeting took place from 14 – 17 June 2004 in Delft (The Netherlands). During this meeting the work program was presented. The first task would be to prepare revised documents for OIML R71 and R85, fully in accordance with the terms of reference of the working group.

Because there is a need for developing provisions for automatic calculation of volume and/or converted volume and/or mass based on an automatic level measurement and the tank table the working group proposes to develop a new OIML Recommendation “Measuring systems for the volume of liquids in fixed storage tanks”.

Moreover there is a need for an OIML Recommendation concerning Hybrid Tank Measuring Systems. The working group proposes the development of a new OIML Recommendation “Hybrid Tank Measuring Systems for determination of volume, density and mass of liquid and liquefied hydrocarbons and liquid chemicals in vertical cylindrical fixed storage tanks”.

During the OIML TC8/SC1 meeting in Vienna to be held on 21 and 22 April 2005 the working group will ask for permission to develop these two new Recommendations.

End of September 2004 the second working draft for revision of OIML R 85 was sent for comments by 1 November 2004 to the working group members. This working draft contains the decisions made on the first working draft during the WG meeting in Delft.

A first Committee Draft on OIML R 85 has been distributed to P-, O- and liaison Members on 13 January 2005. These Members being requested to send their comments and urgent matters for discussion during the TC8/SC1 meeting in Vienna not later than 15 April 2005.
The chairman of the working group, together with the secretariat TC8/SC1, made a selection of these urgent matters. And these were discussed on 21 and 22 April 2005 in Vienna.

During that meeting in Vienna, it was also discussed to start the work on 2 other projects:
* Measuring Systems for the volume of liquids in fixed storage tanks
* Hybrid Tank Measuring Systems for determination of volume, density and mass of liquefied hydrocarbons in vertical cylindrical fixed storage tanks.

These projects could either been regarded as a logical extension of the revision of R 71 and R 85 (within the scope of these existing projects) or as 2 new projects of TC8/SC1.
Further communication with the BIML resulted in the decision that these are to be considered as 2 new projects. So, in accordance with the Directives for the Technical Work - Part 1, the Subcommittee first has to make a proposal to the CIML. After being accepted by CIML, the Subcommittee (or its Working Group) can formally start this work.

The comments made in that meeting are implemented in the second Committee Draft, and superfluous definitions have been deleted. The consistency between the definitions and the text has been improved.
Furthermore, this draft has been brought in better compliance with the OIML Directives for the Technical Work, Part 2, in particular clause 3 and 4, and with the horizontal document OIML D 11. Doing so, the secretary of TC8/SC1/WG2 observed that there were many more changes to make in Part 2 (in particular with respect to the proper implementation of OIML D 11).
In particular, both the concepts of “Checking Facilities” (the checking facilities as mentioned in OIML D 11, as well as the facilities checking the integrity of data storage and data communication) have been combined. See definition 3.9 and sub clause 7.8.
In this respect, it should be emphasized that the application of the checking facilities intended to prevent significant faults are not mandatory: the choice to apply these is clearly left to the manufacturer (see 7.8.2.3).
The extensive rearrangement of the chapters made it not practical to distribute a marked version of the draft. Some aspects to be discussed in particular, are marked in yellow.
In this stage, the authors mainly focused on the requirements for ALG’s (Part 1) as these should be agreed on before going into detail about the Parts 2 and 3.

Contents:

Foreword

The International Organization of Legal Metrology (OIML) is a worldwide, intergovernmental organization whose primary aim is to harmonize the regulations and metrological controls applied by the national metrological services, or related organizations, of its Member States. The two main categories of OIML publications are:

• **International Recommendations (OIML R**),which are model regulations that establish the metrological characteristics required of certain measuring instruments and which specify methods and equipment for checking their conformity; the OIML Member States shall implement these Recommendations to the greatest possible extent;

• **International Documents (OIML D**), which are informative in nature and intended to improve the work of the metrological services.

OIML Draft Recommendations and Documents are developed by technical committees or subcommittees which are formed by the Member States. Certain international and regional institutions also participate on a consultation basis.

Cooperative agreements are established between OIML and certain institutions, such as ISO and IEC, with the objective of avoiding contradictory requirements; consequently, manufacturers and users of measuring instruments, test laboratories, etc. may apply simultaneously OIML publications and those of other institutions.

International Recommendations and International Documents are published in French (F) and English (E)and are subject to periodic revision.

This publication – reference OIML R 85, edition XXXX (E) – was developed by the OIML Technical Subcommittee TC 8/SC 1 *Static volume measurement*. It was approved for final publication by the International Committee of Legal Metrology in XXXX and will be submitted to the International Conference of Legal Metrology in ..... for formal sanction. It supersedes the previous edition dated 1998.

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PART 1 Metrological and technical requirements

1 Introduction

[In the final text, this will be an excerpt of the present Explanatory Note.]

2 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. These requirements concern:

- tanks at atmospheric pressure;
- pressurized tanks;
- cooled tanks;
- heated tanks

The metrological purpose of tank level measurements is the application in conjunction with tank calibration tables for the determination of liquid volume received from, delivered to or contained in stationary storage tanks.
[Should we add the possibility of tanks of a defined geometrical shape like a mathematical accurate sphere or cylinder, without the application of a calibration table for the tank ?? To be discussed]

3 Terminology

The terminology used in this Recommendation conforms to the *International Vocabulary of Basic and General Terms in Metrology* (VIM) [1], to the *International Vocabulary of Terms in Legal Metrology* (VIML) [2], and to OIML D 11 *General Requirements for electronic measuring instruments* [3]. In addition, for the purposes of this Recommendation, the following definitions apply:

3.1 Automatic level gauge

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

An automatic level gauge includes at least a liquid level detecting element, a transducer, if applicable, and an indicating device.

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

3.2 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.

3.3 Ancillary device

A device intended to perform a particular function, directly involved in elaborating, transmitting or displaying measurement results.
Examples:

- repeating indicating device
- printing device
- memory device
- conversion device

3.4 Liquid level detecting element
An element that senses the presence of the liquid surface and gives information on its level.

3.5 Transducer
A device that provides an output quantity, having a determined relationship to the input quantity.

3.6 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.

3.7 Calculator
A part of the ALG that receives the output signals from the measuring device(s) and, if applicable, from ancillary devices and/or other devices, processes them and, if appropriate, stores in memory the results until they are used. In addition, the calculator may be capable of communicating both ways with other devices

3.8 Indicating device
A part of the ALG that 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).

3.9 Checking facility
A facility incorporated in an electronic automatic level gauge that enables:
* significant faults and/or
* incorrect functioning of a specific device of the ALG and/or
* disturbed communication between specific devices of the ALG
to be detected and acted upon.
Note: «Acted upon» refers to any adequate response by the measuring instrument (luminous signal, acoustic signal, prevention of the measurement process, etc.).

3.10 Automatic checking facility
Checking facility that operates without the intervention of an operator.

3.11 Permanent automatic checking facility (type P)
Automatic checking facility that operates at each measurement cycle.

3.12 Intermittent automatic checking facility (type I)
Automatic checking facility that operates at certain time intervals or per fixed number of measurement cycles.

3.13 Non-automatic checking facility (type N)
Checking facility that requires the intervention of an operator.

3.14 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.

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

3.16 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).

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

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

Note: The term “innage” is synonymous.

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

Note: The term “outage” is synonymous.

3.20 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
Note: The rated operating conditions generally specifies intervals of values for the quantity being measured and for any influence quantity.

3.21 Reference conditions
A set of specified values of influence factors fixed to ensure valid inter comparisons of the results of measurements
Note: Reference conditions generally specify intervals of values for any influence quantity.

3.22 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 .

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

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

3.25 Performance
The ability of the ALG to accomplish the intended functions.

3.26 Durability
The ability of the ALG to maintain its performance characteristics over a period of use.
Remark: - subsequence verification is necessary.

3.27 Error (of indication)
The indication of an ALG minus a true value of the corresponding input quantity

3.28 Maximum permissible error
The extreme permitted value by the present Recommendation for the error of indication.

3.29 Intrinsic error
The error of an ALG determined under reference conditions

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

3.31 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 ALG.

3.32 Significant fault
A fault greater than the maximum permissible error specified in Table 1 (see 6.2.1).

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.

3.33 Discrimination
The largest change in a stimulus that produces no detectable change in the response of a measuring instrument, the change in the stimulus taking place slowly and monotonically

3.34 Abbreviations

AC	Alternating Current
ALG	Automatic Level Gauge
AM	Amplitude Modulation
ASD	Acceleration Spectral Density
DC	Direct Current
EM	Electromagnetic
EMC	Electromagnetic Compatibility
e.m.f.	electromotive force
ESD	Electrostatic Discharge
EUT	Equipment Under Test
GSM	Global System for Mobile communication
IEC	International Electrotechnical Committee
I/O	Input / Output (refers to ports)
ISO	International Organization for Standardization
MPE	Maximum Permissible Error
N.A.	Not Applicable
OIML	International Organization of Legal Metrology
RH	Relative Humidity
RMS	Root Mean Square
T.	Number of the test (in Part 3)

4 Description of the category of instrument

An automatic level gauge (ALG) comprises at least a liquid-level detecting element, a transducer, and an indicating device.

The general configuration of an automatic level gauge is given in Figure 1:

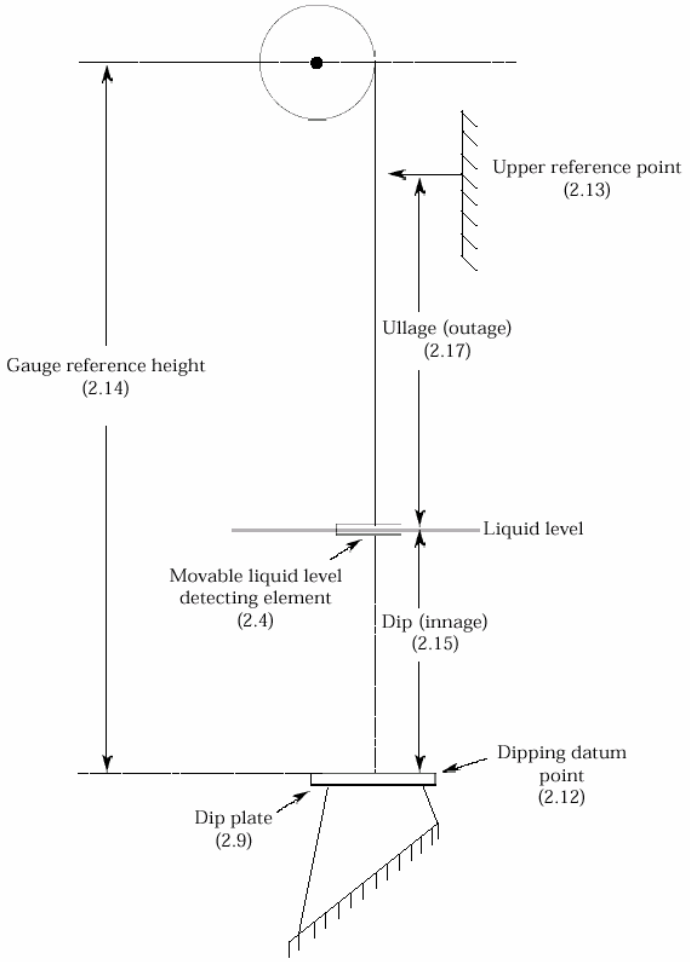

Figure 1

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

5 Units of measurement

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.

6 Metrological requirements

6.1 Rated operating conditions

Automatic level gauges shall be designed and manufactured such that their errors do not exceed the maximum permissible errors under the following rated operating conditions:

<table>
<tr><td rowspan="2">a)</td><td rowspan="2">Temperature</td><td>low</td><td>+ 5 °C, - 10 °C, or - 25 ° C (**)</td></tr>
<tr><td>high</td><td>+ 30 °C, + 40 °C, or + 55 °C (**)</td></tr>
<tr><td>b)</td><td>Humidity</td><td colspan="2">up to 93% RH</td></tr>
<tr><td>c)</td><td>DC mains voltage (*)</td><td colspan="2">As specified by the manufacturer</td></tr>
<tr><td>d)</td><td>AC mains voltage (*)</td><td colspan="2">U_{nom} - 15 % to U_{nom} + 10 %</td></tr>
<tr><td>e)</td><td colspan="2">The minimum and maximum temperatures of the liquid and the medium above the liquid</td><td rowspan="4">As specified by the manufacturer</td></tr>
<tr><td></td><td colspan="2">The minimum and maximum pressures in the tank</td></tr>
<tr><td>f)</td><td colspan="2">The characteristics of the liquid and of the medium above the liquid</td></tr>
<tr><td>g)</td><td colspan="2">The minimum and maximum densities of the liquid and of the medium above the liquid</td></tr>
<tr><td colspan="4">(*) Whatever is applicable
(**) This value is to be decided by the national authority as it depends on the climatic conditions and the expected conditions of application (indoors, outdoors, etc.) that are different in different countries.</td></tr>
</table>

6.2 Maximum permissible errors

6.2.1 The maximum permissible errors, positive and negative, under rated operating conditions to be applied for the relevant indications as referred to in 6.2.1.1 and in the situations of 6.2.1.2 shall be taken from the values of Table 1.

Table 1

Description	Maximum Permissible Error
ALG stand alone	1 mm
After installation	4 mm

6.2.1.1 The maximum permissible errors of Table 1 apply to the inventory of the indication of a dip or an ullage according to the measuring principle of the ALG;

The hysteresis error when changing the direction of the movement of the level shall not exceed 1 mm.

6.2.1.2 The MPE for the "ALG stand alone" applies to the ALG itself, before being installed on the tank, for type approval and for initial verification.
The MPE "after installation" applies to the ALG after installation on the storage tank, for initial and subsequent verification.

6.2.3 The discrimination of the ALG itself shall be such that level measurements are in all cases within 1 mm.

6.2.4 If an ALG gives more than one indication and/or printout, each indication shall comply with the applicable maximum permissible error of 6.2.1. In addition, the difference between any two of them shall not be greater than 1 mm resp. 1 scale interval* under stable level conditions. ** in case the scale intervals differ: the greater one.*

6.3 Presumption of compliance

An automatic level gauge is presumed to comply with the provisions in 6.1 and 6.2 if it passes the relevant examination and tests specified in Part 2 of this Recommendation.
[In a later stage, the word "relevant" is to be replaced by an exact reference to these "relevant" tests in Part 2.]

7 Technical requirements

7.1 Indicating device

7.1.1 For an analogue indication, the distance between successive marks on the scale shall be not less than 1 mm.

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

Other indicating devices, not to be used for Custody Transfer, may be connected, provided these are clearly marked as such. However, national legislation may prohibit this

7.1.3 An additional indicating device may be common when connected to more than one ALG.

7.1.4 A remote indication on an indicating device shall be unambiguously identified with respect to the ALG it belongs to.

7.1.5 An ALG shall indicate the innage (dip). Other measured values, as ullage, may be indicated on the same display but these indications shall at least after 10 s be replaced by the innage.
For metrological purposes, an indication of the ullage shall either be permanently available or be available on demand, together with the indication that the ullage is presented and, if applicable, which ALG is presented.

7.1.6 Reading of the results shall be reliable, easy and unambiguous under conditions of normal use.
The figures forming the results shall be of a size, shape and clarity for reading to be easy.
The scales, numbering and printing shall permit the figures which form the results to be read by simple juxtaposition.

7.1.7 The presentation of the measuring results shall contain the names or symbols of the units of length in which they are expressed.
The scale interval of each display or print must be in the form 1×10^n,2×10^n, or 5×10^n units of length, n being a whole positive or negative number, or zero.

7.1.8 A digital indication shall display at least one figure beginning at the extreme right.
A decimal fraction shall be separated from its integer by a decimal sign (in general a comma or in English speaking countries a dot), with the indication showing at least one figure to the left of the sign and all figures to the right.
Zero may be indicated by one zero to the extreme right, without a decimal sign.
The unit shall be chosen so that the displayed or printed values have not more than one non-significant zero to the right. For values with decimal sign, the non-significant zero is allowed only in the third position after the decimal sign.

7.1.9 If an ALG gives more than one indication and/or printout, each indication shall comply with the applicable maximum permissible error of 6.2.1. In addition, the difference between any two of them shall not be greater than 1 mm resp. 1 scale interval* under stable level conditions. * *in case the scale intervals differ: the greater one.*

7.1.10 Sub clauses 7.1.1 through 7.1.9 are applicable to printing devices, as appropriate.

7.2 Technical requirements for ALG's with movable detecting element

7.2.1 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.
Note: An example of a situation where this is applicable, is a dipstick having a movable part (the float) but the gauge does not have the possibility to force a movement

7.2.2 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.

7.3 Installation requirements

7.3.1 General

7.3.1.1 ALG's shall be installed in such a way that the requirements of sub clauses 7.4 through 7.7 are fulfilled.
The indication shall be easily accessible and legible.

7.3.1.2 ALG's must be equipped and installed in such a way that they can be verified when mounted on the tank.

7.3.1.5 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.

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

7.3.1.7 The liquid level detecting element shall be in-stalled 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.

7.3.1.8 The ALG shall be installed on the tank in such a way that the deviation of the gauge reference length plus level due to movement of the tank shell, tank bottom, tank roof or stilling well remains within the MPE.

For construction details refer to applicable standards, which are listed at the end of the document.
Remark: This may imply that influences must be compensated for, using correction devices.

7.3.1.9 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.

7.3.1.10 The thermal expansion of the tank shell or, if applicable, the support pipe, shall be such that the total deviation for temperature changes will fall within the maximum permissible errors for the installed ALG, or if necessary compensated for. (Note: this requirement may be verified by calculation).

7.4 Ancillary devices

Ancillary devices shall not affect the measurement and shall have no characteristics that facilitate fraudulent use

7.5 Markings

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

• name of the manufacturer or trademark;
• serial number and year of manufacture;
• type approval mark;
• any information required in the type approval certificate.

7.5.2 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.

7.6 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.

7.7 Sealing

It shall be possible to seal the data plate mentioned in 7.5.2 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.

Sealing may be carried out with metal, plastic or other suitable material as long as it is sufficiently durable and provides evidence of tampering.
When access to parameters that participate in the determination of results of measurements is not protected by mechanical sealing devices, a electronic sealing can be applied. The software sealing shall fulfil the following provisions:

a) Access shall only be allowed to authorized persons, e.g. by using a "password" and, after changing parameters, the measuring system may be put into use "in sealed condition" again without any restriction,
   or
   Access is allowed without restrictions (similar with the classical sealing) but, after changing parameters, the measuring system shall only be put into use "in sealed condition" again by authorized persons, e.g. by using a "password"
b) The "password" must be changeable.

c) The device shall either clearly indicate when it is in the configuration mode (not under legal metrological control). Or it shall not operate while in this mode. This status shall remain until the measuring system has been put into use "in sealed condition" in accordance with 2.20.2.1.1.
d) For identification, data concerning the latest intervention shall be recorded into an event logger. The record shall include at least:
   - an event counter,
   - the date the parameter was changed,
   - the new value of the parameter, and
   - an identification of the person that implemented the intervention

e) The traceability of the last intervention shall be assured for at least two years, if it is not over-written on the occasion of a further intervention.

If it is possible to store more than one intervention, and if deletion of a previous intervention must occur to permit a new record, the oldest record shall be deleted.

7.8 Safeguarding the integrity of the measurement

7.8.1 General requirements

ALG's shall be designed and manufactured such that their metrological functions are safeguarded and their errors do not exceed the maximum permissible errors under rated operating conditions.
It shall be possible to determine the presence and correct functioning of the checking facilities.
The checking facilities shall be of type I or P.

7.8.2 Prevention or signalling of significant faults

7.8.2.1 ALG's shall be designed and manufactured such that when they are exposed to the following disturbances, either:
(a) Significant faults do not occur, or
(b) Significant faults are detected and acted upon by means of a checking facility:

7.8.2.1.1 during the following disturbances:
a) Radiated, radio-frequency, electromagnetic fields;
b) Conducted radio-frequency fields;
c) Electrostatic discharge;
d) Bursts (transients) on signal, data and control lines;
e) Surges on signal, data and control lines;
f) AC mains voltage dips, short interruptions and voltage variations;
g) Bursts (transients) on AC and DC mains;
h) Voltage dips, short interruptions and voltage variations on DC mains power;
i) Ripple on DC mains power,

7.8.2.1.2 after the following disturbances:
a) Damp heat cyclic (condensing);
b) Surges on AC and DC mains power.

Note: A fault equal to or smaller than the significant fault according to 3.32 is allowed irrespective of the value of the error of indication.

7.8.2.1.3 Application

The provisions in 7.8.2.1 (a) and 7.8.2.1 (b) may be applied separately to:
(a) Each individual cause of significant fault; and/or
(b) Each part of the measuring instrument.
The choice of whether 7.8.2.1 (a) or 7.8.2.1 (b) is applied, is left to the manufacturer.

Note: In case of a disturbance, a fault equal to or smaller than the MPE as specified in Table 1 is allowed irrespective of the value of the error of indication.

7.8.3 The provisions in 7.8.1 and 7.8.2 shall be met durably.
ALG's shall be designed and manufactured such that either:
(a) Significant durability errors do not occur, or
(b) Significant durability errors are detected and acted upon by means of a durability protection facility.

7.8.2.3
The choice of whether 7.8.2.1 (a) or (b) and whether 7.8.3 (a) or (b) is applied, is left to the manufacturer.

7.8.2.4
If a significant fault is detected by a checking facility, a visual and/or audible indication shall automatically occur and shall continue until the user takes action or the fault is corrected.

7.8.2.5
The type of an ALG is presumed to comply with the provisions in 7.8.2.1 and 7.8.2.2 if it passes the relevant examination and tests specified in Part 2 of this Recommendation.
[In a later stage, the word "relevant" is to be replaced by an exact reference to these "relevant" tests in Part 2.]

7.8.3 Signalling the loss or garbling (distortion?, disturbtion?) of data

7.8.3.1
The loss or garbling (distortion?, disturbtion?) of data shall be signalled by one or more checking facilities enabling:
(a) incorrect functioning of a specific device of the ALG and
(b) disturbed communication between specific devices of the ALG
to be detected and acted upon.
If a risk of loss or garbling (distortion?, disturbtion? of data is detected by a checking facility, a visual and/or audible indication shall automatically occur and shall continue until the user takes action or the fault is corrected.

7.8.3.2
The design of the instrument shall prevent that the values of permanently memorized instructions are incorrect [1].
[The secretary suggests to move this footer in a later stage to an informative annex]

7.8.3.3
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.

7.8.3.4 Checking facilities of the calculator

The objective of the checking of the functioning of the calculator is to verify that the values of all permanently memorized instructions and data are correct, and all procedures of internal

1 For example:
• 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);
• multiple storage of data, both in the same code;
• multiple 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.

transfer and storage of data relevant to the measurement result are performed correctly.

The objective of the checking the correct value of all data related to the measurement whenever these data are internally stored or transmitted to an ancillary device through an interface. In addition, the calculation system shall be provided with a means of controlling the continuity of the calculation program (“watch-dog”).

7.8.3.5 Checking facilities of the indicating device

Automatically check the data transmitted to the indicating device and the electronic circuits used for the indicating device, except the driving circuits of the display itself.
The display may be checked either automatically or manually.
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.
If a PC is used as a common indication device, and the communication with the transducer is digital, it is assumed that the device meets the requirements for the checking facilities.

7.8.3.6 Checking facilities of ancillary devices

Devices intended to perform a particular function, involved in elaborating and transmitting measurement results for custody transfer purposes shall be checked on presence and correct operation.

Devices intended to perform a particular function, involved in transmitting or displaying measurement results for custody transfer purposes shall also comply with paragraph 7.8.3.

The object of this checking facility is to verify the presence of the ancillary device, and to verify the correct transmission of data from the calculator to the ancillary device
Note: The use of parity bit alone is not sufficient in case of storing or reading metrological data for an electronic ALG.

PART 2 Metrological controls and tests

[To be completed after there is agreement about the basic principles of Part 1]

8 Metrological controls

8.1 Type evaluation

8.1.1 Number of units submitted to type test

The applicant for the type test shall supply one production sample of the instrument for type testing.
In case the applicant wants to have approved several versions or measuring ranges, the testing laboratory decides which version(s) and range(s) shall be supplied.
Several tests can be carried out in parallel on different specimen. In this case, the testing laboratory decides which version or measuring range will be subjected to a specific test.
If a specimen does not pass a specific test and as a result, it has to be modified or repaired, the applicant shall carry out this modification to all the instruments supplied for test. If the testing laboratory has sound reasons to fear that the modification has negative influence on tests that already had a positive result, these tests shall be repeated.

8.1.2 Documentation

The documentation submitted with the application for type approval shall include:
(a) A list of the electronic sub-assemblies with their essential characteristics;
(b) A description of the electronic devices with drawings, diagrams and general software information explaining their characteristics and operation;
(c) Mechanical drawings;
(d) Installation and security sealing plan;

(f) Operating instructions; and
(g) Test outputs, their use, and their relationships to the parameters being measured.
(h) Documentation or other evidence that supports the assumption that the design and characteristics of the measuring instrument comply with the requirements of this Recommendation.

8.1.3 Equipment under test (EUT)

As a rule, tests will be carried out on the complete automatic level gauge.
Simulation of any part of the automatic level gauge tested should be avoided. If this is not possible, all parts of the automatic level gauge that can be affected by the test must play an active role in the measurements.
If the size or configuration of the automatic level gauge does not lend itself to testing as a whole unit, or if only a separate device (module) of the measuring instrument is concerned, the tests, or certain tests, shall be carried out on the devices (modules) separately, provided that, in case of tests with the devices in operation, these devices are included in a simulated set-up, sufficiently representative of its normal operation.
Note: As a general rule, the dismantling of the automatic level gauge or devices for the tests is not intended.

8.1.4 Reference conditions

Except for the parameter being tested, the following reference conditions shall be kept by the testing laboratory during the tests:

	Influence	**Value**
a)	Temperature	20 °C ± 5 °C
b)	Humidity	65 % RH ± 5 %

d)	DC mains voltage (*)	Les than 10 % of the variation specified by the manufacturer of the EUT
e)	AC mains voltage (*)	U_{nom} ± 1 %
f)	AC mains frequency (*)	f_{nom} ± 0,5 %

8.1.4.1 Tests under reference conditions

8.1.4.1.1 General

The procedures described in this Appendix pertain to the tests to be carried out prior to installation of the ALG on the 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.

8.1.4.1.2 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.

8.1.4.1.3 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 sub clause 3.4.3 according to the accuracy class. The change of the indication is noted.

Level measurement devices with a static level detecting element, based on microwave (radar) technology are exempt of this test.

8.1.4.1.4 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.

Level measurement devices with a static level detecting element, based on microwave (radar) technology are exempt of this test.

8.1.4.1.5 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 7.1

8.1.4.2 Severity levels (see OIML D11)

8.1.4.2.1 General
For each performance test, typical test conditions are indicated: they correspond to the climatic, electrical and mechanical environment conditions to which measuring systems are usually exposed.

However, the applicant for type approval may indicate specific environmental conditions in the documentation supplied to the metrology service, based on the intended use of the instrument. In this case, the metrology service carries out performance tests at severity levels corresponding to these environmental conditions. If type approval is granted, the data plate shall indicate the corresponding limits of use. Manufacturers shall inform potential users of the conditions of use for which the instrument is approved. The metrology service shall verify that the conditions of use are met.

8.1.4.2.2 Severity levels for temperature

The thermal conditions in which measuring systems and ancillary devices are used, vary considerably; they are not only highly dependent of the place on earth, ranging from arctic to tropical regions, but are also considerably dependent on indoors or outdoors applications. Devices being typically used indoors in one country can be typically used outdoors in other countries. Therefore, no classes combining low and high temperature limits have been described in this Recommendation.
In general, the choice of the lower and the upper temperature limits should preferably left to national (or regional) legislation, taking into account the severity levels in 8.1.5.2.1 and 8.1.5.2.2

8.1.4.2.3 Severity levels for humidity

The following table gives a classification for the severity levels for the humidity tests

Class	Severity level Damp heat (cyclic)	Description
H1	-	This class applies to enclosed locations. Humidity is not controlled. Humidification is used to maintain the required conditions, where necessary. Measuring instruments are not subject to condensed water, precipitation, or ice formations. The conditions of this class may be found in continuously manned offices, certain workshops, and other rooms for special applications.
H2	1	This class applies to enclosed locations whose humidity is not controlled. Measuring instruments may be subject to condensed water, water from sources other than rain and to ice formations.

		The conditions of this class may be found in some entrances and staircases of buildings, in garages, cellars, certain workshops, factory buildings and industrial process plants, ordinary storage rooms for frost-resistant products, farm buildings, etc.
H3	2	This class applies to open locations with average climatic conditions, thus excluding polar and desert environments.

8.1.4.2.4 Severity levels for electrical disturbance tests

The following table gives a classification for electrical disturbance tests:

Class	Description
E1	This class applies to instruments used in locations with electromagnetic disturbances corresponding to those likely to be found in residential, commercial and light industrial buildings
E2	This class applies to instruments used in locations with electromagnetic disturbances corresponding to those likely to be found in industrial buildings

The relation between the class and the applicable severity levels is given in the following table.

Severity level for class		*Test*	
E1	E2	Number	*Description*
1	2	8.1.6.1.6	AC mains voltage dips, short interruptions and voltage variations
2	3	8.1.6.1.7	Bursts (transients) on AC and DC mains
3	3	8.1.6.1.3	Electrostatic discharge
2	3	8.1.6.1.4	Bursts (transients) on signal, data and control lines
3	3	8.1.6.1.5	Surges on signal, data and control lines
-	1	8.1.6.1.8	Voltage dips, short interruptions and voltage variations on DC mains power
-	1	8.1.6.1.9	Ripple on DC input power ports
3	3	8.1.6.1.10	Surges on AC and DC mains lines
2	3	8.1.6.1.1	Radiated radio frequency electromagnetic fields of general origin
3	3	-????	Radiated radio frequency electromagnetic fields (digital radio telephones)
2	3	8.1.6.1.2	Conducted disturbances, induced by radio-frequency fields

8.1.5 Influence factor tests

The type of an automatic level gauge is presumed to comply with the provisions specified in 6.1 of Part 1 of this Recommendation if it passes the following test 8.1.5.1 to 8.1.5.5:

8.1.5.1 Maximum permissible error under reference conditions.
Before, during, and after the following tests 8.1.5.2 - 8.1.5.5, the error of the ALG shall not exceed the maximum permissible error on initial verification specified in 6.2 of Part 1 of this Recommendation under the reference conditions in 8.1.4.

8.1.5.2 Static temperatures

8.1.5.2.1 Dry heat
This test is applied to verify compliance with the provisions in 6.1, a) under condition of dry heat (high environmental temperature).

Applied standards	IEC 60068-2-2 (1974-01), with amendments 1 (1993-02) and 2 (1994-05), environmental testing, part 2:Test, test Bd: Dry heat, for heat. IEC 60068-3-1 (1974-01) + Supplement A (1978-01), environmental testing part 3: Background information, section 1: Cold and dry heat tests
Precondition:	16 hours.
Condition of the EUT:	Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Power is to be "on" for the duration of the test.
Stabilization:	2 hours at each temperature under "free air" conditions.
Temperature:	High temperature as specified in clause 6.1, a) of Part 1.
Temperature sequence:	Reference temperature of 20 °C; Specified high temperature; Reference temperature of 20 °C.
Number of test cycles:	At least one cycle.
Test	After stabilization at the relevant temperature, apply at least five different test values
Maximum allowable variations:	All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in clause 6.2 of Part 1

8.1.5.2.2 Cold

This test is applied to verify compliance with the provisions in 6.1, a) under condition of cold (low environmental temperature).

Applied standards	IEC 60068-2-1 (1990-05), with amendments 1 (1993-02) and 2 (1994-06), environmental testing, part 2: Test, test a: Dry heat: cold. IEC 60068-3-1 (1974-01) + Supplement A (1978-01), environmental testing part 3: Background information, section 1: Cold and dry heat tests.
Precondition:	16 hours.
Condition of the EUT:	Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Power is to be "on" for the duration of the test.
Stabilization:	2 hours at each temperature under "free air" conditions.
Temperature:	Low temperature as specified in clause 6.1, a) of Part 1.
Temperature sequence:	Reference temperature of 20 °C; Specified low temperature; Reference temperature of 20 °C.
Number of test cycles:	At least one cycle.
Test:	After stabilization at the relevant temperature, apply at least five different test values, equally spaced in the measuring range
Maximum allowable variations:	All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in clause 6.2 of Part 1

8.1.5.3 Damp heat, cyclic (condensing)

This test is applied to verify compliance with the provisions in 6.1) under condition of condensing damp heat.

Applicable standards	IEC 60068-2-30 (1980-01) with amendment 1 (1985-01) Environmental testing Part 2: Tests, test Db and guidance: Damp heat, cyclic (12+12 hour cycle, Amendment No. 1 replaces the third paragraph of clause 8, Recovery IEC 60068-3-4 (2001-08) Environmental testing- Part 3-4: Supporting documentation and guidance – Damp heat tests		
Test method	Damp heat, cyclic		
Object of the test	To verify compliance with the provisions in 6.1 under conditions of high humidity when combined with cyclic temperature changes Cyclic tests shall be applied in all the cases where condensation is important or when the penetration of vapour will be accelerated by the breathing effect.		
Test procedure in brief	The test consists of exposure to cyclic temperature variation between 25 °C and the appropriate upper temperature, maintaining the relative humidity above 95 % during the temperature change and low temperature phases, and at 93 % at the upper temperature phases. Condensation should occur on the EUT during the temperature rise. The 24 h cycle consists of: 1) temperature rise during 3 h 2) temperature maintained at upper value until 12 h from the start of the cycle 3) temperature lowered to lower value within 3 h to 6 h, the rate of fall during the first hour and a half being such that the lower value would be reached in 3 h 4) temperature maintained at lower value until the 24 h cycle is completed. The stabilizing period before and recovery after the cyclic exposure shall be such that all parts of the EUT are within 3 °C of their final temperature. Special electrical conditions and recovery conditions may be specified.		
Test severities	The following severities may be specified:		
Severity levels	1	2	unit
Upper temperature:	40	55	°C
Duration	2	2	cycles
Maximum allowable variations:	All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in clause 6.2 of Part 1		

8.1.5.4 DC mains voltage variation

This test is only applicable for ALG's powered by DC networks and is applied to verify compliance with the provisions in 6.1, c) under condition of DC mains voltage variation.
In case this test is not applicable, the justification shall be mentioned in the test report.

Applicable standard	IEC 60654-2 (1979-01), with amendment 1 (1992-09) Operating conditions for industrial-process measurement and control equipment. Part 2: Power
Test method	Variation in DC mains power voltage
Test procedure in brief	The test consists of exposure to the specified power supply condition for a period sufficient for establishing stability.
Test severity	The upper limit will be the DC level at which the EUT has been manufactured to automatically detect high-level conditions. The lower limit will be the DC level at which the EUT has been manufactured to automatically detect low-level conditions. The EUT shall comply with the specified maximum permissible errors at voltage levels between the two levels.

8.1.5.5 AC mains voltage variation
This test is only applicable for ALG's powered by public AC networks and is applied to verify compliance with the provisions in 6.1, d) under condition of AC mains voltage variation.
In case this test is not applicable, the justification shall be mentioned in the test report.

Applicable standards	IEC/TR3 61000-2-1 (1990-05) Electromagnetic compatibility (EMC), Part 2: Environment Section 1: Description of the environment – Electromagnetic environment for low-frequency conducted disturbances and signalling in public power supply systems. IEC 61000-4-1 (2000-04) Basic EMC Publication, Electromagnetic compatibility (EMC), Part 4: Testing and measurement techniques, Section 1: Overview of IEC 61000-4 series	
Test method	Variation in AC mains power voltage (single phase)	
Test procedure in brief	The test consists of exposure to the specified power condition for a period sufficient for achieving temperature stability and for performing the required measurements.	
Mains voltage (1), (2)	Upper limit	$\boldsymbol{U_{nom}}$ **+ 10 %**
	Lower limit	$\boldsymbol{U_{nom}}$ **- 15 %**
Notes	(1) In the case of three phase mains power, the voltage variation shall apply for each phase successively. (2) The values of U_{nom} are those marked on the measuring instrument. In case a range is specified, the "-" relates to the lowest value and the "+" to the highest value of the range.	

8.1.6 Disturbances

The type of ALG is presumed to comply with the provisions specified in 6.3, of Part 1 of this Recommendation if it passes the following tests:

8.1.6.1 Electromagnetic susceptibility

8.1.6.1.1Radiated, radio-frequency, electromagnetic fields

Instruments that do not contain any active electronic circuits (transistors, IC's, radio tubes), are presumed to comply with the provisions in 6.3.1, a), without being subjected to this test. This justification shall be mentioned in the test report.

For instruments containing electronics, this test is applied to verify compliance with the provisions in 6.3.1, a) under conditions of radiated electromagnetic fields.

In addition to the information to the test procedures in IEC 61000-4-3 (1995-03 consolidated Edition 2.1 (2002-09) with amendment 1 (2002-08) Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques, Section3: Radiated, radio-frequency, electromagnetic field immunity test.], the following test procedure in brief shall be applied: The instrument shall be subjected to the following frequencies and field strength, the signal being modulated with 1 kHz, 80 % AM sine wave:

Frequency	Field strength	Remarks
26 - 800 MHz	10 V/m	For EUT having no mains or other input port available, the lower limit of the radiation test should be 26 MHz taking into account that the test cannot be applied (refer to Annex H of IEC 61000-4-3 [29]). In all other cases both 8.1.6.1.1 and 8.1.6.1.2 shall apply.
80 - 800 MHz	10 V/m	IEC 61000-4-3 [..] only specifies test levels above 80 MHz. For frequencies in the lower range the test methods for conducted radio frequency disturbances (8.1.6.1.2) are recommended
800 - 960 MHz	10 V/m	
960 - 1400 MHz	10 V/m	
1.4 GHz - 2 GHz	10 V/m	
Maximum allowable variations:	During the disturbance, either: (a) Significant faults do not occur, or (b) Significant faults are detected and acted upon by means of a checking facility:	

8.1.6.1.2 Conducted, radio-frequency, electromagnetic fields

Instruments that do not contain any active electronic circuits (transistors, IC's, radio tubes), are presumed to comply with the provisions in 6.3.1, b), without being subjected to this test. This justification shall be mentioned in the test report.

For instruments containing electronics, this test is applied to verify compliance with the provisions in 6.3.1, b) under conditions of conducted electromagnetic fields.

Applicable standard	IEC 61000-4-6 (2003-05) (1996-04), with correction 1 (1996-10) and Amendment 1 (2000-11). Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques, Section 6: Immunity to conducted disturbances, induced by radio frequency fields.
Test method	Conducted electromagnetic fields
Object of the test	To verify compliance with the provisions in 6.3.1. b under conditions of electromagnetic fields
Test procedure in brief	Radio frequency EM current, simulating the influence of EM fields shall be coupled or injected into the power ports and I/O ports of the EUT using coupling/decoupling devices as defined in the referred standard. The performance of the test equipment consisting of an RF generator, (de-)coupling devices, attenuators, etc. shall be verified.

Test severities	The following severities may be specified:				
Severity levels			3		unit
RF amplitude (50 Ω)			10		V (e.m.f.)
Frequency range [5]	0.15 - 80				MHz
Modulation	80 % AM, 1 kHz sine wave				
Notes	[1] This test is not applicable when the EUT has no mains or other input port. [2] If the EUT is composed of several elements, the tests shall be performed at each extremity of the cable if both of the elements are part of the EUT. [3] For the frequency range 26 ÷ 80 MHz, the testing laboratory can either carry out the test according to 8.1.6.1.1or according to 8.1.6.1.2 But in case of a dispute, the results according to 8.1.6.1.2 shall prevail.				
Maximum allowable variations:	During the disturbance, either: (a) Significant faults do not occur, or (b) Significant faults are detected and acted upon by means of a checking facility:				

8.1.6.1.3 Electrostatic discharge

Instruments that do not contain any active electronic circuits (transistors, IC's, radio tubes), are presumed to comply with the provisions in 6.3.1, c), without being subjected to this test. This justification shall be mentioned in the test report.

For instruments containing electronics, this test is applied to verify compliance with the provisions in 6.3.1, c) under conditions of electrostatic discharges.

Applicable standard	***IEC 61000-4-2 (1995-01) with amendment 1 (1998-01) Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques, Section 2: Electrostatic discharge immunity test.*** Consolidated Edition: IEC 61000-4-2 (2001-04) Ed. 1.2
Test method	Electrostatic discharge (ESD)
Object of the test	To verify compliance with the provisions in 6.3.1 electrostatic discharges
Test procedure in brief	An ESD generator shall be used with a performance as defined in the referred standard. Before starting the tests, the performance of the generator shall be verified. At least 10 discharges shall be applied. The time interval between successive discharges shall be at least 10 seconds. For EUT not equipped with a ground terminal, the EUT shall be fully discharged between discharges. If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measuring time. Contact discharge is the preferred test method. Air discharge shall be used where contact discharge cannot be applied.

		Direct application: In the contact discharge mode to be carried out on conductive surfaces, the electrode shall be in contact with the EUT. In the air discharge mode on insulated surfaces, the electrode is approached to the EUT and the discharge occurs by spark. Indirect application: The discharges are applied in the contact mode to coupling planes mounted in the vicinity of the EUT.	
Test severities		The following severities may be specified:	
Severity levels (1)		3	unit
Test voltage	Contact discharge	6	kV
	Air discharge	8	kV
Notes		Contact discharges shall be applied on conductive surfaces. Air discharges shall be applied on non-conductive surfaces.	
Maximum allowable variations:		During the disturbance, either: (a) Significant faults do not occur, or (b) Significant faults are detected and acted upon by means of a checking facility:	

8.1.6.1.4 Bursts (transients) on signal, data and control lines
Instruments that do not contain any active electronic circuits (transistors, IC's, radio tubes), or not being provided with external signal, data or control lines, are presumed to comply with the provisions in 6.3.1, d), without being subjected to this test. This justification shall be mentioned in the test report.

For instruments containing electronics, this test is applied to verify compliance with the provisions in 6.3.1, d) under conditions of Bursts (transients) on signal, data and control lines.

Applicable standards	IEC 61000-4-1 (2000-04) Basis EMC Publication; Electromagnetic compatibility (EMC); Part 4: Testing and measurement techniques; Section 1: Overview of IEC 61000-4 series. IEC 61000-4-4 (1995-01) with Amendment 1 (2000-11) and Amendment 2 (2001-07); Electromagnetic compatibility (EMC) – Part 4: Testing and Measurement techniques – Section 4: Electrical fast transient/burst immunity test. Basic EMC Publication.
Test method	Electrical bursts
Object of the test	To verify compliance with the provisions in under conditions where electrical bursts are superimposed on I/O and communication ports
Test procedure in brief	A burst generator shall be used with the performance characteristics as specified in the referred standard. The test consist of exposure to bursts of voltage spikes for which the output voltage on 50 Ω and 1000 Ω load are defined in the referred standard. The characteristics of the generator shall be verified before connecting the EUT.

	Both positive and negative polarity of the bursts shall be applied. The duration of the test shall not be less than 1 min for each amplitude and polarity. For the coupling of the bursts into the I/O and communication lines, a capacitive coupling clamp as defined in the standard shall be used.	
Test severities	The following severities may be specified:	
Severity levels	2	unit
Amplitude (peak value)	0.5	kV
Repetition rate	5	kHz
Maximum allowable variations:	During the disturbance, either: (a) Significant faults do not occur, or (b) Significant faults are detected and acted upon by means of a checking facility:	

8.1.6.1.5 Surges on signal, data and control lines
Instruments that do not contain any active electronic circuits (transistors, IC's, radio tubes), or not being provided with external signal, data or control lines, are presumed to comply with the provisions in 6.3.1, e), without being subjected to this test. This justification shall be mentioned in the test report.

For instruments containing electronics, this test is applied to verify compliance with the provisions in 6.3.1, e) under conditions of surges on signal, data and control lines.

Applicable standard		IEC 61000-4-5 (2001-04) consolidated edition (Including Amendment 1 and correction 1); Electromagnetic compatibility (EMC) – Part 4-5: Testing and Measurement techniques – Surge immunity test	
Test method		Electrical surges	
Object of the test		To verify compliance with the provisions in .6.3.1 e under conditions where electrical surges are superimposed on I/O and communication ports	
Test procedure in brief		A surge generator shall be used with the performance characteristics as specified in the referred standard. The test consists of exposure to surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impedance load and minimum time interval between two successive pulses are defined in the referred standard. The characteristics of the generator shall be verified before connecting the EUT. At least 3 positive and 3 negative surges shall be applied. The injection network depends on the lines the surge is coupled into and is defined in the referred standard. If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measuring time.	
Test severities		The following severities may be specified:	
Severity level (Installation class)		3	unit
Unbalanced lines	Line to line	1.0	kV

	Line to earth	2.0 (1)	kV
Balanced lines	Line to line	N.A.	kV
	Line to earth	2.0 (1)	kV
Notes		(1) Normally tested with primary protection	
Maximum allowable variations:		During the disturbance, either: (a) Significant faults do not occur, or (b) Significant faults are detected and acted upon by means of a checking facility:	

8.1.6.1.6 AC mains voltage dips, short interruptions and voltage variations
This test is only applicable for electronic ALG's powered by public AC networks and is applied to verify compliance with the provisions in 6.3.1, f) under conditions of AC mains voltage dips, short interruptions and voltage variations.
In case this test is not applicable, the justification shall be mentioned in the test report.

Applicable standards		IEC 61000-4-11 (1994-06) with amendment 1 (2000-11) Electromagnetic compatibility (EMC) - Part.4-11: Testing and Measuring techniques – Voltage dips, short interruptions and voltage variations immunity tests. Consolidated Edition IEC 61000-4-11 (2001-03) Ed. 1.1. IEC 61000-6-1 (1997-07) Electromagnetic compatibility (EMC) - Part 6: Generic standards - Section 1: Immunity for residential, commercial and light-industrial environments IEC 61000-6-2 (1999-01) Electromagnetic compatibility (EMC) - Part 6-2: Generic standards – Immunity for industrial environments					
Test method		Short-time reductions in mains voltage					
Object of the test		To verify compliance with the provisions in6.3.1, f under conditions of short time mains voltage reductions					
Test procedure in brief		A test generator suitable to reduce for a defined period of time the amplitude of the AC mains voltage is used. The performance of the test generator shall be verified before connecting the EUT. The mains voltage reductions shall be repeated 10 times with an interval of at least 10 seconds. If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measuring time.					
Test severities		The following severities may be specified:					
Severity levels				2(1)	3 (1)		unit
Voltage dips	Test a	Reduction		30	0		%
		Duration		0.5	0.5		cycles
	Test b	Reduction		60	0		%
		Duration		5	1		cycles
	Test c	Reduction		60	40		%
		Duration		50	10/12 (2)		cycles

	Test d	Reduction			70		%
		Duration			25/30 (2)		cycles
	Test e	Reduction			80		%
		Duration			250/300 (2)		cycles
Short interruptions	Reduction			0			%
	Duration			250/300 (2)			cycles
Notes	(1) To be defined by the product committee. For equipment connected directly or indirectly to the public network, the levels must not be less severe than level 2. (2) These values are for 50 Hz / 60 Hz respectively						
Maximum allowable variations:	During the disturbance, either: (a) Significant faults do not occur, or (b) Significant faults are detected and acted upon by means of a checking facility:						

8.1.6.1.7 Bursts (transients) on AC and DC mains

This test is only applicable for electronic ALG's powered by DC or public AC networks and is applied to verify compliance with the provisions in 6.3.1, g) under conditions of Bursts (transients) on AC and DC mains.

In case this test is not applicable, the justification shall be mentioned in the test report.

Applicable standards	IEC 61000-4-1 (2000-04) Basic EMC Publication, Electromagnetic compatibility (EMC), Part 4: Testing and measurement techniques, Section 1: Overview of IEC 61000-4 series IEC 61000-4-4 (1995-01) with Amendment 1 (2000-11) and Amendment 2 (2001-07) Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test. Basic EMC Publication
Test method	Electrical bursts
Object of the test	To verify compliance with the provisions in 6.3.1, g. under conditions where electrical bursts are superimposed on the mains voltage and. If applicable, on input/output and communication ports
Test procedure in brief	A burst generator shall be used with the performance characteristics as specified in the referred standard. The test consist of exposure to bursts of voltage spikes for which the output voltage on 50 Ω and 1000 Ω load are defined in the referred standard. The characteristics of the generator shall be verified before connecting the EUT. At least 10 positive and negative randomly phased bursts shall be applied Both positive and negative polarity of the bursts shall be applied. The duration of the test shall not be less than 1 min for each amplitude and polarity. The injection network on the mains shall contain blocking filters to prevent the burst energy being dissipated in the mains.

Test severities		The following severities may be specified:		
Severity levels		2	3	unit
Amplitude (peak value)	Supply lines	1	2	kV
	Signal lines	0.5	1	kV
Notes		- Tests on supply lines apply only for instruments powered by AC or DC mains power supply - Tests on signal lines apply only for I/O signal, data and control ports with a cable length greater than 3 meters.		
Maximum allowable variations:		During the disturbance, either: (a) Significant faults do not occur, or (b) Significant faults are detected and acted upon by means of a checking facility:		

8.1.6.1.8 Voltage dips, short interruptions and voltage variations on DC mains power
This test is only applicable for ALG's powered by DC networks and is applied to verify compliance with the provisions in 6.3.1, h) under conditions of Voltage dips, short interruptions and voltage variations on DC mains power.
In case this test is not applicable, the justification shall be mentioned in the test report.

Applicable standard		IEC 61000-4-29 (2000-08) Electromagnetic compatibility (EMC) – Part 4-29: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations on DC input power port immunity tests	
Test method		Voltage dips, short interruptions and voltage variations on DC mains power.	
Object of the test		To verify compliance with the provisions in 6.3.1, h under conditions of voltage dips, voltage variations and short interruptions on DC mains power	
Test procedure in brief		A test generator as defined in the referred standard shall be used. Before starting the tests, the performance of the generator shall be verified. The voltage dips and short interruptions shall be tested on the EUT, for each selected combination of test level and duration, with a sequence of tree dips/interruptions with intervals of 10 s minimum between each test event. The EUT shall be tested for each of the specified voltage variations, three times at 10 s intervals in the most representative operating modes. If the EUT is an integrating instrument, the test pulses shall be continuously applied during the measuring time.	
Test severities		The following severities may be specified:	
Voltage dips	Severity level	1	unit
	Test levels	40 and 70	% of the rated voltage
	Duration (1)	0.01; 0.03; 0.1; 0.3; 1	s
Short interrup-tions (4)	Test condition	High impedance and/or low impedance	
	Test levels	0	% of the rated voltage
	Duration (1)	0.001; 0.003; 0.01; 0.03; 0.1; 0.3; 1	s

Voltage variations	Severity levels	1	
	Test level	85 and 120	% of the rated voltage
	Duration (1)	0.1; 0.3; 1; 3; 10; x(2)	s
Notes		(1) One or more of the test levels and durations specified in each table may be given in the product specification (OIML Recommendation). At least the shortest duration in the table should be tested. (2) If the EUT is tested for short interruptions, it is unnecessary to test for other levels of the same duration, unless the immunity of the equipment is detrimentally affected by voltage dips of less than 70% of the rated voltage.	
Maximum allowable variations:		During the disturbance, either: (a) Significant faults do not occur, or (b) Significant faults are detected and acted upon by means of a checking facility:	

8.1.6.1.9 Ripple on DC mains power

This test is only applicable for ALG's powered by DC networks and is applied to verify compliance with the provisions in 6.3, i) under condition of Ripple on DC mains power.
In case this test is not applicable, the justification shall be mentioned in the test report.

Applicable standard	IEC 61000-4-17 [..]
Test method	Ripple on DC input power port.
Object of the test	To verify compliance with the provisions in 6.3, i under conditions of ripple on the low voltage DC mains power. This test does not apply to instruments connected to battery charger systems incorporating switch mode converters.
Test procedure in brief	A test generator as defined in the referred standard shall be used. Before starting the tests, the performance of the generator shall be verified. The test consist subjecting the EUT to ripple voltages such as those generated by rectifier systems and/or auxiliary service battery chargers overlaying on DC power supply sources. The frequency of the ripple is the power frequency or its multiple 2, 3 or 6, as specified in the product specification. The waveform of the ripple, at the output of the test generator, has a sinusoid-linear character. The test shall be applied for at least 10 min or for the period time necessary to allow a complete verification of the EUT's operating performance.
Test severities	The following severities may be specified:
Severity levels	1
Percentage of the nominal DC voltage (3)	2
Note	The test levels are a peak-to-peak voltage expressed as a percentage of the nominal DC voltage.
Maximum allowable variations:	During the disturbance, either: (a) Significant faults do not occur, or (b) Significant faults are detected and acted upon by means of a checking facility:

8.1.6.1.10 Surges on AC and DC mains power lines

This test is only applicable for electronic ALG's powered by DC or public AC networks and is applied to verify compliance with the provisions in 6.3.1 j) under conditions of Surges on AC and DC mains power lines.
In case this test is not applicable, the justification shall be mentioned in the test report.

Applicable standard	IEC 61000-4-5 [..]	
Test method	Electrical surges	
Object of the test	To verify compliance with the provisions in 6.3.1 j under conditions where electrical surges are superimposed on the mains voltage	
Test procedure in brief	A surge generator shall be used with the performance characteristics as specified in the referred standard. The test consists of exposure to surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impedance load and minimum time interval between two successive pulses are defined in the referred standard. The characteristics of the generator shall be verified before connecting the EUT. On AC mains supply lines at least 3 positive and 3 negative surges shall be applied synchronously with AC supply voltage in angles 0°, 90°, 180° and 270°. On DC power lines, at least 3 positive and 3 negative surges shall be applied. The injection network depends on the lines the surge is coupled into and is defined in the referred standard.	
Test severities	The following severities may be specified:	
Severity level (installation class)	3(1)	unit
Line to line	1.0	kV
Line to earth	2.0	kV
Maximum allowable variations:	After the disturbance, either: (a) Significant faults do not occur, or (b) Significant faults are detected and acted upon by means of a checking facility:	

8.2 Initial verification

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

8.2.1 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 type. Tests have to be done on accuracy, discrimination and hysteresis (see 8.1.4.1.2 through 8.1.4.1.4) to verify compliance with the requirements. Tests shall be carried out within the rated operating conditions.

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

• check that the requirements of 7.1, and 7.3 are met;
• check that the conditions of the tank match with the rated operating conditions specified according to 6.1

The actual operating conditions shall be checked. If national regulations allow the use of an ALG under conditions outside the rated operating conditions (see 6.1.1) 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 part 2.

The instrument shall remain within the maximum permissible errors specified for ALG's installed on tanks.

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

8.3 Subsequent verification

8.3.1 Periodic verification with a period of validity of 1 year is recommended.
Subsequent verification is to verify the ALG accuracy at a single level within the normal operating range

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

8.3.3 Subsequent verification shall be carried out according to 8.2.2.
In principal national authorities may require subsequent verification. If subsequent verification is required this verification shall be carried out according 8.2.2. Section 8.3.2. could be maintained. The maximum permissible errors to be applied for subsequent verification shall be in accordance with 6.2.1.
If an ALG is adjusted or "reset" to match manual gauge (dip), the ALG should be verified following the "initial field verification" procedure – if ISO 4266 is followed.

8.4 Metrological supervision

8.4.1 For countries having a system of mandatory subsequent verification
Subsequent verification shall be carried out as specified in 8.3.
Metrological supervision of measuring instrument in use, consists of randomly checking the presence of the right and valid and undamaged verification marks and seals

8.4.2 For countries not having a system of mandatory subsequent verification
Metrological supervision of measuring instrument in use, consists of randomly checking the presence of the right and valid and undamaged verification marks and seals.

PART 3 Test Report Format

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

[To be completed after Part 2 is (almost) ready]

Should be reviewed after revision of this Recommendation

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 Instrument*s, 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 type of an automatic level gauge shall be submitted with a view to its approval.

It is recommended that all metrology services or laboratories evaluating types 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 type

Manufacturer's trade mark/corporate name	
Type	electronic / non-electronic
Liquid level detecting element	static / movable
Model number	
Serial number	
type 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
T.1	Description (4)				
T.2	Field of operation (6.1)				
T.3	Special conditions (6.1.1)				
T.4	Indicating device (7.1)				
T.5	Printers (7.1.9)				
T.6	Ancillary devices (7.4)				
T.7	Markings (7.5)				
T.8	Verification marks (7.6)				
T.9	Sealing (7.7)				
T.10	Checking facilities (7.8.2)				
T.11.1	Accuracy (8.1.4.1.2)				
T.11.2	Discrimination (8.1.4.1.3)				
T.11.3	Hysteresis (8.1.4.1.4)				
T.12	Dry heat (8.1.5.2.1)				
T.13	Cold (8.1.5.2.2)				
T.14	Damp heat, cyclic (condensing) (8.1.5.3)				
T.15	DC mains voltage variation (8.1.5.4)				
T.16	AC main voltage variation (8.1.5.5)				
T.17	Radiated, radio-frequency, electromagnetic fields (8.1.6.1.1)				
T.18	Conducted, radio-frequency, electromagnetic fields (8.1.6.1.2)				
T.19	Electrostatic discharge (8.1.6.1.3)				
T.20	Bursts (transients) on signal, data and control lines (8.1.6.1.4)				
T.21	Surges on signal, data and control lines (8.1.6.1.5)				
T.22	AC mains voltage dips, short interruptions and voltage variations (8.1.6.1.6)				
T.23	Bursts (transients) on AC and DC mains (8.1.6.1.7)				
T.24	Voltage dips, short interruptions and voltage variations on DC mains power (8.1.6.1.8)				

Subclause	Test	+	-	Remarks	Page
T.25	Ripple on DC mains power (8.1.6.1.9)				
T.26	Surges on AC and DC mains power lines (8.1.6.1.10)				
OVERALL RESULT					

Remarks:

T.1 Description (4)

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

T.2 Field of operation (6.1)

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

T.3 Special conditions (6.1.1)

T.4 Indicating device (7.1)

Subclause	Performance tests and requirements of OIML R85	Remarks	+	-
5	Unit of measurement	SI		
7.1.5	Default display of	Dip/ullage		
7.1.7	Symbol or name of unit present			
7.1.6	Display additional information possible? Non confusing?			
7.1.8	Scale interval (mm)	Analogue/digital		
7.1.1	Scale spacing (analogue only) (mm)			

7.1.2	Number of indicating devices			
7.1.3	Common indicating device			
7.1.4	Remote indication duly identified			
7.1.5	Both dip and ullage available			

T.5 Printer (7.1.9, 7.1.10)

Subclause	Performance tests and requirements of OIML R85	Remarks	+	-
5	Unit of measurement	SI		
7.1.5	Default display of	Dip/ullage		
7.1.7	Symbol or name of unit present			
7.1.6	Display additional information possible? Non confusing?			
7.1.2	Number of printers			
7.1.3	Common printer			
7.1.4	Remote printer duly identified			
7.1.5	Both dip and ullage available			

Remarks:

T.6 Ancillary devices (7.4)

Description	Remarks	+	-

T.7 Markings (7.5)

	Marking	+	-
Location of the markings			
Name of the manufacturer			
Serial number			
Type approval sign			
Accuracy class designation			
Ranges defining the field of operation			
Additional information (if required)			

T.8 Verification marks (7.6)

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

T.9 Sealing (7.7)

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

Remarks:

T.10 Checking facilities (7.8.2)

Subclause	Performance tests and requirements of OIML R85	Remarks	+	-
7.8.2.1	Presence of checking facility			
7.8.2.2	Design			
7.8.2.3	Way of checking			
7.8.2.4	Checking facility of the calculator			
7.8.2.5	Checking facility of the indicating device			
7.8.2.6	Checking facility of the ancillary device			

Remarks:

T Performance tests

T.11.1 Accuracy (8.1.4.1.2)

Serial number:	Accuracy class:	Observer:
Temperature ºC	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:

T.11.1 Accuracy (*cont'd)*

Observations in mm: downwards

Level	Indication	Error	Diff.	MPE	+	-

Maximum differences mm

Levels	Diff.	MPE	Levels	Diff.	MPE	+	-

Remarks:

T.11.2 Discrimination (8.1.4.1.3)

Discrimination	Level	Indication	Level change	Indication change	+	-
Upwards						
Downwards						

T.11.3 Hysteresis (8.1.4.1.4)

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:

T.12 Dry heat (8.1.5.2.1)				
Condition	Level [mm]	Error[mm]	MPE [mm]	
Reference value				
Value under test				
Reference value				

T.13 Cold (8.1.5.2.2)				
Condition	Level [mm]	Error[mm]	MPE [mm]	
Reference value				
Value under test				
Reference value				

T.14 Damp heat, cyclic (condensing) (8.1.5.4)				
Condition	Level [mm]	Error[mm]	MPE [mm]	
Reference value				
Value under test				
Reference value				

T.15 DC mains voltage variation (8.1.5.5)				
Condition	Level [mm]	Error[mm]	MPE [mm]	
Reference value				
Value under test				
Reference value				

T.16 AC main voltage variation (8.1.5.6)				
Condition	Level [mm]	Error[mm]	MPE [mm]	
Reference value				
Value under test				
Reference value				

T.17 Radiated, radio-frequency, electromagnetic fields (8.1.6.1.1)				
Condition	Level [mm]	Error[mm]	MPE [mm]	
Reference value				
Value under test				
Reference value				

T.18 Conducted, radio-frequency, electromagnetic fields (8.1.6.1.2)				
Condition	Level [mm]	Error[mm]	MPE [mm]	
Reference value				
Value under test				
Reference value				

T.19 Electrostatic discharge (8.1.6.3)				
Condition	Level [mm]	Error[mm]	MPE [mm]	
Reference value				
Value under test				
Reference value				

T.20 Bursts (transients) on signal, data and control lines (8.1.6.1.4)				
Condition	Level [mm]	Error[mm]	MPE [mm]	
Reference value				
Value under test				
Reference value				

T.21 Surges on signal, data and control lines (8.1.6.1.5)				
Condition	Level [mm]	Error[mm]	MPE [mm]	
Reference value				
Value under test				
Reference value				

T.22 AC mains voltage dips, short interruptions and voltage variations (8.1.6.1.6)				
Condition	Level [mm]	Error[mm]	MPE [mm]	
Reference value				
Value under test				
Reference value				

T.23 Bursts (transients) on AC and DC mains (8.1.6.1.7)				
Condition	Level [mm]	Error[mm]	MPE [mm]	
Reference value				
Value under test				
Reference value				

T.24 Voltage dips, short interruptions and voltage variations on DC mains power (8.1.6.1.8)				
Condition	Level [mm]	Error[mm]	MPE [mm]	
Reference value				
Value under test				
Reference value				

T.25 Ripple on DC mains power (8.1.6.1.9)				
Condition	Level [mm]	Error[mm]	MPE [mm]	
Reference value				
Value under test				
Reference value				

T.26 Surges on AC and DC mains power lines (8.1.6.1.10)				
Condition	Level [mm]	Error[mm]	MPE [mm]	
Reference value				
Value under test				
Reference value				

Annex A Bibliography

[This list should updated after the rest of this recommendation has been adopted]

Ref.	Standards and reference documents
[1]	International vocabulary of basic and general terms in metrology (VIM) (1993)
[2]	International Vocabulary of Terms in Legal Metrology (VIML)
[3]	OIML D 11 (2004) Requirements for electronic measuring instruments
[4]	OIML B 3 (2003) OIML Certificate System for Measuring Instruments (formerly OIML P1)
[5]	IEC 60068-1 (1988-6), Appendix B (including Amendment 1, 1992-4) Environmental testing. Part 1: General and guidance
[6]	IEC 60068-2-1 (1990-05) with amendments 1 (1993-02) and 2 (1994-06) Environmental testing, Part2: Tests, Test A: Cold
etc.	